

2018 Biennial Review of T & E Species of NM, October 5, 2018

**THREATENED AND ENDANGERED SPECIES
OF NEW MEXICO**

2018 BIENNIAL REVIEW

October 5, 2018



**New Mexico Department of Game and Fish
Wildlife Management and Fisheries Management Divisions
2018 Biennial Review and Recommendations**

Authority: Wildlife Conservation Act (17-2-37 through 17-2-46 NMSA 1978)

EXECUTIVE SUMMARY: Species or subspecies of mammals, birds, reptiles, amphibians, fishes, mollusks, and crustaceans native to New Mexico may be listed as threatened or endangered under the Wildlife Conservation Act (WCA). A total of 116 species and subspecies are included on the 2018 list of threatened and endangered New Mexico wildlife, the list comprising 2 crustaceans, 25 mollusks, 22 fishes, 6 amphibians, 15 reptiles, 32 birds, and 14 mammals (Tables 1, 2).

A species is categorized as endangered if it is in jeopardy of extinction or extirpation from the state; a species is considered threatened if it is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in New Mexico. During the Biennial Review open comment period, listed species may be upgraded from threatened to endangered, or downgraded from endangered to threatened on the basis of new data, reviews, and other information regarding the biological and ecological status of the species. Upgrading from threatened to endangered confers no regulatory authority to the New Mexico Department of Game and Fish (NMDGF) over the habitat of these species. However, NMDGF believes that a state-endangered status emphasizes the importance of, and the potential for, state-level management to support the long-term persistence of otherwise imperiled native wildlife. Investigations in support of new listings or removals from the list (delistings) can be undertaken at any time, but require additional statutory procedures that are outside the scope of the Biennial Review process.

The 2018 Biennial Review was opened by the State Game Commission its March 1, 2018 meeting. Department biologists subsequently reviewed and updated each species account. A 90-day public comment period (March 21 – June 18) was announced via legal ads placed in newspapers throughout New Mexico during the last week of April. The draft Review was posted on the Department public website, copies of which were also available upon request by electronic or public mail. No comments were received during the 90-day open period.

A draft of the 2018 Biennial Review was presented to the State Game Commission at its August 23, 2018 meeting, at which time the Department requested that a second, 14-day public comment period be opened from September 3-16, 2018. No comments were received during the 14-day open period. The final draft was submitted for approval by the State Game Commission at its October 5, 2018 meeting.

The 2018 Biennial Review contains information and recommendations regarding the listing status for each of the 116 species or subspecies listed as threatened or endangered under the WCA. No change in listing status is recommended for any species, although two fish species that appeared on previous lists (*Gila intermedia* and *G. nigra*) were removed in 2018 due to a formal taxonomic revision that combined them with *G. robusta*. For each species or subspecies on the state list, we also present a summary of the distribution, current status, and threats (existing, past, or future actions that can create uncertainty of species persistence if they are not carried out in a manner that considers wildlife and habitat needs). For those species that have a state recovery plan, an update on implementation of the plan is provided. Species accounts contain only key references. Databases for individual species are available on the internet at: <http://www.bison-m.org>. The Department's

database on New Mexico wildlife consists of over 6000 taxa, including both listed and non-listed animals.

The NMDGF emphasizes the need for identifying and protecting endangered wildlife in New Mexico. The State of New Mexico has lost, and continues to lose, its wildlife diversity. More than 90 different taxa have been extirpated from one or more counties, including 25 that are believed to be extinct (i.e., no longer exist anywhere), and at least 15 others that have been extirpated from the state (but continue to exist elsewhere).

Table 1. Summary of review and recommendation for 2018 New Mexico threatened and endangered species list.

TAXA and 2018 STATUS	Number of Species or Subspecies and 2018 Recommendations		
	No Change	Reclassify As Endangered	Reclassify As Threatened
INVERTEBRATES			
Endangered	12	--	0
Threatened	15	0	--
FISHES			
Endangered	13	--	0
Threatened	9	0	--
AMPHIBIANS			
Endangered	4	--	0
Threatened	2	0	--
REPTILES			
Endangered	7	--	0
Threatened	8	0	--
BIRDS			
Endangered	12	--	0
Threatened	20	0	--
MAMMALS			
Endangered	6	--	0
Threatened	8	0	--
TOTAL	116	0	0

Table 2. Taxonomic summary of New Mexico threatened and endangered species. Taxa listed as subspecies under the Wildlife Conservation Act are denoted by placing subspecies name in parentheses.

MAMMALS (14 total species)

Endangered (6 species; no change):

Arizona shrew, *Sorex arizonae*
Mexican long-nosed bat, *Leptonycteris nivalis*
(Penasco) least chipmunk, *Tamias minimus atristriatus*
meadow jumping mouse, *Zapus hudsonius*
(Arizona) montane vole, *Microtus montanus arizonensis*
gray wolf, *Canis lupus*

Threatened (8 species; no change):

North American least shrew, *Cryptotis parva*
lesser long-nosed bat, *Leptonycteris yerbabuenae*
spotted bat, *Euderma maculatum*
western yellow bat, *Lasiurus xanthinus*
white-sided jackrabbit, *Lepus callotis*
(Organ mountains) Colorado chipmunk, *Tamias quadrivittatus australis*
southern pocket gopher, *Thomomys umbrinus*
Pacific marten, *Martes caurina*

BIRDS (32 total species)

Endangered (12 species; no change):

brown pelican, *Pelecanus occidentalis*
aplomado falcon, *Falco femoralis*
white-tailed ptarmigan, *Lagopus leucura*
whooping crane, *Grus americana*
least tern, *Sterna antillarum*
common ground-dove, *Columbina passerina*
buff-collared nightjar, *Caprimulgus ridgway*
elegant trogon, *Trogon elegans*
northern beardless-tyrannulet, *Camptostoma imberbe*
(southwestern) willow flycatcher, *Empidonax traillii extimus*
thick-billed kingbird, *Tyrannus crassirostris*
(Arizona) grasshopper sparrow, *Ammodramus savannarum ammolegus*

Threatened (20 species; no change):

neotropic cormorant, *Phalacrocorax brasilianus*
bald eagle, *Haliaeetus leucocephalus*
common black-hawk, *Buteogallus anthracinus*
peregrine falcon, *Falco peregrinus*
(Gould's) wild turkey, *Meleagris gallopavo mexicana*
piping plover, *Charadrius melodus*
whiskered screech-owl, *Megascops trichopsis*
boreal owl, *Aegolius funereus*
broad-billed hummingbird, *Cynanthus latirostris*
white-eared hummingbird, *Hylocharis leucotis*
violet-crowned hummingbird, *Amazilia violiceps*
lucifer hummingbird, *Calothorax lucifer*
Costa's hummingbird, *Calypte costae*
Gila woodpecker, *Melanerpes uropygialis*
Bell's vireo, *Vireo bellii*
gray vireo, *vireo vicinior*

Abert's towhee, *Melospiza aberti*
Baird's sparrow, *Ammodramus bairdii*
yellow-eyed junco, *Junco phaeonotus*
varied bunting, *Passerina versicolor*

REPTILES (15 total species)

Endangered (7 species; no change):

Gila monster, *Heloderma suspectum*
dunes sagebrush lizard, *Sceloporus arenicolus*
gray-checked whiptail *Aspidoscelis dixonii*
gray-banded kingsnake, *Lampropeltis alterna*
Mexican gartersnake, *Thamnophis eques*
plain-bellied water snake, *Nerodia erythrogaster*
(New Mexico) ridgenosed rattlesnake, *Crotalus willardi obscurus*

Threatened (8 species; no change):

western river cooter, *Pseudemys gorzugi*
Slevin's bunch grass lizard, *Sceloporus slevini*
giant spotted whiptail, *Aspidoscelis stictogramma*
mountain skink, *Plestiodon callicephalus*
green ratsnake, *Senticolis triaspis*
narrow-headed gartersnake, *Thamnophis rufipunctatus*
western ribbonsnake, *Thamnophis proximus*
(mottled) rock rattlesnake, *Crotalus lepidus lepidus*

AMPHIBIANS (6 total species)

Endangered (4 species; no change):

Jemez mountains salamander, *Plethodon neomexicanus*
lowland leopard frog, *Lithobates yavapaiensis*
boreal toad, *Anaxyrus boreas*
Western narrow-mouthed toad, *Gastrophyrne olivacea*

Threatened (2 species; no change):

Sacramento mountains salamander, *Aneides hardii*
Sonoran desert toad, *Incilius alvarius*

FISHES (22 total species)

Endangered (13 species; 2 fewer species than in 2016 due to taxonomic revision):

Gila chub, ~~*Gila intermedia*~~ (revised to *G. robusta*)
headwater chub, ~~*Gila nigra*~~ (revised to *G. robusta*)
Chihuahua chub, *Gila nigrescens*
roundtail chub, *Gila robusta*
Rio Grande silvery minnow, *Hybognathus amarus*
spikedace *Meda fulgia*
Arkansas River shiner, *Notropis girardi*
(Pecos) bluntnose shiner, *Notropis simus pecosensis*
southern redbelly dace, *Phoxinus erythrogaster*
Colorado pikeminnow, *Ptychocheilus lucius*
loach minnow, *Tiaroga cobitis*
(Zuni) bluehead sucker, *Catostomus discobolus yarrowi*
blue sucker, *Cycleptus elongatus*
gray redbhorse, *Moxostoma congestum*
Pecos gambusia, *Gambusia nobilis*

Threatened (9 species; no change):

Gila trout, *Oncorhynchus gilae*
Mexican tetra, *Astyanax mexicanus*
peppered chub, *Macrhybopsis tetranema*
suckermouth minnow, *Phenacobius mirabilis*
Pecos pupfish, *Cyprinodon pecosensis*
White Sands pupfish, *Cyprinodon Tularosa*
Gila topminnow, *Poeciliopsis occidentalis*
greenthroat darter, *Etheostoma lepidum*
bigscale logperch, *Percina macrolepida*
(**Listing exceptions:** Arkansas River shiner- excludes the population in the Pecos river drainage; bigscale logperch- excludes the population in the Canadian river drainage.)

CRUSTACEANS (2 total species)

Endangered (2 species; no change):

Socorro isopod, *Thermosphaeroma thermophilum*
Noel's amphipod, *Gammarus desperatus*

MOLLUSKS (25 total species)

Endangered (10 species; no change):

paper pondshell, *Utterbackia imbecillis*
Texas hornshell, *Popenaias popeii*
Koster's springsnail, *Juturnia kosteri*
Alamosa springsnail, *Pseudotryonia alamosae*
Chupadera springsnail, *Pyrgulopsis chupaderae*
Socorro springsnail, *Pyrgulopsis neomexicana*
Roswell springsnail, *Pyrgulopsis roswellensis*
Pecos assimineia, *Assimineia pecos*,
wrinkled marshsnail, *Stagnicola caperata*
Florida mountainsnail, *Oreohelix florida*

Threatened (15 species; no change):

lake fingernailclam, *Musculium lacustre*
swamp fingernailclam, *Musculium partumeium*
long fingernailclam, *Musculium transversum*
Lilljeborg's peaclam, *Pisidium lilljeborgi*
Sangre de Cristo peaclam, *Pisidium sanguinichristi*
Gila springsnail, *Pyrgulopsis gilae*
Pecos springsnail, *Pyrgulopsis pecosensis*
New Mexico springsnail, *Pyrgulopsis thermalis*
star gyro, *Gyraulus crista*
shortneck snaggletooth, *Gastrocopta dalliana dalliana*
ovate vertigo, *Vertigo ovata*
Hacheta Grande woodlandsnail, *Ashmunella hebardi*
Cooke's peak woodlandsnail, *Ashmunella macromphala*
Mineral creek mountainsnail, *Oreohelix pilsbryi*
Doña Ana talussnail, *Sonorella todseni*

TAXONOMIC AUTHORITIES

INVERTEBRATES

- Hershler, R. H. and F. C. Thompson. 1987. North American Hydrobiidae (Gastropoda: Rissoacea): redescription and systematic relationships of *Tryonia* Stimpson, 1865 and *Pyrgulopsis* Call and Pilsbry, 1896. *The Nautilus* 101(1):25-32.
- Hershler, R. H. 2001. Systematics of the North and Central American genus *Tryonia* (Rissoidea: Hydrobiidae). Smithsonian Institution Press, Washington, D. C. Smithsonian Contributions to Zoology, No. 612. 53 pp.
- Hershler, R. H., H. Liu, and C. A. Stockwell. 2002. A new genus and species of aquatic gastropods (Rissoidea: Hydrobiidae) from the North American Southwest: phylogenetic relationships and biogeography. *Proceedings of the Biological Society of Washington* 115(1):171-188.
- Mackie, G. L. 2007. Biology of Freshwater Corbiculid and Sphaeriid Clams of North America. Ohio Biological Survey, Columbus, OH. 436 pp.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico. *New Mexico Museum of Natural History and Science, Bulletin* 10. 145 pp.
- Taylor, D. W. 1987. Fresh-water molluscs from New Mexico and vicinity. *New Mexico Bureau of Mines & Mineral Resources, Bulletin* 116.
- Turgeon, D. D., J. F. Quinn, A. E. Bogan, E.V. Coan, F. C. Hochberg, W. G. Lyons, P. M. Mikkelsen, R. J. Neves, C. F. E. Roper, G. Rosenberg, B. Roth, A. Scheltema, F. G. Thompson, M. Vecchione, and J. D. Williams. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks. 2nd edition. American Fisheries Society Special Publication 26.

FISHES

- Nelson, J. S., J. Crossman, H. Espinosa-Perez, L. T. Findley, C. R. Gilbert, R. N. Lea, and J. D. Williams. 2004. Common and scientific names of fishes from the United States, Canada, and Mexico. American Fisheries Society Special Publication 29. Bethesda, Maryland.

Exception:

Tiaroga cobitis from: Minckley, W. L. 1973. *Fishes of Arizona*. Arizona Game and Fish Department, Phoenix, Arizona.

AMPHIBIANS AND REPTILES

- Crother, B. I., J. Boundy, J. A. Campbell, K. DeQuieroz, D. Frost, D.M. Green, R. Highton, J. B. Iverson, R.W. McDiarmid, P.A. Meylan, T.W. Reeder, M.E. Seidel, J.W. Sites Jr., S.G. Tilley, and D.B. Wake. 2012. Scientific and standard English names of amphibians and reptiles of North America north of Mexico: Update. *Herpetol. Rev.* 34(3):196-203.

BIRDS

American Ornithologists' Union. 1998. Check-list of North American Birds, 7th edition. American Ornithologists' Union, Washington, D.C. 829 p.

Chesser, R. Terry, Richard C. Banks, F. Keith Barker, Carla Cicero, JonDunn, Andrew W. Kratter, Irby J. Lovette, Pamela C. Rasmussen, J. V. Remsen, James D. Rising, Douglas F. Stotz, and Kevin Winker. 2010. Fifty-first supplement to the American Ornithologists' Union check-list of North American birds. *The Auk* 127(3):726–744.

MAMMALS

Bradley, R.D., L.E. Ammerman, R.J. Baker, L.C. Bradley, J.A. Cook, R.C. Dowler, C. Jones, D.J. Schmidly, F.B. Stangl, Jr., R.A. Van Den Bussche, and B. Würsig. 2014. Revised checklist of North American mammals north of Mexico, 2014. *Occasional Papers of the Museum of Texas Tech University* (327):1-27.

Wilson, D. E. and D. M. Reeder. 2005. *Mammal Species of the World: A Taxonomic and Geographic Reference*, 3rd edition. Johns Hopkins University Press, Baltimore, 2 vols., xxxviii +2142 pp.

SPECIES ACCOUNTS

VERTEBRATES

MAMMALS

ENDANGERED

Arizona shrew, *Sorex arizonae*

Distribution: Arizona shrew is known from the Huachuca, Santa Rita, and Chiricahua Mountains of southeastern Arizona (Diersing and Hoffmeister, 1977; Hoffmeister, 1986), and portions of Chihuahua, Mexico (Caire et al., 1978). In New Mexico, it is known only from the Animas Mountains (Conway and Schmitt, 1978; Cook, 1986) where it has been verified at four sites (Simons and Maldonado, 2007). In the Animas Mountains, Arizona shrew occupies mesic woodlands dominated by Douglas fir (*Pseudotsuga menziesii*), quaking aspen (*Populus tremuloides*), and netleaf oak (*Quercus reticulata*), often near springs. In Arizona, it is associated with silver-leaf oak (*Q. hypoleucoides*), Arizona white oak (*Q. arizonica*), Arizona madrone (*Arbutus arizonica*), Chihuahua pine (*Pinus leiophylla* var. *chihuahuana*), and Arizona sycamore (*Platanus wrightii*) (Simons and Van Pelt, 1999). The known elevation range is from approximately 5170 to 8500 ft. Mature forest with ground cover, including live understory vegetation and woody debris, are important habitat features for this species (Simons and Van Pelt, 1999; Simons and Hoffmeister, 2003).

This is a terrestrial shrew that does not hibernate and forages for invertebrates in and under forest litter during alternating periods of activity during the day and night. The reproductive biology of this species is largely unknown; breeding occurs at least from late July through October (Simons and Hoffmeister, 2003).

Current Status: The New Mexico State Game Commission approved the listing of Arizona shrew as endangered in 1978 (Jones and Schmitt, 1997). Limited information on New Mexico populations has suggested that the Arizona shrew is a very rare and extremely localized species, although Maldonado et al. (2015:411) stated that the species “remains well distributed and relatively abundant within its restricted and fragmented range in Arizona and New Mexico, particularly in many riparian zones and upland areas, including some ridgelines and mountaintop saddles with sufficient moisture, vegetation, and soil development to provide cover and a food base.” Surveys in 2001 documented the presence of Arizona shrew at two new locations in the Animas Mountains (Simons and Maldonado, 2007). The species appears to be reasonably abundant at several sites in southern Arizona (Simons and Van Pelt, 1999). Maldonado et al. (2015) examined genetic differentiation among populations in the Animas Mountains and in Arizona (Chiricahua, Huachuca, and Santa Rita mountains) and found that a unique mitochondrial DNA haplotype is present in the Animas Mountains population.

Threats: The apparent rarity, extremely limited distribution, and small population size in New Mexico make this species highly vulnerable to any adverse habitat alterations. Destruction of mature riparian forest communities and associated understory vegetation and woody debris, such as by wildfire, is the primary threat to the Arizona shrew in New Mexico. The Adobe Fire in the Animas Mountains during May-June 2006 burned through at least one known location for this species. Surveys are needed to assess the impact of this fire on habitat for Arizona shrew.

Recommendations: No change in the listing status of Arizona shrew is recommended. Periodic surveys (approximately once every 5 years) of distribution and population status in the Animas Mountains are warranted but depend on landowner permitting for access. A field study of the impact of the Adobe Fire on at least one known population should be initiated. Other possibly suitable habitats in the Peloncillo Mountains should be surveyed for presence. Assessment of the relationships between New Mexico and other populations (Ortega et al., 2005) should be continued.

Literature Cited:

- Caire, W. J., E. Vaughan, and V. E. Diersing. 1978. First record of *Sorex arizonae* (Insectivora: Soricidae) from Mexico. *Southwestern Naturalist* 23:532-533.
- Conway, M. C. and C. G. Schmitt. 1978. Record of the Arizona shrew *Sorex arizonae* from New Mexico. *Journal of Mammalogy* 59:631.
- 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.
- Diersing, V. and D. F. Hoffmeister. 1977. Revision of the shrews *Sorex merriami* and a description of a new species of the subgenus *Sorex*. *Journal of Mammalogy* 58:321-333.
- Hoffmeister, D. F. 1986. *Mammals of Arizona*. The University of Arizona Press and Arizona Game and Fish Department. 602 pp.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. *Life Among the Muses: Papers in Honor of James S. Findley*. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Maldonado, J.E., S. Young, L.H. Simons, S. Stone, L.D. Parker, and J. Ortega. 2015. Conservation genetics and phylogeny of the Arizona shrew in the “Sky Islands” of the southwestern United States. *Therya* 6:401-420.
- Ortega, J., S. Young, L. H. Simons, and E. Maldonado. 2005. Characterization of six microsatellite DNA loci for *Sorex arizonae*. *Molecular Ecology Notes* 5:851-853.
- Simons, L. H. and D. F. Hoffmeister. 2003. *Sorex arizonae*. *Mammalian Species* 732:1-3.
- Simons, L. H. and J. E. Maldonado. 2007. Genetics of Arizona shrew (*Sorex arizonae*). Final report to Arizona Game and Fish Dept., Heritage Grants-in-Aid Project No. 199023.
- Simons, L. H. and W. E. Van Pelt. 1999. Occurrence of *Sorex arizonae* and other shrews (Insectivora) in southern Arizona. *Southwestern Naturalist* 44:334-342.

Mexican long-nosed bat, *Leptonycteris nivalis*

Distribution: Mexican long-nosed bats are known to occur at higher elevations (1550 to 9300 ft) in at least 15 states in Mexico (Arita and Humphrey, 1988). In the United States, the species is only found in southwest Texas (Borell and Bryant, 1942; Easterla, 1972; Mollhagen, 1973) and southwestern New Mexico (Arita and Humphrey, 1988; Hensley and Wilkins, 1988; Hoyt et al., 1994). Two bats collected in 1963 and 1967 in Hidalgo County, New Mexico and identified as lesser long-nosed bats (*L. yerbabuena*) were later identified as *L. nivalis* (Arita and Humphrey, 1988), and the presence of this species in southern Hidalgo County was re-confirmed in 1992 (Hoyt et al., 1994) and during 2003-2005 (Bogan et al., 2006a-b, 2017). Lewis (2001) reported a specimen from the Gila Lower Box in northern Hidalgo Co., although the specimen was not retained and potentially could have been the similar *L. yerbabuena*. Primary areas of occurrence in New Mexico are the Animas, Peloncillo, and Big Hatchet mountain ranges and the valleys between these ranges (Bogan et al., 2006a-b, 2017). The species apparently uses many of the same areas and resources (e.g., roost sites and food sources) in New Mexico as the similar lesser long-nosed bat, a state threatened species.

Mexican long-nosed bats inhabiting southwest New Mexico represent summer migrants from Mexico (Hoyt et al., 1994), and they are present only from mid-July to mid-September (Bogan et al., 2006a-b, 2017). In New Mexico, Mexican long-nosed bats inhabit upper desert scrub and pine-oak woodlands in or near mountainous areas. Characteristic vegetation in these areas includes agave (*Agave* spp.), juniper (*Juniperus* spp.), oak (*Quercus* spp.), and Mexican piñon (*Pinus cembroides*). Roosting habitats of this species in New Mexico have been recently studied, and all known day roosts are in caves and rock fissures, and an abandoned building near the Animas Mountains is used as a night roost between feeding forays (Bogan et al., 2006a-b, 2017; Cryan, 2007; Goodbar, 2007). They roost in caves, mines, hollow trees, and man-made structures in other portions of their range (Hall and Dalquest, 1963; Novick, 1963; Hensley and Wilkins, 1988).

Information on the reproductive biology of this species is very limited. Easterla (1973) speculated that young are born in Mexico before their arrival to Big Bend National Park, Texas during summer. Mexican long-nosed bats are active at night, when they leave day roost sites to search for night-blooming food plants, principally agaves and various cacti (Hall and Dalquest, 1963; Easterla, 1972; 1973; Gardner, 1977; Hensley and Wilkins, 1988). These bats primarily feed upon nectar and pollen, but may also eat some soft fruits and insects associated with flowering plants. Individuals forage long distances, often across valleys separating mountain ranges, between their day roosts and areas where food plants are available.

Current Status: The Mexican long-nosed bat was listed as endangered by the U. S. Fish and Wildlife Service in 1988, and a federal recovery plan has been prepared (USFWS, 1994). As of 2018, a 5-year review of the federal recovery plan by the USFWS has been initiated (USFWS, 2018). The New Mexico State Game Commission approved listing the species as endangered under the Wildlife Conservation Act in 1990; it was also listed during 1975-1978, apparently based on the species nomenclature in use at the time for long-nosed bats (Jones and Schmitt, 1997). In 2016, a binational multi-agency team (collectively called the Nivalis Conservation Network) was formed to identify conservation needs of this species in the United States and Mexico, with the goal of developing a conservation action plan and a revised federal recovery plan. Population sizes, migratory habits and distribution in New Mexico are not fully understood, in part because various passive monitoring techniques such as audio detection and exit counts at day roosts cannot distinguish between this species and the similar lesser long-nosed bat which occurs in the same area. Hoyt et al. (1994) conservatively estimated that they netted 150 to 200 individuals of *Leptonycteris* in the proportion of two lesser long-nosed bats for every one Mexican long-nosed bat in the Animas Mountains. A study by Bogan et al. (2006a-b; 2017) identified night roost sites in the Animas, Peloncillo, and Big Hatched mountains; numbers of long-nosed bats (both species) at these roosts ranged from 4 to a few thousand individuals and varied during the summer.

Threats: The species was federally listed as a result of identified population declines and the lack of formal protection for the species' habitat, particularly food plants such as agave. Disturbance of roost sites, including maternal colonies, has also been identified as a threat to this species in both the United States and Mexico.

Recommendations: No change in the current listing status of Mexican long-nosed bat is recommended. Identification and protection of roost sites and maintenance of viable populations of food plants (particularly agave) are necessary to conserve this species in New Mexico. Studies of both long-nosed bat species have been conducted in southern Hidalgo County (e.g., Bogan et al., 2006a-b, 2017; Cryan, 2007; Goodbar, 2007) and have provided a more thorough understanding of this bat's population status, movements, and habitat use in New Mexico. Pending completion of the 5-year review of this species by the U.S. Fish and Wildlife Service, the NMDGF should have a primary role in any revision of the existing federal recovery plan with a goal of adopting the revised document for use as a state recovery plan.

Literature Cited:

- Arita, H. T. and S. R. Humphrey. 1988. Revisión taxonómica de los murciélagos magueyeros del género *Leptonycteris* (Chiroptera: Phyllostomidae). *Acta Zoologica Mexicana* (n.s.), 29:1-60.
- Bogan, M. A., P. M. Cryan, C. D. Weise, and A. England. 2006a. Roosts and movements of bats of the genus *Leptonycteris* in southwestern New Mexico. Presentation at the 39th Joint Annual Meeting of the Arizona and New Mexico Chapters of The Wildlife Society, Flagstaff, AZ, 2-4 February 2006 (abstract).
- Bogan, M. A., P. M. Cryan, and C. D. Weise. 2006b. Roosts and nocturnal movements of long-nosed bats (*Leptonycteris curasoae* and *L. nivalis*) in southwestern New Mexico. Report to Las Cruces Office, Bureau of Land Management.
- Bogan, M.A., P.M. Cryan, C.D. Weise, and E.W. Valdez. 2017. Landscape movements by two species of migratory nectar-feeding bats (*Leptonycteris*) in a northern area of seasonal sympatry. *Western North American Naturalist* 77:317-330.
- Borell, A. E. and M. D. Bryant. 1942. Mammals of the Big Bend area of Texas. *Univ. California Publ. Zool.* 48:1-62.
- Cryan, P. M. 2007. Emergence counts of endangered long-nosed bats (*Leptonycteris curasoae* and *L. nivalis*) at major roosts in southwestern New Mexico. Report to Las Cruces District Office, Bureau of Land Management.
- Easterla, D. A. 1972. Status of *Leptonycteris nivalis* (Phyllostomatidae) in Big Bend National Park, Texas. *Southwestern Naturalist* 17:287-292.
- Easterla, D. A. 1973. Ecology of the 18 species of Chiroptera at Big Bend National Park, Texas. *Northwest Missouri State University Studies.* 43:1-16
- Gardner, A. L. 1977. Food habits. Pp. 293-350, *in* Biology of bats of the New World family Phyllostomatidae, part II. R. J. Baker, J. K. Jones, Jr., and D. C. Carter, eds. *Special Publications of the Museum, Texas Tech University, Lubbock*, 13:1-364.
- Goodbar, J. 2007. Summary report: Lepto Splat Cave, Hidalgo County, New Mexico – Bureau of Land Management, Las Cruces District. Report to U.S. Department of Interior, Bureau of Land Management.

- Hall, E. R. and W. W. Dalquest. 1963. The mammals of Veracruz. University of Kansas Publications, Museum of Natural History. 14:165-362.
- Hensley, A. P. and K. T. Wilkins. 1988. *Leptonycteris nivalis*. Mammalian Species 307:1-4.
- Hoyt, R. A., J. S. Altenbach, and D. J. Hafner. 1994. Observations on long-nosed bats (*Leptonycteris*) in New Mexico. Southwestern Naturalist 39:175-179.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Lewis, L. 2001. Eighty mile range extension for *Leptonycteris nivalis*. Bat Research News 42(1):17.
- Mollhagen, T. 1973. Distributional and taxonomic notes on some west Texas bats. Southwestern Naturalist 17:427-430.
- Novick, A. 1963. Orientation in Neotropical bats. II. Phyllostomidae and Desmondontidae. Journal of Mammalogy 44:44-63.
- U. S. Fish and Wildlife Service (USFWS). 1994. Mexican long-nosed bat (*Leptonycteris nivalis*) recovery plan. U. S. Fish and Wildlife Service, Albuquerque, NM. 91 pp.
- U.S. Fish and Wildlife Service (USFWS). 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 38 species in the Southwest region (Arizona, New Mexico, Oklahoma, and Texas). Federal Register 83(105):25034-25038 (May 31).

(Peñasco) least chipmunk, *Tamias minimus atristriatus*

Distribution: The least chipmunk (*Tamias minimus*) occurs from central Yukon to western Quebec, south to California and New Mexico, and northeast to Wisconsin (Hall, 1981). In New Mexico, least chipmunks inhabit the northern mountain ranges (Chuska, San Juan, Jemez, Sangre de Cristo, and Sandia). In addition, disjunct and isolated populations assigned to the subspecies *T. minimus atristriatus* (Peñasco least chipmunk) occur in portions of the Sacramento and White mountains in southcentral New Mexico, including James Canyon, Peñasco Canyon, and Sierra Blanca Peak (Findley et al., 1975; Sullivan and Petersen, 1988; Frey et al. 2009).

Historically, Peñasco least chipmunks in the Sacramento and White mountains occupied two distinctly different habitats. Habitat in James and Peñasco canyons was characterized by mesic meadows and herbaceous riparian communities adjacent to agricultural fields, ponderosa pine (*Pinus ponderosa*) forest, and juniper (*Juniperus monosperma*) woodlands. In contrast, habitat at Sierra Blanca is more typical for least chipmunks from other localities, and includes high elevation talus slopes and glacial cirques surrounded by Engelmann spruce (*Picea engelmanni*), quaking aspen (*Populus tremuloides*), corkbark fir (*Abies lasiocarpa*), and Douglas fir (*Pseudotsuga menziesii*) (Conley, 1970; Sullivan, 1985; Sullivan and Petersen, 1988; Frey and Boykin, 2007). This chipmunk was recently detected at Lookout Mountain, north of Sierra Blanca Peak, on grassy/shrubby slopes, at about 11,000 ft elevation (Frey, 2016; Frey and Hays, 2017).

Foods of the Peñasco least chipmunk include a variety of nuts, seeds, and fruits such as those from sunflowers (*Helianthus* spp.), gooseberry (*Ribes* spp.), wild strawberry (*Fragaria ovalis*), piñon (*Pinus edulis*), and Gambel's oak (*Quercus gambelii*), as well as a variety of flowers, leaves, and insects (Bailey, 1932). Young are born mid-summer, and juveniles have been observed in early September (Bailey, 1932).

Current Status: The subspecies was approved for listing as threatened by the New Mexico State Game Commission in 1983 (Jones and Schmitt, 1997) and subsequently uplisted to endangered. This chipmunk has not been confirmed in James Canyon or Peñasco Canyon since the 1960s (Conley, 1970) despite intensive capture efforts in 1981-1982 (Yates, 1982). Given habitat changes in these areas, it is likely that the James Canyon and Peñasco Canyon populations have been extirpated. The species' status on the Mescalero Apache Indian Reservation is unknown (Frey and Boykin, 2007). The remaining known populations of Peñasco least chipmunk are restricted to high elevation talus slopes and the Sierra Blanca area (White Mountains). A survey conducted on Sierra Blanca in 1981-1982 estimated a population of only 15-20 individuals. A reported specimen of least chipmunk captured in Sixteen Springs Canyon in 1996 was subsequently identified as a gray-footed chipmunk (*Tamias canipes*), a very similar species. Surveys by Hope and Frey (2000) found Peñasco least chipmunks in high elevation talus slopes in the White Mountains and verified its presence on Buck Peak as reported by Ortiz (1999) and Ortiz et al. (1998). Preliminary results of surveys during 2016 indicate this chipmunk occurs at at least two sites on Lookout Mountain,

north of Sierra Blanca Peak, on the Lincoln National Forest, Lincoln Co.; the capture of three individuals during June 2016 provides the first evidence since 2000 of the persistence of this subspecies (Frey, 2016; Frey and Hays, 2017). Studies of the population in the White Mountains are currently ongoing to better define the status, natural history, and habitat requirements of this subspecies in its limited range (Frey and Hays, 2017; Frey and McKibben, 2018).

In 2011, the U.S. Fish and Wildlife Service (USFWS) was petitioned to list the Peñasco least chipmunk under the U.S. Endangered Species Act (WildEarth Guardians, 2011). The USFWS designated the subspecies as a Candidate for listing the following year and indicated that threats to this animal are of high magnitude but not imminent (USFWS, 2012). As of 2018, a species status assessment for the Peñasco least chipmunk is being developed by USFWS.

Threats: Historic habitat of Peñasco least chipmunk in James and Peñasco canyons has been significantly altered by grazing and agricultural activities. These areas appear to no longer support populations of Peñasco least chipmunk. Known populations are restricted to small patches of high elevation talus habitat and montane meadows adjacent to forest, and the species is sensitive to any natural or human-induced changes to these habitats. Long-term drought and wildfire pose threats to forested habitat where this subspecies may persist. Additionally, the species is possibly threatened by competition from the closely related gray-footed chipmunk, which appears to have replaced Peñasco least chipmunk in several areas of former occurrence (Frey and Boykin 2007; Frey, 2010). It is unknown if this replacement is due to direct competition, habitat changes that have favored one species over the other (such as increased density of mixed-conifer forest), or a combination of both.

Recommendations: No change in the current listing status of Peñasco least chipmunk is recommended. Protection of known habitats in the Sacramento and White mountains (including the Sierra Blanca Peak vicinity) and additional survey work to better define current distribution, population size, and habitat requirements are needed. Studies are currently underway to address questions about the subspecies' status and habitat needs (Frey and McKibben, 2018). Forest management actions that encourage the development of open ponderosa pine stands interspersed with areas of shrubs, forbs, and bunchgrasses to provide food sources would benefit this species (Frey and Boykin, 2007). Actions to benefit this chipmunk should be carried out as a cooperative effort among several resource management agencies, including Lincoln National Forest, Mescalero Apache Indian Reservation, NMDGF, and USFWS (Sullivan and Nagorsen, 1998; Frey and Boykin, 2007). The close similarity in appearance between this species and the gray-footed chipmunk, which occurs in the same area, can complicate identification in the field and must be taken into consideration when conducting survey efforts (Frey, 2010). Although the genus *Tamias* has been applied for all chipmunk species in New Mexico to conform with recent taxonomic information (Thorington and Hoffmann, 2005; Bradley et al. 2014), a more recent study by Patterson and Norris (2016) proposes the use of *Neotamias* for all western North American species. We retain *Tamias* for the time being, pending evaluation of this taxonomic change.

Literature Cited:

- Bailey, V. 1932. Mammals of New Mexico. North American Fauna 53:1-412.
- Bradley, R.D., L.E. Ammerman, R.J. Baker, L.C. Bradley, J.A. Cook, R.C. Dowler, C. Jones, D.J. Schmidly, F.B. Stangl, R.A. Van Den Bussche, and B. Würsig. 2014. Revised checklist of North American mammals north of Mexico. Occasional Papers of the Museum of Texas Tech University (327):1-27.
- Conley, W. H. 1970. Geographic variation in the least chipmunk, *Eutamias minimus* in New Mexico and eastern Arizona. Journal of Mammalogy 51:695-702.
- Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM. xxii + 360 pp.
- Frey, J. K. 2010. Identification of chipmunks from the Sacramento Mountains in the Academy of Natural Sciences of Philadelphia: are they the endangered Peñasco least chipmunk (*Tamias minimus atristriatus*)? Final report to Share With Wildlife Program, New Mexico Dept. Game and Fish, Santa Fe. 22 pp.
- Frey, J.K. 2016. Survey for the Peñasco least chipmunk (*Tamias minimus atristriatus*). Interim report to Share With Wildlife Prog., New Mexico Dept. Game & Fish, Santa Fe.
- Frey, J. K. and K. Boykin. 2007. Status assessment of the Peñasco least chipmunk (*Tamias minimus atristriatus*). Final report to New Mexico Dept. Game and Fish, Conserv. Serv. Div., contract 07-2231, 72 pp.
- Frey, J. K., R. D. Fisher, and S. C. Peurach. 2009. Capture locations of two endangered rodents during a 1902 exploration of the Sacramento Mountains, New Mexico. West. North Amer. Nat. 69(2):267-271.

- Frey, J.K. and Q.R. Hays. 2017. Surveys for the Penasco least chipmunk (*Tamias minimus atristriatus*) 2016. Unpublished final report to New Mexico Department of Game and Fish, Share With Wildlife Program, Santa Fe and Lincoln National Forest, Alamogordo, NM. 47 pp.
- Frey, J.K. and F. McKibben. 2018. Distribution, abundance, and habitat selection by the Penasco least chipmunk (*Neotamias minimus atristriatus*), 2018. Interim report to New Mexico Dept. Game and Fish, Share With Wildlife Program, Santa Fe. 35 pp.
- Hall, E. R. 1981. The Mammals of North America. John Wiley & Sons, New York, NY, 2nd ed., 1:xv + 1-600 + 90.
- Hope, A. G. and J. K. Frey. 2000. Survey for the Peñasco least chipmunk (*Tamias minimus atristriatus*) in the Lincoln National Forest with notes on rodent community assemblages. Final report to Lincoln National Forest, Alamogordo, NM.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Ortiz, B., D. Ortiz, and B. Perez. 1998. 1998 survey of the Peñasco least chipmunk (*Tamias minimus atristriatus*) in the northern Sacramento Mountains, New Mexico. Unpublished report on file at Lincoln National Forest, Alamogordo, NM.
- Ortiz, D.M. 1999. The determination of the existence and predominant habitat of the Penasco Least Chipmunk (*Tamias minimus atristriatus*) in the Sacramento Mountain region of New Mexico throughout June and July of 1998. Research investigation presented as a requirement for attaining the degree of Baccalaureate of Science with specialization in Environmental Science. Univ. of Puerto Rico, Rio Piedras Campus, Environmental Science Prog. 29 pp.
- Patterson, B.D. and R.W. Norris. 2016. Towards a uniform nomenclature for ground squirrels: the status of Holarctic chipmunks. *Mammalia* 80:241-251.
- Sullivan, R. M. 1985. Phyletic, biogeographic, and ecologic relationships among montane populations of least chipmunks *Eutamias minimus* in the Southwest. *Systematic Zoology* 34:419-448.
- Sullivan, R. M. and D. W. Nagorsen. 1998. *Tamias minimus* Bachman 1839: least chipmunk. Pp. 54-55 in Status survey and conservation action plan: North American Rodents (D.J. Hafner, E. Yensen, and G.L. Kirkland, Jr., compilers and editors). IUCN, Gland, Switzerland.
- Sullivan, R. M. and K. E. Petersen. 1988. Systematics of southwestern populations of least chipmunks *Tamias minimus* reexamined: a synthetic approach. *Occasional Papers, Museum of Southwestern Biology* 5:1-27.
- Thorington, R.W., Jr., and R.S. Hoffmann. 2005. Family Sciuridae. Pp. 754-818 in D.E. Wilson and D.M. Reeder (eds.), *Mammal Species of the World: A Taxonomic and Geographic Reference*, 3rd ed. Johns Hopkins Univ. Press, Baltimore. 2 vols., xxxviii+2142 pp.
- U.S. Fish and Wildlife Service (USFWS). 2012. Endangered and threatened wildlife and plants; review of native species that are candidates for listing as endangered or threatened ; annual notice of findings on resubmitted petitions; annual description of progress on listing actions. *Fed. Reg.* 77(225):69994-70060. (Nov 21).
- WildEarth Guardians. 2011. Petition to list the Penasco least chipmunk (*Tamias minimus atristriatus*) under the U.S. Endangered Species Act. Submitted to U.S. Secretary of Interior from WildEarth Guardians, Denver, CO. 17 pp.
- Yates, T. L. 1982. Status of the Peñasco chipmunk. Preliminary report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 519-71-01. 3 pp.

Meadow jumping mouse, *Zapus hudsonius*

Distribution: The meadow jumping mouse (*Zapus hudsonius*) occurs from Alaska, southward through British Columbia to the southwest United States, and southeastward to Georgia (Hafner et al., 1981; Hall, 1981). The subspecies *Z. h. luteus* (New Mexico meadow jumping mouse) is endemic to New Mexico, southern Colorado, and Arizona (Hafner et al., 1981). Hafner et al. (1981) reported this subspecies at 14 localities in New Mexico in the San Juan, Sangre de Cristo, Jemez, and Sacramento Mountains, and in the Rio Grande Valley between Española and Bosque del Apache National Wildlife Refuge. Morrison (1992) subsequently verified the presence of meadow jumping mouse in most New Mexico localities reported by Hafner et al. (1981), and located new populations in the Jemez Mountains (8 localities in the upper Guadalupe River drainage), the Rio Grande Valley (2 new localities near Española and Isleta), the Rio Chama (1 new locality), and in the Sacramento Mountains (13 different sites along tributaries of the Rio Peñasco). One historic locality in the Sangre de Cristo Mountains was not reconfirmed in 2006;

however, the species was found at two new sites at Sugarite Canyon State Park and on Coyote Creek (J. K. Frey, personal communication, 2006). A closely-related species, the western jumping mouse (*Zapus princeps*), also occurs in the Sangre de Cristo range; the two species have been confused by previous researchers and can be difficult to tell apart (Frey, 2005a, 2008). The species was recently discovered in the Blue River drainage in western Catron Co., which represents an eastward extension of the known range in eastern Arizona (NMDGF, unpubl. data).

In the Sacramento Mountains, soil moisture, vegetative cover characteristics and composition, and proximity of permanent water were similar to other meadow jumping mouse habitat in New Mexico (Morrison, 1990). Typical plant species associated with meadow jumping mouse habitat include spikerush (*Eleocharis macrostachya*), sedges (*Carex* spp.), rushes (*Juncus* spp.), and numerous species of grasses (e.g., *Agrostis*, *Poa*, *Agropyron*, and *Bromus*), forbs, and willows.

The extremely short activity season of this rodent is limited to June–October in montane areas and May–October in the Rio Grande Valley. At Bosque del Apache National Wildlife Refuge, juveniles have been confirmed to be active into late October, although adults enter hibernation a month earlier (Wright and Frey, 2011). Surveys must therefore be conducted during mid to late summer, otherwise the species is not likely to be detected during small mammal trapping efforts. The diet is comprised primarily of grass seeds, with fungi, plants, and invertebrates also consumed. Due to the short activity season, only a single litter is produced each year.

Current Status: The meadow jumping mouse was listed as threatened under the New Mexico Wildlife Conservation Act by the New Mexico Game Commission in 1983 (Jones and Schmitt, 1997) and was uplisted to endangered in 2006. In 2007, the U.S. Fish and Wildlife Service (USFWS) designated the New Mexico meadow jumping mouse (*Z. h. luteus*, which includes all New Mexico populations) a Candidate for federal listing under the U.S. Endangered Species Act (ESA). In 2008, NMDGF developed a joint recovery plan for both the meadow jumping mouse and Arizona montane vole, but the plan was not approved by the State Game Commission. In 2013, the USFWS proposed the New Mexico meadow jumping mouse be listed as Endangered under the ESA throughout its range in New Mexico, Colorado, and Arizona (USFWS, 2013a) and that critical habitat be designated where populations are known or likely to be still extant (USFWS, 2013b). A species status assessment report (USFWS, 2014a) was prepared concurrently which summarized the available information on this subspecies. The New Mexico meadow jumping mouse was listed as federal Endangered in 2014 and critical habitat was designated in portions of New Mexico, Colorado, and Arizona in 2016 (USFWS, 2014b, 2016). A 5-year review of the federal listing status of the New Mexico meadow jumping mouse was initiated in 2018 (USFWS, 2018).

Recent life history studies of this species have been conducted on the small population at Bosque del Apache National Wildlife Refuge (Frey, 2015; Wright and Frey, 2014, 2015) which is the only location in the Rio Grande Valley where the species has been recently detected. Zwank et al. (1997) captured meadow jumping mice in all habitats that they surveyed at Bosque del Apache. Other extant populations in the Rio Grande and Rio Chama valleys were surveyed in the late 1980s (Morrison, 1992) and the species was found at four of seven historical localities. These localities appear to represent relicts of a formerly more extensive range in this river valley. Recent surveys at Bosque del Apache indicate that the species persists, but only along canals that support moist-soil conditions and herbaceous riparian vegetation; water manipulation and canal maintenance at the refuge can either enhance or degrade microhabitat, depending on timing and location (Frey, 2012a; Wright, 2012). The species is currently less abundant and more restricted in its distribution at Bosque del Apache than it was in the early 1990s (Wright, 2012), but a small population is still present as of 2018 as determined via the use of camera trap surveys (M. Goyette, pers. comm., 2018). Surveys conducted in 2012 at a historic locality on NMDGF-managed land at Casa Colorada, Valencia Co., failed to detect it although a small area of suitable habitat is still present (Frey, 2012b). Its current status elsewhere in the Rio Grande and Chama River valleys, where suitable habitat has been largely eliminated, is not known (Frey, 2012a).

Surveys for this species were conducted in the Jemez and Sacramento mountains during 2005 (Frey, 2005b; Frey and Malaney, 2009) and the results indicated a significant decline in presence and suitable habitat for these montane populations than was reported by Morrison (1992) based on her surveys in the late 1980s. Frey (2005b) found that the species and its habitat were found at only 2 of 12 historic sites in the Jemez Mountains and 2 of 11 historic sites in the Sacramento Mountains. Frey (2005b) found that herbaceous vegetation, particularly sedges, with a vertical height of at least 24 inches was a significant predictor of meadow jumping mouse presence at survey sites in the Sacramento and Jemez Mountains. In all cases where meadow jumping mice were found, livestock were currently

being excluded (Frey, 2005b). Drought conditions and loss of dense herbaceous vegetation and moist soil conditions along streams due to excessive grazing pressure were identified as the primary reasons for the significant loss of habitat in these two ranges. Subsequently, surveys in 2006 in the Sangre de Cristo Mountains found this species at 2 of 3 historic localities, and persisting at two other previously unknown locations within that range (J. K. Frey, pers. comm., 2006). The species was absent at the only known historic site in the San Juan Mountains. Studies of distribution and natural history in the Jemez Mountains by Northern Arizona University are currently ongoing (C. Chambers, pers comm).

Despite the presence of this species in eastern Arizona (Frey, 2011), the meadow jumping mouse was never detected in western and southwestern New Mexico (e.g., in the Mogollon Mountains and Black Range) and was thought to have been extirpated from this region. However, the species was detected in the Blue River drainage system just east of the Arizona-New Mexico state line in 2018, which represents its first documentation in southwestern New Mexico (NMDGF, unpubl. data). Holocene fossils are available from the Plains of San Agustin, indicating the species once had a more widespread distribution in New Mexico (Malaney et al. 2012).

Many of the montane sites where the species persists are very small, only a few acres in size, and are widely separated from other occupied sites. The presence of beaver dams and/or human-made impoundments and the exclusion of livestock from riparian areas have been identified as the most important factors for the presence of suitable habitat for this species in montane parts of its range.

Malaney et al. (2017) proposed a taxonomic revision of the *Zapus hudsonius* species complex and assigned all populations currently recognized as *Zapus hudsonius luteus* to the taxon *Zapus luteus luteus*. This taxonomic revision has not yet been fully evaluated by the mammalogical community.

Threats: As a result of the species' reliance on mesic and densely-grassed habitats in proximity to water, primary threats to the meadow jumping mouse in New Mexico include habitat degradation due to development, conversion of mesic areas to agricultural crop production, excessive grazing pressure from livestock, removal of beavers and their dams, down-cutting of streams, wildfire, drought, and water diversions. The drastic reduction in herbaceous vegetation along streams in many areas of historic occurrence due to drought and excessive grazing poses the most immediate threat to this species. Major wildfires during 2011 (the Track Fire near Raton and the Wallow Fire in eastern Arizona) impacted riparian areas known to be occupied by this species; habitat surveys of these burned areas in 2013 indicated persistence but also loss of habitat due to post-fire runoff. The highly fragmented nature of its distribution in the U.S. Southwest states is also a major contributor to the vulnerability of this species in New Mexico and increases the likelihood of very small, isolated populations being extirpated. Even if suitable habitat exists (or is restored) in some locations, the likelihood of recolonization from other populations without reintroduction efforts is extremely limited.

Recommendations: No change in the current listing status of the meadow jumping mouse is recommended. We have not followed the taxonomic revision proposed by Malaney et al. (2017) pending further evaluation by the mammalogical community, although the recognition of Southwestern populations as specifically distinct from *Z. hudsonius* is likely warranted. The NMDGF should continue to work with the U.S. Fish and Wildlife Service to address research and conservation needs for populations of this species in New Mexico, and should be a participant in the development of a federal recovery plan for the subspecies. During development of the joint state recovery plan for meadow jumping mouse and Arizona montane vole (which has not been approved by the Commission), all known information on the biology and habitat requirements of *Zapus hudsonius* was compiled and reviewed. Additional information on the status and ecology of this species in New Mexico was compiled by Frey (2012a, 2016) and by USWFS (2014a). Based on available information, NMDGF determined that immediate efforts to protect and, where appropriate, enhance herbaceous moist-soil habitat for this species in montane areas of its range should be implemented, through construction of new habitat enclosures or improvement of existing enclosures to create a series of refugial habitat areas, particularly in the Sacramento and Jemez mountains. Longer-term habitat improvement efforts that are needed to maintain this species in montane areas include: 1) implementation of grazing management practices that enhance and maintain herbaceous riparian wetlands with required habitat components, including adequate vertical cover as provided by sedges, grasses, and forbs; 2) restoration of suitable habitat in montane riparian areas where the species has been extirpated, such as by willow planting, check-dam construction, and erosion protection features; and 3) re-establishment of beaver in montane streams where channel downcutting and loss of riparian and wet meadow vegetation has occurred. NMDGF, in coordination with USFWS and land

management agencies, should implement a regular monitoring program of all known populations and locations where habitat restoration has been achieved, possibly once per every 2-3 years, and should continue surveys to document other potential extant populations, such as in the Rio Grande and Chama River valleys and in southwestern New Mexico. A draft survey protocol for the New Mexico meadow jumping mouse has been developed to assist resource managers in assessing the presence or likelihood of presence of this species on lands where habitat-disturbing activities are proposed (Frey, 2013). Additional research on specimens of *Zapus* historically collected in New Mexico is also needed, especially collections from the Sangre de Cristo Mountains, given the extreme similarity between this species and the closely-related western jumping mouse found in northern New Mexico (Frey, 2005a).

Literature Cited:

- Frey, J. K. 2005a. Key to the squirrels, pocket gophers, New World rats and mice, voles, and jumping mice of New Mexico. Final report to Share with Wildlife Program, New Mexico Dept. Game and Fish, Santa Fe, NM, contract 05-516.18. 75 pp.
- Frey, J. K. 2005b. Status assessment of montane populations of the New Mexico jumping mouse (*Zapus hudsonius luteus*) in New Mexico. Final report to New Mexico Dept. Game and Fish, Santa Fe, NM, contract 05-516.57. 74 pp. + appendices.
- Frey, J. K. 2008. Morphology and genetics of the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). Final rep. to New Mexico Dept. Game and Fish, Santa Fe. 77 pp.
- Frey, J.K. 2011. Inventory of the meadow jumping mouse in Arizona. Final rep., Arizona Game & Fish Department, Heritage Fund Grant I09004. 114 pp.
- Frey, J.K. 2012a. Synopsis of the status and ecology of the meadow jumping mouse (*Zapus hudsonius luteus*): an imperiled species in the Southwest (Abstract). Presentation at the Joint Annual Meeting of the Arizona and New Mexico Chapters of The Wildlife Society, Phoenix, AZ, February 2012.
- Frey, J.K. 2012b. Survey for the meadow jumping mouse (*Zapus hudsonius luteus*) at Casa Colorada Wildlife Area, Valencia County, New Mexico. Report to New Mexico Dept. Game and Fish, Share With Wildlife Prog., Santa Fe.
- Frey, J.K. 2013. Draft survey protocol for the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). Report to New Mexico Dept. Game and Fish, Santa Fe.
- Frey, J.K. 2015. Variation in phenology of hibernation and reproduction in the endangered New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). PeerJ 3:e1138; DOI 10.7717/peerj.1138
<https://peerj.com/articles/1138/>
- Frey, J.K. 2016. Bibliography: New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). Updated 1 March 2016. Unpublished technical report, New Mexico State University, Las Cruces.
- Frey, J. K. and J. L. Malaney. 2009. Decline of the meadow jumping mouse (*Zapus hudsonius luteus*) in two mountain ranges in New Mexico. *Southwestern Naturalist* 54:31-44.
- Hafner, D. J., K. E. Petersen, and T. L. Yates. 1981. Evolutionary relationships of jumping mice (genus *Zapus*) of the southwestern United States. *Journal of Mammalogy* 62:501-512.
- Hall, E. R. 1981. *The Mammals of North America*. John Wiley & Sons, New York, NY, 2nd ed., 2: vi + 601-1181 + 90.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. *Life Among the Muses: Papers in Honor of James S. Findley*. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Malaney, J.L., J.R. Demboski, and J.A. Cook. 2017. Integrative species delimitation of the widespread North American jumping mice (Zapodidae). *Molecular Phylogenetics and Evolution* 114:137-152.
- Malaney, J.L. J.K. Frey, and J.A. Cook. 2012. The biogeographic legacy of an imperiled taxon provides a foundation for assessing lineage diversification, demography and conservation genetics. *Diversity and Distribution* 18:689-703.
- Morrison, J. L. 1990. The meadow jumping mouse in New Mexico: habitat preferences and management recommendations. Pp. 136-141, *In Proceedings of the symposium on managing wildlife in the Southwest*. P. R. Krausman and N. S. Smith, eds. Arizona Chapter, The Wildlife Society, Phoenix, AZ.
- Morrison, J. L. 1992. Persistence of the meadow jumping mouse, *Zapus hudsonius luteus*, in New Mexico. *Southwestern Naturalist* 37:308-311.
- U.S. Fish and Wildlife Service (USFWS). 2013a. Endangered and threatened wildlife and plants; listing determination for the New Mexico Meadow Jumping Mouse. Fed. Reg. 78(119):37363-37369 (Jun 20).

- U.S. Fish and Wildlife Service (USFWS). 2013b. Endangered and threatened wildlife and plants; proposed designation of critical habitat for the New Mexico Meadow Jumping Mouse. Fed. Reg. 78(119):37328-37363 (Jun 20).
- U.S. Fish and Wildlife Service (USFWS). 2014a. Species Status Assessment Report: New Mexico Meadow Jumping Mouse (*Zapus hudsonius luteus*). Listing Review Team, USFWS, Albuquerque, NM. 149 pp.
- U.S. Fish & Wildlife Service (USFWS). 2014b. Endangered and threatened wildlife and plants; determination of endangered status for the New Mexico meadow jumping mouse throughout its range. Fed. Reg. 79(111):33119-33137 (Jun 10).
- U.S. Fish and Wildlife Service (USFWS). 2016. Endangered and threatened wildlife and plants; designation of critical habitat for the New Mexico meadow jumping mouse. Fed. Reg. 81(51):14264-14325 (Mar 16).
- U.S. Fish and Wildlife Service (USFWS). 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 38 species in the Southwest region (Arizona, New Mexico, Oklahoma, and Texas). Federal Register 83(105):25034-25038 (May 31).
- Wright, G.D. 2012. Multiple scale habitat selection by a small mammal habitat specialist (*Zapus hudsonius luteus*) in a managed floodplain landscape. M. Sci. thesis, New Mexico State Univ., Las Cruces. 109 pp.
- Wright, G.D. and J.K. Frey. 2011. Cool season activity of the meadow jumping mouse in the middle Rio Grande, 2010. Final Rep. to Share With Wildlife Prog., New Mexico Dept. Game & Fish, Santa Fe. 18 pp.
- Wright, G.D., and J.K. Frey. 2014. Herbeal feeding behavior of the New Mexico meadow jumping mouse (*Zapus hudsonius luteus*). Western North American Naturalist 74:231-235.
- Wright, G.D., and J.K. Frey. 2015. Habitat selection by the endangered New Mexico meadow jumping mouse on an irrigated floodplain. Journal of Fish and Wildlife Management 6:112-129.
- Zwank, P. J., S. R. Najera, and M. Cardenas. 1997. Life history and habitat affinities of meadow jumping mice (*Zapus hudsonius*) in the middle Rio Grande Valley of New Mexico. Southwestern Naturalist 42:318-322.

(Arizona) montane vole, *Microtus montanus arizonensis*

Distribution: The montane vole (*Microtus montanus*) occurs from British Columbia south to east-central California, Arizona, and New Mexico (Hall, 1981; Sera and Early, 2003). The Arizona subspecies, *Microtus montanus arizonensis*, is restricted to the White Mountains of eastern Arizona (Hoffmeister, 1986; Frey, 2011) and adjacent portions of the Gila National Forest in New Mexico and is the southernmost and most geographically isolated of montane vole subspecies (Hubbard et al., 1983; Frey et al., 1995; Frey, 2005). In New Mexico, Arizona montane voles are known only from Catron County where they have been documented at Centerfire Bog, Jenkins Creek, Flanagan Spring, Romero Creek, SA Creek, and the upper San Francisco River (Hubbard et al., 1983; Frey et al., 1995; Frey, 2005, 2010). The subspecies has been suspected of also occurring along the Tularosa River, although recently-examined vole specimens from this tributary of the San Francisco are not Arizona montane vole (Frey, 2010). Using specimens collected in the White Mountains of Arizona, Frey (2009) provided evidence derived from allozyme and mtDNA data that supported continued recognition of *M. m. arizonensis* as a subspecies distinct from other allopatric populations of montane vole in the southwestern U.S.

Arizona montane vole habitat in New Mexico consists of mesic sedge and grass meadows bordering small creeks and marshes at elevations around 6800 ft. Sedge and grass cover used by this vole is typically 9 or more inches in height (Frey, 2005). The sympatric Mexican vole (*M. mexicanus*) also occurs in these areas, but generally prefers drier habitats. Arizona montane voles construct distinct runways and build houses among grasses and matted sedges. Their diet consists primarily of grasses and sedges.

Current Status: The New Mexico State Game Commission approved listing the Arizona montane vole as endangered in 1979 (Jones and Schmitt, 1997). In 2008, NMDGF developed a joint recovery plan for both this species and meadow jumping mouse, although the plan was not approved. Current information suggests that the New Mexico populations are small and isolated; however vole populations are known to fluctuate dramatically in response to habitat changes (Findley et al., 1975). Surveys conducted along Jenkins Creek by the Department in 1998 and 2000 reconfirmed the presence of this species in this locality. Surveys in 2004 found Arizona montane vole still persists at the Jenkins Creek locality and documented four new localities on the Gila National Forest, all within the San Francisco River drainage system (Frey, 2005).

Threats: The combination of small, isolated populations and limited habitat increase the vulnerability of the Arizona montane vole to any adverse habitat alterations due to natural climatic changes and human activities such as livestock grazing, water diversion, and wetland conversion. Catastrophic wildfires due to extreme drought also pose a major threat to habitat. Although much of the known habitat occurs on the Gila National Forest, other historic sites that may persist are on private land.

Recommendations: No change in the current listing status of Arizona montane vole is recommended at this time. During development of the joint recovery plan for Arizona montane vole and meadow jumping mouse (not approved by the New Mexico State Game Commission), all available information on this vole was compiled. This information indicates that efforts should be made to protect sensitive mesic meadow habitat on both public and private lands in the areas of known occurrence and other high-elevation riparian areas in the San Francisco River watershed of west-central New Mexico. Maintenance of habitat enclosures and addition of new enclosures to protect areas of occurrence from overgrazing would benefit this vole. Cooperative projects between NMDGF and the U.S. Forest Service to enhance stream and riparian habitat and restore cienegas on the Gila National Forest would benefit this subspecies. Funding and implementation for such projects is needed to improve the habitat and population status for this vole.

Literature Cited:

- Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM. xxii + 360 pp.
- Frey, J. K. 2005. Status assessment of the Arizona montane vole (*Microtus montanus arizonensis*) in New Mexico. Final report to New Mexico Dept. Game and Fish, Santa Fe, NM, contract 04-516.75. 39 pp. + appendices.
- Frey, J.K. 2009. Genetics of allopatric populations of the montane vole (*Microtus montanus*) and Mogollon vole (*Microtus mogollonensis*) in the American Southwest. West. North Amer. Nat. 69:215-222.
- Frey, J.K. 2010. Identification of voles from Aragon, Catron County, New Mexico: are they the endangered Arizona montane vole (*Microtus montanus arizonensis*)? Final report to Share With Wildlife Program, New Mexico Dept. of Game and Fish, Santa Fe. 20 pp.
- Frey, J.K. 2011. Inventory of the meadow jumping mouse in Arizona. Final rep., Arizona Game & Fish Department, Heritage Fund Grant IO9004. 114 pp.
- Frey, J. K., J. H. Fraga, and F. C. Bermudez. 1995. A new locality of the montane vole (*Microtus montanus arizonensis*) in New Mexico. Southwestern Naturalist 40:421-422.
- Hall, E. R. 1981. The mammals of North America. John Wiley & Sons, New York, NY, 2nd ed., 2: vi + 601-1181 + 90.
- Hoffmeister, D. F. 1986. Mammals of Arizona. University of Arizona Press and Arizona Game and Fish Department. 602 pp.
- Hubbard, J. P., C. S. Thaeler, Jr., and C. G. Schmitt. 1983. Notes on voles (*Microtus*, Family Cricetidae) in New Mexico. Nemouria, Occas. Papers, Delaware Museum Natural History 28:1-8.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Sera, W. E. and C. N. Early. 2003. *Microtus montanus*. Mammalian Species 716:1-10.

Gray wolf, *Canis lupus*

Distribution: The historic distribution of the gray wolf included much of North America extending from northern tundra regions southward to Durango, Mexico (Hall, 1981). In the north-central portion of the United States, gray wolves occur in Michigan, Wisconsin, and Minnesota, while in the Northern Rocky Mountain region, gray wolves are presently found in Wyoming, Idaho, Montana, Oregon, Washington, and northern California.. Past research on the taxonomy of gray wolves by Young and Goldman (1944) and Hall (1981) revealed 24 subspecies of gray wolf in North America, five of which occurred in the Southwest and Mexico: *C. l. baileyi*, *C. l. mogollonensis*, *C. l. monstrabilis*, *C. l. nubilus*, and *C. l. youngi*. Taxonomic revisions of Southwestern wolves by Bogan and Mehlhop (1983) lumped *C. l. mogollonensis* and *C. l. monstrabilis* into *C. l. baileyi*. More recently, Nowak (1995) proposed reducing the original 24 subspecies of North American gray wolves into five, of which the Mexican wolf (*C. l. baileyi*) is one. Taxonomic classifications by Young and Goldman (1944), Hall (1981), Bogan and Mehlhop (1983),

and Nowak (1995) were based on comparisons of morphological characteristics, relying heavily on skull measurements. They concluded that *C. l. baileyi* is a morphologically distinct subspecies of the gray wolf. More recently, molecular genetic (DNA) analyses have identified distinct genetic attributes in Mexican wolves (García-Moreno et al., 1996; Hedrick, 1995; Wayne, et al., 1992). Chambers et al. (2012) re-evaluated the current taxonomy of wolves in North America based on morphology and genetics but continued to recognize the Mexican wolf as a distinct entity.

The U. S. Fish and Wildlife Service concluded that a realistic delineation of the original range of the Mexican wolf should include the restricted range of *C. l. baileyi* as described by Young and Goldman (1944), Hall (1981), and Nowak (1995); much of the expanded range resulted from consolidation of subspecies by Bogan and Mehlhop (1983) and expansion of *C. l. baileyi* into ranges of exterminated subspecies of wolves described by Nowak (1995). This estimated range is consistent with the dispersal capability of gray wolves (Fritts, 1983). The range of the Mexican wolf for purposes of reintroduction includes portions of central and north Mexico, southern New Mexico, and central and southwest Arizona (Parsons, 1996) and formerly included west Texas. Information on territory size of Mexican wolves does not exist; however, territories of wolves in other regions of North America range from 25 to over 5,000 square miles (Mech, 1970; Fuller et al, 1992).

The natural history of the Mexican wolf is based largely on anecdotal observations of northern wolf populations. Mexican wolves were virtually eliminated before in-depth studies of their biology could be undertaken. Most Mexican wolves were taken in pine-oak woodlands, pinyon-juniper woodlands, and grasslands interspersed between these areas, generally above 4500 ft. (Brown, 1983). The combination of prey availability, cover, and water found in montane woodlands appear to have been preferred by Mexican wolves. Diets of Mexican wolves were poorly documented; however, they probably preyed on larger mammals such as mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), elk (*Cervus canadensis*), collared peccaries (*Pecari tajacu*), beavers (*Castor canadensis*), cottontails (*Sylvilagus* spp.), and jackrabbits (*Lepus* spp.) (Bailey, 1932; Leopold, 1959; Parsons, 1996). For Mexican wolves released in Arizona since 1998, approximately 80% of wild prey has been identified as elk with lesser numbers of mule deer, white-tailed deer, and domestic livestock also confirmed as wolf kills (USFWS, unpublished data). Wolves generally capture their prey by chasing, often in groups pursuing prey for long distances. Family groups (packs) form the basic social unit of wolves that typically consist of a breeding pair and yearling offspring (Mech, 1970).

Control activities aimed at elimination of wolves undoubtedly affected the structure of these social animals (Parsons, 1996). Precise data on pack sizes and social structure were not documented before these animals were extirpated. Most information gathered on wild Mexican wolves comes from trappers, who generally targeted lone animals. Most information on the productivity of wild Mexican wolves has been obtained by persons engaged in digging in wolf dens to kill the young (Brown, 1983). A sample of eight dens from Mexico had litter sizes of 4 to 8 pups (McBride, 1980). A sample of 86 litters of captive Mexican wolves ranged from one to nine, with a mean of 4.6 (Siminski, 1996). Captive females come into estrous between mid-February and mid-March, gestation periods average 63 days, and parturition occurs in April and May (Parsons, 1996).

Current Status: The gray wolf within the southwestern United States and Mexico is federally-listed as endangered by the U. S. Fish and Wildlife Service (USFWS) under the U.S. Endangered Species Act. However, based in part on recent changes in the understanding of wolf taxonomy (Chambers et al., 2012), the USFWS (2013) recently listed the Mexican wolf (*C. l. baileyi*) as an endangered subspecies, This action did not change the status of wolves that occur in New Mexico as all known wolves in the Southwestern U.S. are of the subspecies *C. l. baileyi*.

The New Mexico State Game Commission approved a state listing of the wolf (*Canis lupus*) as endangered in 1975 (Jones and Schmitt, 1997). In 1978, McBride (1980) estimated that fewer than 50 wolves existed in the Mexican States of Chihuahua and Durango. Subsequent surveys in Mexico failed to detect any wolves in the wild (Carrera, 1994). Intensive investigation of reports of wolves along the U. S./Mexico border areas of New Mexico and Arizona failed to provide any clear evidence of Mexican wolves in any of these areas.

In 1982, a federal recovery plan for the Mexican wolf was prepared with the goal to re-establish at least 100 wolves in 5,000 mi² of the subspecies historic range (USFWS, 1982). In 2017, the USFWS issued a biological report on the status of the subspecies (USFWS, 2017a) and a revised federal recovery plan (USFWS 2017b). The current recovery strategy for the Mexican wolf is to establish and maintain at least two resilient and genetically diverse

populations in the range of the subspecies in the U.S. and Mexico. A 5-year status review of the Mexican wolf was initiated by the USFWS in 2018 (USFWS, 2018).

In March 1997, the Secretary of the Department of the Interior authorized the reintroduction of Mexican wolves to the Southwest. This decision included selection of the preferred alternative as described in the Final Environmental Impact Statement. Beginning in March 1998, captive-reared Mexican wolves were released into the Blue Range Wolf Recovery Area in the Apache National Forest in eastern Arizona. Initial releases occurred at 6 different locations within Arizona. The Final Rule for the experimental population of Mexican wolves allowed for the translocation of wolves throughout the recovery zone, and for wolves from the initial releases to naturally disperse onto public lands in Arizona and adjacent New Mexico on the Gila National Forest.

Reintroduced Mexican gray wolves have been present continuously in New Mexico since about 2000. Wolves naturally dispersed to New Mexico after being released in Arizona, and other wolves were translocated to remote sites in the Gila Wilderness. The 2007 end-of-year count yielded a minimum of 52 free-ranging Mexican wolves associated with known groups within the recovery area, with two pups killed by vehicles in Arizona shortly after the count. Of these wolves, 6 packs, as well as a few single animals, were in New Mexico. One of these NM packs was confirmed as a successful breeding pair in 2007. As of 2009, there were a minimum of 42 wolves in both Arizona and New Mexico, and a minimum of 15 are in New Mexico. Thirty-one pups were born in 2009 (all in Arizona) although only 7 survived to year's end. The 2011 population surveys indicated a minimum of 58 wolves were present in both states, an increase from 50 in 2010. Of these 58 known wolves, 26 (in six packs) were present in New Mexico (USFWS, 2012). The minimum population estimate at the end of 2013 was 83 wolves with five breeding pairs. The minimum estimate increased to 109 individuals at the end of 2014 and decreased to 97 (including 23 wild-born pups) at the end of 2015. Roughly half of the 97 wolves counted in the two states in 2015 occurred in New Mexico. The end of year count for 2017 indicated a minimum estimated population of 114 in both states, an increase of one from the previous year.

In June 2011, the New Mexico State Game Commission directed NMDGF to suspend its participation in the Mexican Wolf Reintroduction Program except for activities required under the Wildlife Conservation Act. This action became effective on 30 June 2011. Also in 2011, the U.S. Fish and Wildlife Service convened a Mexican Wolf Recovery Team with its cooperators with the goal of revising and updating the 1982 recovery plan for the Mexican gray wolf (USFWS, 2012). However, recovery planning efforts were put on hold in 2013 to revise the 10(J) rule associated with the federal listing. NMDGF became a cooperating agency in the development of an Environmental Impact Statement for the *Proposed Revision to the Regulations for the Nonessential Experimental Population of the Mexican Wolf (Canis lupus baileyi)* (2014) and participated in the development of the 2017 biological report and revised recovery plan.

Mexico recently began releases of Mexican wolf just south of the U.S.-Mexico border. In October 2011, five wolves were released in the Sierra San Luis, Sonora. As of early 2012, four of these animals had been killed by poisoning. After the initial failed attempt in Mexico the reintroduction area was moved farther south into the mountains outside of Nuevo Casas Grandes, Chihuahua. At the end of 2015 there were approximately 20 wolves in the wild in Mexico. As of early 2018, that number was 37.

Threats: The principal cause of the decline and apparent extirpation of the wolf in New Mexico was a highly-efficient and persistent predator control program, the goal of which was to eradicate the species. Causes of death for reintroduced wolves released since 1998 have been primarily management actions, shooting, and collisions with vehicles, but have also included mountain lions, rattlesnake bites, and diseases.

Recommendations: No change in the listing status of the gray wolf is recommended. As directed by the New Mexico Game Commission, NMDGF will continue to participate in management of this species as mandated by the Wildlife Conservation Act (WCA). Authorized activities under the WCA include evaluation of its state status through the Biennial Review process and law enforcement actions pertaining to protection of wolves in the state. In addition, the NMDGF will remain involved in conservation actions benefiting the subspecies, its habitat, and its prey base as outlined in the revised recovery plan (USFWS, 2017b).

Literature Cited:

Bailey, V. 1932. Mammals of New Mexico. North American Fauna 53:1-412.

- Bogan, M. A. and P. Mehlhop. 1983. Systematic relationships of gray wolves (*Canis lupus*) in southwestern North America. Occasional Papers, Museum of Southwestern Biology, 1:1-21.
- Brown, D. E. 1983. The wolf in the Southwest: The making of an endangered species. University of Arizona Press, Tucson, AZ. 195 pp.
- Carrera, J. 1994. Mexican wolf recovery program. Annual report. PROFAUNA, A. C. Saltillo, Coahuila, Mexico. 10 pp.
- Chambers, S.M., S.R. Fain, B. Fazio, and M. Amaral. 2012. An account of the taxonomy of North American wolves from morphological and genetic analyses. North Amer. Fauna (77):1-67.
- Fritts, S. H. 1983. Record dispersal of a wolf from Minnesota. J. Mammal. 64(1): 166-167.
- Fuller, T. K., W. E. Berg, G. L. Radde, M. S. Lenarz, and G. B. Joselyn. 1992. A history and current estimate of wolf distribution and numbers in Minnesota. Wildl. Soc. Bull. 20:42-55.
- Garcia-Moreno, J., M. Motoq, M. Roy, E. Geffen, and R.K. Wayne. 1996. Relationships and genetic purity of the endangered Mexican wolf based on analysis of microsatellite loci. Conserv Biol. 10:376-389.
- Hall, E. R. 1981. The mammals of North America. John Wiley & Sons, New York, NY, 2nd ed., 2: vi + 601-1181 + 90.
- Hedrick, P. 1995. Genetic evaluation of the three captive Mexican wolf lineages and consequent recommendations. Unpublished report of the Mexican Wolf Recovery Team Genetics committee to U. S. Fish and Wildlife Service, Albuquerque, NM. 23 pp.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. The Museum of Southwestern Biology, The University of New Mexico. 290 pp.
- Leopold, A. S. 1959. Wildlife of Mexico: The game birds and mammals. University of California Press, Berkeley, CA.
- McBride, R. T. 1980. The Mexican wolf (*Canis lupus baileyi*): A historical review and observations on its status and distribution. Endangered Species Report 8, U. S. Fish and Wildlife Service, Albuquerque, NM. 38 pp.
- Mech, L. D. 1970. The wolf: the ecology and behavior of an endangered species. Natural History Press. Doubleday Publ. Co., New York, NY. 380 pp.
- Nowak, R. M. 1995. Another look at wolf taxonomy. Pages 375-397 in L. N. Carbyn, S. H. Fritts, and D. R. Seip, eds. Ecology and conservation of wolves in a changing world. Canadian circumpolar Institute, Edmonton, Alberta, Occasional Publication No. 35. 642 pp.
- Parsons, D. R. 1996. Case study: The Mexican wolf. Pages 101-123 in E. A. Herrera and L. F. Huenneke, eds. New Mexico's natural heritage: Biological diversity in the land of enchantment. New Mexico Journal of Science, vol. 36.
- Siminski, D. P. 1996. International studbook for the Mexican gray wolf (*Canis lupus baileyi*). Arizona-Sonora Desert Museum, Tucson, AZ.
- U. S. Fish and Wildlife Service (USFWS). 1982. Mexican wolf recovery plan. U. S. Fish and Wildlife Service, Albuquerque, NM.
- U. S. Fish and Wildlife Service (USFWS). 2012. Lower 48-state and Mexico Gray wolf (*Canis lupus*) listing, as revised. 5-year review: summary and evaluation. USFWS, Washington office, Arlington, VA. 22 pp.
- U.S Fish and Wildlife Service (USFWS). 2013. Endangered and threatened wildlife and plants; removing the gray wolf (*Canis lupus*) from the list of endangered and threatened wildlife and maintaining protections for the Mexican wolf (*Canis lupus baileyi*) by listing it as endangered. Fed. Reg. 78(114):35664-35719 (Jun 13).
- U.S. Fish and Wildlife Service (USFWS). 2017a. Biological report for the Mexican wolf (*Canis lupus baileyi*). USFWS, Southwest Region (Region 2), Albuquerque, NM. 50 pp.
- U.S. Fish and Wildlife Service (USFWS). 2017b. Mexican wolf recovery plan, first revision. USFWS, Southwest Region (Region 2), Albuquerque, NM. 36 pp.
- U.S. Fish and Wildlife Service (USFWS). 2018. Endangered and threatened wildlife and plants; initiation of 5-year status reviews of 38 species in the Southwest region (Arizona, New Mexico, Oklahoma, and Texas). Federal Register 83(105):25034-25038 (May 31).
- Wayne, R. K., N. Lehman, M. W. Allard, and R. L. Honeycutt. 1992. Mitochondrial DNA and variability of the gray wolf: Genetic consequences of population decline and habitat fragmentation. Conservation Biology 6:559-569.
- Young, S. P. and E. A. Goldman. 1944. The wolves of North America. American Wildlife Institute, Wash., DC.

THREATENED

North American least shrew, *Cryptotis parva*

Distribution: The North American least shrew is the northernmost of several species of least shrew, a primarily tropical group of mammals. The species occurs from extreme southeastern Canada south to the Gulf Coast, westward into Colorado and New Mexico, and southward into Mexico (Hall, 1981; Fitzgerald et al., 1994; Hutterer, 2005). Eastern New Mexico represents the westernmost extent of the species' distribution. The least shrew was first discovered in the state at Tukumcari in 1981 (Hoditschek et al., 1985). This species is currently known from several areas in eastern New Mexico: 1) the Tukumcari area, including Tukumcari Lake (Quay County), 2) Salt Lake on Grulla National Wildlife Refuge near Portales (Roosevelt County), 3) the Pecos River Valley and associated wetlands at Bitter Lake National Wildlife Refuge, Bottomless Lakes State Park, and the BLM Overflow Wetlands near the park (Chaves County); 4) the Pecos Valley in northern Eddy Co.; 5) the vicinity of Clayton Lake State Park (Union Co.); and 6) southeastern Curry Co (Hoditschek et al., 1985; Owen and Hamilton, 1986; Frey, 2005; NMDGF, unpubl. data). Efforts to trap least shrews in other suitable habitats in eastern New Mexico (areas near Santa Rosa, Carlsbad, Artesia, Fort Sumner, and Conchas Lake) have failed to find this species (Shuster, 1987; NMDGF, unpubl. data). However, many potentially suitable areas in the Pecos Valley and on the eastern plains have not yet been adequately surveyed for the species.

As presently understood, the North American least shrew in New Mexico may consist of two subspecies, *C. p. parva* on the eastern plains and *C. p. berlandieri* in the Pecos River Valley (Hafner and Shuster, 1996). The populations in the Pecos River Valley are likely relicts of a more widespread distribution that have become isolated since the Pleistocene by climatic changes, whereas those from the vicinities of Tukumcari and Portales may be the result of more recent westward expansion of populations in western Texas and Oklahoma.

The North American least shrew occupies a variety of habitats within the western portion of its range. The species inhabits riparian woodlands in southeastern Colorado (Choate and Reed, 1988) and short grass prairie and mesic meadows in northeastern Colorado (Fitzgerald et al., 1994). Mesic areas with dense grass cover appear to represent primary habitat for this species in New Mexico. They occupy mesic meadows with willows (*Salix gooddingii*) and cattails (*Typha angustifolia*) along the edge of Tukumcari Lake (Cully, 1983; Hoditschek et al., 1985). At Grulla National Wildlife Refuge, they were found in communities of alkali sacaton (*Sporobolus airoides*), grama (*Bouteloua* sp.), and various forbs (Owen and Hamilton, 1986). Frey (2005) found this species associated with saltgrass (*Distichlis stricta*) meadows and cattail/bulrush (*Scirpus* spp.) marshes, but also in mesic areas dominated by non-native grasses.

Food habits of the North American least shrew are similar to other shrew species, and include insects, arthropods, and earthworms (Fitzgerald et al., 1994). Gestation takes 21 to 23 days, young are born blind and hairless, and weaning occurs about 21-23 days after birth (Fitzgerald et al., 1994).

Current Status: The North American least shrew was approved for listing as threatened by the New Mexico State Game Commission in 1985 (Jones and Schmitt, 1997). Known distribution in New Mexico is limited to the eastern one-third of the state. Surveys by Frey (2005) found that the species persists at all historic sites in New Mexico and occurs elsewhere in the Tukumcari area and the Pecos River Valley, including at Bitter Lake National Wildlife Refuge and in the BLM Overflow Wetlands near Bottomless Lakes State Park. A saltcedar removal and wetlands restoration project was completed in 2010 on BLM land between Bottomless Lakes State Park and the Overflow Wetlands that should benefit the species. The North American least shrew appears to be more common and widespread in eastern New Mexico than previously known (Frey, 2005; NMDGF, unpubl. data). It is expected the species will be found in other areas of New Mexico from the Pecos River eastward with similar habitat.

Threats: Because of its reliance on mesic grasslands and wetlands, this species is vulnerable to habitat loss and degradation resulting from climatic variation (i.e., drought) and human activities (e.g., water diversion, agriculture, and intensive livestock grazing).

Recommendations: No change in the current listing status of the North American least shrew is recommended. Additional surveys in the vicinity of known localities and in other parts of eastern New Mexico with suitable habitat

should be conducted to better ascertain the species distribution and population status in the state. Conservation projects that maintain suitable mesic habitat and continuity between these habitats in eastern New Mexico would benefit this species. Additional genetic studies of the relationship between the Pecos River Valley and eastern plains populations in New Mexico would provide valuable information for management purposes. Successful implementation of measures to protect and enhance habitat for the North American least shrew in eastern New Mexico could lead to future delisting under the WCA.

Literature Cited:

- Choate, J. R. and M. P. Reed. 1988. Least shrew, *Cryptotis parva*, in southwestern Kansas and southeastern Colorado. *Southwestern Naturalist* 33:361-362.
- Cully, J. F. 1983. Tucumcari Lake wildlife inventory. Final report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 516-71-31. 68 pp.
- Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. *Mammals of Colorado*. Denver Museum of Natural History and University Press of Colorado, Niwot, CO. 467 pp.
- Frey, J. K. 2005. Status and habitat of the least shrew (*Cryptotis parva*) in New Mexico. Final report to New Mexico Dept. Game and Fish, Santa Fe, NM, contract 05-516.0000.0080. 40 pp + appendices.
- 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*. John Wiley & Sons, New York, NY, 2nd ed., 1:xv +1-600 + 90.
- Hoditschek, B., J. F. Cully, Jr., T. L. Best, and C. Painter. 1985. Least shrew (*Cryptotis parva*) in New Mexico. *Southwestern Naturalist* 30:600-601.
- Hutterer, R. 2005. Order Soricomorpha. Pp. 220-311 in D.E. Wilson and D.M. Reeder (eds.), *Mammal Species of the World: A Taxonomic and Geographic Reference*, 3rd ed. Johns Hopkins Univ. Press, Baltimore. 2 vols., xxxviii+2142 pp.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. *Life Among the Muses: Papers in Honor of James S. Findley*. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Owen, R. D. and M. J. Hamilton. 1986. Second record of *Cryptotis parva* (Soricidae: Insectivora) in New Mexico, with review of its status on the Llano Estacado. *Southwestern Naturalist* 31:403-405.
- Shuster, C. J. 1987. Distribution, relative population densities, and habitat of *Cryptotis parva* in New Mexico. Final report, New Mexico Dept. Game and Fish, Santa Fe, NM contract 516.6-75-19. 20 pp.

Lesser long-nosed bat, *Leptonycteris yerbabuena*

Distribution: The lesser long-nosed bat occurs from Central America north through Mexico to southern Arizona, southern California, and southwestern New Mexico; populations in the United States represent the northern extent of the species' range (Findley et al., 1975; Hall, 1981; Hoffmeister, 1986; Simmons, 2005; Cole and Wilson 2006). In New Mexico, this bat is known from the Animas, Peloncillo, and Big Hatchet mountains and adjacent valleys in southern Hidalgo County (Findley et al., 1975; Baltosser, 1980; Hoyt et al., 1994; Bogan et al., 2006a-b, 2017). There are recent unconfirmed but likely valid observations of long-nosed bats from the Burro Mountains and possibly the Silver City area in Grant Co. (M. Ramsey, pers. comm.; K. Geluso, pers. comm). Similar to the Mexican long-nosed bat (*L. nivalis*), the lesser long-nosed bat is a migratory species that is found in the United States only during summer months (Hayward and Cockrum, 1971; Findley et al., 1975; Wilson, 1985). Bogan et al. (2006a-b, 2017) reported occurrence in New Mexico from mid-July to mid-September. Habitats utilized by the lesser long-nosed bat include forested canyons and adjacent desert grassland and shrub lands (Findley et al., 1975; Hoffmeister, 1986). The diet consists of nectar, pollen, and soft fruits of agaves (*Agave* spp.) and various cacti, with insects being taken incidentally. In Arizona, migrant females are pregnant when they arrive from Mexico and subsequently give birth and rear their young in maternal colonies (Hoffmeister, 1986). Caves and rock fissures are the only known day roost sites in New Mexico (Bogan et al., 2006a-b, 2017), but the species is also known to roost in trees, mines, culverts, and buildings elsewhere in its range. An abandoned building near the Animas Mountains is a known night roost used by long-nosed bats between feeding forays (Bogan et al., 2006a-b).

Current Status: The lesser long-nosed bat was until recently listed as federal endangered (as the subspecies *L. curasoae yerbabuena*) by the U. S. Fish and Wildlife Service, and a federal recovery plan was prepared (USFWS,

1995). A federal 5-year review of the species was completed in 2007 (USFWS, 2007) and included a recommendation that the species be downlisted to threatened. The USFWS (2013) formally proposed that the species be reclassified as federal threatened based on survey data, mainly from Arizona, that indicates that the population trend in the Southwest is stable to increasing (USFWS, 2007). However, following completion of a species status assessment that indicated the species was more secure within its range than previously understood (USFWS, 2016), the lesser long-nosed bat was removed from the federal Endangered Species Act list in 2018 (USFWS, 2018).

The New Mexico State Game Commission approved the addition of this species (as *Leptonycteris curasoae*) to the state threatened list in 1975 (Jones and Schmitt, 1997). Until recently, few studies have been conducted on this bat in New Mexico, and its ecology and population size and trends are not fully understood. Hoyt et al. (1994) conservatively estimated that they netted 150 to 200 individuals of *Leptonycteris* in the proportion of two lesser long-nosed bats for every one Mexican long-nosed bat in the Animas Mountains. More recent studies by Bogan et al. (2006a-b, 2017), Cryan (2007), and Goodbar (2007) identified and characterized roost sites in the Animas, Peloncillo, and Big Hatchet mountains; numbers of long-nosed bats (both species) at day roosts ranged from 4 to a few thousand individuals and varied during the summer.

The taxonomy of *Leptonycteris* bats has been a subject of debate, and various scientific and common names have been applied to populations of long-nosed bats that occur in the United States. Simmons (2005) and Cole and Wilson (2006) considered the subspecies *L. curasoae yerbabuena* (lesser long-nosed bat), the form found in the southwestern U.S. and Mexico, to be specifically distinct from *L. curasoae* of South America. Populations in the United States also were formerly placed in the species *L. sanborni* (e.g., Hayward and Cockrum, 1971) The species is very similar to the Mexican long-nosed bat, which also occurs in southwestern New Mexico, and this similarity complicates monitoring efforts that do not involve capture and identification of the bats in hand.

Threats: Current threats are thought to include a lack of formal protection for the species' habitat, disturbance of both day and night roost sites and maternity colonies, and degradation of food resources (agave and cacti) within its limited range in New Mexico.

Recommendations: No change in the current listing status of this species is recommended due to the limited distribution and small number of identified roost sites in New Mexico. Identification and protection of roost sites and maintenance of viable populations of food plants (particularly agave) are necessary to conserve this species in New Mexico. Surveys for long-nosed bats in the Burro Mountains and Silver City area, where it has been detected using hummingbird feeders (NMDGF, unpubl. data), are warranted. Studies of both long-nosed bat species and their habitats in southern Hidalgo County (Bogan et al., 2006a-b, 2017; Cryan, 2007; Goodbar, 2007) provided a more thorough understanding of this bat's population status, movements, and habitat use in this part of New Mexico; future monitoring efforts should be conducted in this area where the species is apparently most abundant. The USFWS has requested that NMDGF implement post-delisting monitoring of this species in New Mexico which would also provide information that would assist the NMDGF in developing state-level recovery actions.

Literature Cited:

- Baltosser, W. H. 1980. A biological inventory of endangered species occurring in Guadalupe Canyon, Hidalgo County, New Mexico. Final report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 519-68-06, 73 pp.
- Bogan, M. A., P. M. Cryan, C. D. Weise, and A. England. 2006a. Roosts and movements of bats of the genus *Leptonycteris* in southwestern New Mexico. Presentation at the 39th Joint Annual Meeting of the Arizona and New Mexico Chapters of The Wildlife Society, Flagstaff, AZ, 2-4 February 2006 (abstract).
- Bogan, M. A., P. M. Cryan, and C. D. Weise. 2006b. Roosts and nocturnal movements of long-nosed bats (*Leptonycteris curasoae* and *L. nivalis*) in southwestern New Mexico. Report to Las Cruces Office, Bureau of Land Management.
- Bogan, M.A., P.M. Cryan, C.D. Weise, and E.W. Valdez. 2017. Landscape movements by two species of migratory nectar-feeding bats (*Leptonycteris*) in a northern area of seasonal sympatry. *Western North American Naturalist* 77:317-330.
- Cole, F. R. and D. E. Wilson. 2006. *Leptonycteris yerbabuena*. *Mammalian Species* 797:1-7.

- Cryan, P. M. 2007. Emergence counts of endangered long-nosed bats (*Leptonycteris curasoae* and *L. nivalis*) at major roosts in southwestern New Mexico. Report to Las Cruces District Office, Bureau of Land Management.
- Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM. xxii + 360 pp.
- Goodbar, J. 2007. Summary report: Lepto Splat Cave, Hidalgo County, New Mexico – Bureau of Land Management, Las Cruces District. Report to U.S. Department of Interior, Bureau of Land Management.
- Hall, E. R. 1981. The Mammals of North America. John Wiley & Sons, New York, NY, 2nd ed., 1:xv +1-600 + 90.
- Hayward, B. J. and E. L. Cockrum. 1971. The natural history of the western long-nosed bat *Leptonycteris sanborni*. Western New Mexico University, Research Sciences 1:75-123.
- Hoffmeister, D. F. 1986. Mammals of Arizona. The University of Arizona Press and Arizona Game and Fish Department. 602 pp.
- Hoyt, R. A., J. S. Altenbach, and D. J. Hafner. 1994. Observations on long-nosed bats (*Leptonycteris*) in New Mexico. Southwestern Naturalist 39:175-179.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Simmons, N. B. 2005. Order Chiroptera. Pp. 312-529 in D.E. Wilson and D.M. Reeder (eds.), Mammal Species of the World: A Taxonomic and Geographic Reference, 3rd ed. Johns Hopkins Univ. Press, Baltimore. 2 vols., xxxviii+2142 pp.
- Wilson, D. E. 1985. Status report, *Leptonycteris sanborni* Hoffmeister, Sanborn's long-nosed bat. U. S. Fish and Wildlife Service, Office of Endangered Species, Albuquerque, NM, unpublished report ii+36 pp.
- U. S. Fish and Wildlife Service (USFWS). 1995. Lesser long-nosed bat recovery plan. USFWS, Albuquerque, NM. 45 pp.
- U.S. Fish and Wildlife Service (USFWS). 2007. Lesser long-nosed bat (*Leptonycteris curasoae yerbabuena*): 5-year review: summary and evaluation. Report by USFWS, Phoenix, Arizona.
- U.S. Fish and Wildlife Service (USFWS). 2013. Endangered and threatened wildlife and plants; 90-day finding on a petition to delist or reclassify from endangered to threatened five southwest species. Fed. Reg. 78(174):55046-55051 (Sep 9).
- U.S. Fish and Wildlife Service (USFWS). 2016. Species status assessment for the Lesser long-nosed bat (*Leptonycteris yerbabuena*). USFWS, Southwest Region, Albuquerque, NM. 84 pp.
- U.S. Fish and Wildlife Service (USFWS). 2018. Endangered and threatened wildlife and plants; removal of the Lesser long-nosed bat from the federal list of endangered and threatened wildlife. Federal Register 83(75):17093-17110 (April 18).

Spotted bat, *Euderma maculatum*

Distribution: The spotted bat is widely distributed across western North America, occurring locally from central California and southern British Columbia, and southward through the Big Bend region of Texas to central Mexico (Hall, 1981; Fenton et al., 1983, 1987). Nowhere within this range is the species considered to be abundant. In New Mexico, spotted bats have been documented from numerous localities throughout the western two-thirds of the state including Albuquerque (Bernalillo Co.), Mount Taylor (Cibola Co.), the Jemez Mountains (Sandoval Co.), the Mogollon Mountains (Catron Co.), the San Mateo Mountains (Socorro Co.), the Sacramento Mountains (Otero Co.), White Sands Missile Range (Otero Co.), Mesilla Park (Doña Ana Co.), Lake Roberts (Grant Co.), Ghost Ranch (Rio Arriba Co.), Nambe (Santa Fe Co.), and Aztec (San Juan Co.) (NMDGF, Wildlife Management Division files; Geluso, 2017)). During 2014-2016, the species was detected by its distinct audible calls at multiple sites along the Gila River in Grant Co. (Geluso, 2016). Distribution information for New Mexico was provided by Perry et al. (1997), Chung-MacCoubrey (2000), and Geluso (2006, 2008, 2017).

This species has been recorded in a wide variety of habitats, including riparian communities, pinyon-juniper woodlands, and ponderosa pine and spruce-fir forests (Findley et al., 1975), and in burned areas of ponderosa pine forest (Ellison et al., 2005). In New Mexico, the spotted bat occurs in forested areas between 3,900 and 10,600 ft elevation. Spotted bats may summer in forested areas at higher elevations and migrate through lower elevations during other seasons (Hoffmeister, 1986). Most New Mexico records of spotted bats are from warmer months

(April - September), but Sherwin and Gannon (2005) documented winter roosting in Albuquerque buildings. Ruffner et al. (1979) captured several specimens in Utah in January and February. Moths represent the principal food source of the spotted bat (Ross, 1967; Easterla, 1973) although beetles are taken also (Geluso, 2017). Young may be born in early summer based on captures of lactating females in late June to mid-July (Findley et al., 1975). Spotted bats use cliff faces and rock crevices for roosting, and such rocky areas are an essential habitat component for this species (Easterla, 1973). Luce and Keinath (2007) reviewed the available information for this species whereas the most recent review of information for New Mexico populations was by Geluso (2017)..

Current Status: The spotted bat was approved for listing as threatened by the New Mexico State Game Commission in 1988 (Jones and Schmitt, 1997). Surveys in New Mexico and other states documented population declines throughout the species' historic range in 1983. Recent spotted bat surveys in New Mexico have relied upon both listening for audible echolocation sounds, use of acoustic detectors, and some use of mist-netting at watering sites. Geluso (2006, 2017) documented the persistence of this species at most historic sites of occurrence in New Mexico and at several new sites. The species persists and reproduces in the vicinity of Mount Taylor (Geluso, 2008). Geluso (2017) concluded that the species has not noticeably declined in the state over a 40 year period.

Threats: Threats and limiting factors are largely unknown, but the species is likely adversely affected by pesticides, disturbance of foraging habitats, and disturbance to roosting sites. This bat is relatively rare throughout its range, thus its scarcity in New Mexico may be a function of its biology rather than due to any impacts.

Recommendations: No change in the current listing status of the spotted bat is recommended. NMDGF should continue to encourage land management agencies to protect known foraging and roosting habitats. Periodic surveys, particularly those based on standardized acoustic methods and direct observations, are needed to better identify the species' distribution, population trends, and potential threats in New Mexico.

Literature Cited:

- Chung-MacCoubrey, A.L. 2000. Bat species composition and roost use at White Sands Missile Range, New Mexico. WSMR proj. no. WSMR97F017, Bats Planning Level Survey (PLS) no. RMRS-99057-IA MIPR9FL4RN022. Unpub. report to Environmental Stewardship Div., U.S. Dept. of the Army, WSMR, NM.
- Easterla, D. A. 1973. Ecology of the 18 species of Chiroptera at Big Bend National Park, Texas. Northwest Missouri State University Studies 43:1-165.
- Ellison, L. E., A. L. Everette, and M. A. Bogan. 2005. Examining patterns of bat activity in Bandelier National Monument, New Mexico, by using walking point transects. Southwestern Naturalist 50:197-208.
- Fenton, M. D., D. C. Tennant, and J. Wyszceki. 1983. A survey of the distribution of *Euderma maculatum* (Chiroptera: Vespertilionidae) throughout its known range in the United States and Canada by monitoring its audible echolocation calls. U. S. Fish and Wildlife Service, contract 14-16-0002-82-210, final report: 1-44.
- Fenton, M. D., D. C. Tennant, and J. Wyszceki. 1987. Using echolocation calls to measure the distribution of bats: the case of *Euderma maculatum*. Journal of Mammalogy 69:142-144.
- Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM. xxii + 360 pp.
- Geluso, K. 2006. Recurrence of the spotted bat (*Euderma maculatum*) and Allen's big-eared bat (*Idionycteris phyllotis*) in New Mexico. Final report to Share With Wildlife Prog., New Mexico Dept. Game and Fish, Santa Fe. 34 pp.
- Geluso, K. 2008. Spotted bats (*Euderma maculatum*) from Mt. Taylor, New Mexico. Western North Am. Nat. 68(1):119-122.
- Geluso, K. 2016. Mammals of the Gila and Mimbres rivers, New Mexico. Draft final report to Share With Wildlife Prog., New Mexico Dept. Game and Fish, Santa Fe.
- Geluso, K. 2017. Recurrence of the Spotted Bat (*Euderma maculatum*) at historical sites in New Mexico, with notes on natural history. Occasional Papers, Museum of Texas Tech University (346):1-14.
- Hall, E. R. 1981. The Mammals of North America. John Wiley & Sons, New York, NY. 2nd ed., 1:xv +1-600 + 90.
- Hoffmeister, D. F. 1986. Mammals of Arizona. The University of Arizona Press and Arizona Game and Fish Department. 602 pp.

- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. *Life Among the Muses: Papers in Honor of James S. Findley*. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Luce, R. J. and D. Keinath. 2007. Spotted Bat (*Euderma maculatum*): a technical conservation assessment. USDA Forest Serv., Rocky Mountain Region. <http://www.fs.fed.us/r2/projects/scp/assessments/spottedbat.pdf>
- Perry, T. W., P. M. Cryan, S. R. Davenport, and M. E. Bogan. 1997. New locality for *Euderma maculatum* (Chiroptera: Vespertilionidae) in New Mexico. *Southwestern Naturalist* 42:99-101.
- Ross, A. 1967. Notes on food habits of bats. *Journal of Mammalogy* 42:66-71.
- Ruffner, G. A., R. M. Poche, M. Meierkord, and J. A. Neal. 1979. Winter bat activity over a desert wash in southwestern Utah. *Southwestern Naturalist* 24:447-453.
- Sherwin, R. E. and W. L. Gannon. 2005. Documentation of an urban winter roost of the spotted bat (*Euderma maculatum*). *Southwestern Naturalist* 50:402-407.

Western yellow bat, *Lasiurus xanthinus*

Distribution: The western yellow bat occurs from southern California eastward through Arizona and southwestern New Mexico and south into Baja California and western and central Mexico (Simmons, 2005). It also has been reported from Big Bend National Park and elsewhere in Trans-Pecos Texas (Higginbotham et al., 1999; Schmidly and Bradley, 2016). In New Mexico, the western yellow bat has been documented only from Guadalupe Canyon and the Animas Mountains in southern Hidalgo County (Mumford and Zimmerman, 1963; Findley et al., 1975; Baltosser, 1980; Cook, 1981, 1986) where its range is marginal in the state and the species might be of irregular occurrence.

This species is associated with riparian woodlands, and is most frequently captured over water (Findley et al., 1975; Baltosser, 1980; Cook, 1981, 1986). In Guadalupe Canyon, western yellow bat habitat includes riparian woodlands with cottonwoods (*Populus fremontii*), Arizona sycamores (*Platanus wrightii*), and Arizona white oaks (*Quercus arizonica*). Similar to the closely related southern yellow bat, western yellow bats probably roost in trees and other large vegetation; elsewhere in its range, it has been reported to use the dead fronds of palms and yucca as roost sites. The species has been recorded in New Mexico only in summer months (May-September), and likely migrates southward for the winter. The diet includes arthropods, particularly flying insects. Pregnant females have been taken in May and June and lactating females in August (Mumford and Zimmerman, 1963; Cook, 1981, 1986), suggesting that young are born in mid-summer. Pregnant specimens of this species examined from New Mexico contained two embryos (Barbour and Davis, 1969).

Current Status: This species was approved for listing as threatened by the New Mexico State Game Commission in 1975 (Jones and Schmitt, 1997). The New Mexico population is likely peripheral and believed to be of low density, although limited access to areas where previously detected has prevented surveys to determine its current status in the state. Formerly considered to be a subspecies of the southern yellow bat (*Lasiurus ega*), genetic studies resulted in the designation of *L. xanthinus* as a distinct species (Baker, et al., 1988; Morales and Bickham, 1995; Baird et al., 2015). Baird et al. (2015) assigned this species to the genus *Dasypterus*, although this proposed arrangement has not yet been fully evaluated or accepted by other mammalogists.

Threats: Loss or alteration of riparian broadleaf forest habitats is the major threat to this peripheral species in the southwestern part of New Mexico.

Recommendations: No change in the current listing status of western yellow bat is recommended. Protection and enhancement of riparian broadleaf woodlands in southwestern New Mexico should be encouraged and would benefit this species. Population surveys and ecological studies of the species should be encouraged although, due to the rarity of this bat, such studies would probably best be done as part of a multi-species survey effort for bats in southwestern New Mexico. The few records of this species in Chihuahuan Desert habitat in Trans-Pecos Texas (Higginbotham et al., 1999; Schmidly and Bradley, 2016) suggest additional surveys in this habitat in extreme southern New Mexico might be warranted.

Literature Cited:

- Baird, A.B., J.K. Braun, M.A. Mares, J.C. Morales, J.C. Patton, C.Q. Tran, and J.W. Bickham. 2015. Molecular systematic revision of tree bats (Lasiurini): doubling the native mammals of the Hawaiian Islands. *Journal of Mammalogy* 96:1255-1274.
- Baltosser, W. H. 1980. A biological inventory of endangered species occurring in Guadalupe Canyon, Hidalgo County, New Mexico. Final report, New Mexico Dept. Game and Fish, Santa Fe, NM, contract 519-68-06, 73 pp.
- Baker, R. J., J. C. Patton, H. H. Genoways, and J. W. Bickham. 1988. Genic studies of *Lasiurus* (Chiroptera: Vespertilionidae). Occasional Papers, Museum of Texas Tech University 17:1-15.
- Barbour, R. W. and W. H. Davis. 1969. Bats of America. University of Kentucky, Lexington, KY. 286 pp.
- Cook, J. A. 1981. The bat fauna of the Animas Mountains in the summer of 1981. Final report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 519-69-04, 25 pp.
- Cook, J. A. 1986. The mammals of the Animas Mountains and adjacent areas, Hidalgo County, New Mexico. Occasional Papers, Museum of Southwestern Biology, University of New Mexico 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, NM. xxii + 360 pp.
- Higginbotham, J. L., L. K. Ammerman, and M. T. Dixon. 1999. First record of *Lasiurus xanthinus* (Chiroptera: Vespertilionidae) in Texas. *Southwestern Naturalist* 44:343-347.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. *Life Among the Muses: Papers in Honor of James S. Findley*. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Morales, J. C. and J. W. Bickham. 1995. Molecular systematics of the genus *Lasiurus* (Chiroptera: Vespertilionidae) based on restriction-site maps of the mitochondrial ribosomal genes. *Journal of Mammalogy* 76:730-749.
- Mumford, R. E. and D. A. Zimmerman. 1963. The southern yellow bat in New Mexico. *Journal of Mammalogy* 44:417-418.
- Schmidly, D.J. and R.D. Bradley. 2016. *The Mammals of Texas*, 7th ed. University of Texas Press, Austin. 694 pp.
- Simmons, N. B. 2005. Order Chiroptera. Pp. 312-529 in D.E. Wilson and D.M. Reeder (eds.), *Mammal Species of the World: A Taxonomic and Geographic Reference*, 3rd ed. Johns Hopkins Univ. Press, Baltimore. 2 vols., xxxviii+2142 pp.

White-sided jackrabbit, *Lepus callotis*

Distribution: The white-sided jackrabbit (*Lepus callotis*) is a species almost entirely confined to Mexico, which represents the core distribution for this species. The subspecies *L. c. gaillardi* occurs throughout the Mexican Plateau, from Jalisco north to southwestern New Mexico (Findley et al., 1975; Hall, 1981). In New Mexico, it is known only from the Animas Valley and very limited parts of the Playas Valley in southern Hidalgo County; these two valleys constitute the entire range in the United States (Findley et al., 1975; Bednarz, 1977; Bednarz and Cook, 1984).

This elusive hare was reported only a few times after its discovery along the U.S.-Mexico border in 1892 (Mearns, 1896). Two were collected in the Playas Valley in 1931 (Anderson and Gaunt, 1962). Bogan and Jones (1975) obtained a single specimen in 1974. Systematic surveys for this species in New Mexico were initiated in the 1980s, and spotlighting from a vehicle at night was found to be an effective survey method.

White-sided jackrabbits tend to form male-female pairs, which is most evident during the breeding season (at least mid-April to mid-August) but may persist year-round. Pregnant females have been found March through October. Males with mates defend territories from intruder males. This species rests in shelter forms in dense grass and rarely uses underground burrows (Best, 1999).

Studies by Bednarz and Cook (1984), Conway (1975), and Conley and Brown (1977) confirmed that the white-sided jackrabbit is a desert grassland specialist. Plants species associated with white-sided jackrabbit habitat in the Animas and Playa Valleys include blue grama (*Bouteloua gracilis*), black grama (*B. eriopoda*), tobosa (*Hilaria mutica*), buffalograss (*Buchloe dactyloides*), wolftail (*Lycurus pheloides*), flatsedge (*Cyperus* spp.), snakeweed (*Gutierrezia sarothrae*), soap tree yucca (*Yucca elata*), and honey mesquite (*Prosopis glandulosa*). Traphagen (2002) found that presence of buffalograss is an important indicator of white-sided jackrabbit presence, whereas

shrub cover was negatively correlated with presence. Most observations (97%) of this species have been recorded in pure grasslands, with the remaining 3% recorded in grasslands with very limited forb and shrub components (Bednarz and Cook, 1984).

Current Status: This species was approved for listing as threatened by the New Mexico State Game Commission in 1975 (Jones and Schmitt, 1997). Spotlight censuses conducted in the Animas Valley between May and August 1976 revealed a mean of 15 individuals (range: 5-25) per census, and resulted in a population estimate of 250 to 300 individuals (Bednarz, 1977). During eight censuses conducted in 1981, Cook counted a mean of 7.5 individuals per census (Cook, 1981a; 1981b). Cook also noted that numbers of black-tailed jackrabbits (*L. californicus*) increased 22 times and desert cottontail (*Sylvilagus auduboni*) increased approximately four times, while white-sided jackrabbit sightings decreased by 50% compared to the findings of Bednarz (1977). Bednarz and Cook (1984) postulated that the decrease of white-sided jackrabbit and increase of black-tailed jackrabbit and desert cottontail was associated with a decrease in the density and vigor of grasses and concomitant increase in forb and shrub cover.

During five surveys in the Animas Valley during 1990, only 3.2 individuals were observed per census (Mehlhop, 1995). During 1994 and 1995, seven surveys conducted in the same general areas surveyed by Bednarz and Cook revealed a mean of 1.1 individuals per census and a total of eight individuals (Mehlhop, 1995). While different sampling efforts by Mehlhop (1995) and Bednarz and Cook preclude statistical comparison, these data strongly suggest a significant decrease in the population from 1976 to 1995. Whether these surveys accurately reflected the overall New Mexico population of white-sided jackrabbit is unknown.

Data from NMDGF surveys conducted between 1997 and 2002 indicated more individuals detected per survey than were reported by Mehlhop (1995). Variation in survey methodology may have influenced results conducted by different biologist over this time period. No observations of this species have been made in the Playas Valley during recent surveys, and the status of white-sided jackrabbit in this area remains uncertain, although increased shrub growth in the valley may have eliminated suitable habitat. While the overall status of the species remains unclear, the Animas Valley population appears to be persisting whereas the Playas Valley population is likely extirpated. The species remains present in the Janos area of Chihuahua, Mexico (south of the New Mexico border) as of 2008 (M. Watson, pers. comm.).

Traphagen (2011) conducted nighttime visual surveys of this species in the Animas and Playas valleys in 2010-2011 using a methodology similar to that of Bednarz's (1977). A total of 73 white-sided jackrabbits were detected (64% of the sightings were of pairs) in the Animas Valley and none were detected in the Playas Valley. Shrub encroachment into suitable grassland habitat, increased borderland vehicle traffic, and isolation of the Animas Valley population appear to pose the greatest threats to the species in New Mexico (Traphagen, 2011).

In 2008, the U.S. Fish and Wildlife Service (USFWS) was petitioned to list this species under the U.S. Endangered Species Act (WildEarth Guardians 2008). A 12-month finding by USFWS on this petition concluded that listing of either the species (*L. callotis*) or the subspecies which occurs in New Mexico (*L. c. gaillardi*) was "not warranted at this time" (USFWS 2010).

Threats: Loss and degradation of grassland habitats in the Animas Valley through drought, shrub encroachment, and changes in grass species composition represent the primary threats to the white-sided jackrabbit in New Mexico. In Zacatecas, Mexico, overgrazing and shrub encroachment are thought to have encouraged expansion of the range of black-tailed jackrabbit and the exclusion of white-sided jackrabbit (Matson and Baker, 1986); similar patterns of habitat use between these two hares have been observed in Chihuahua, Mexico (Desmond, 2004). Baker (1977) noted that excessive grazing might be one of the factors contributing to the decline of white-sided jackrabbit and apparent replacement by black-tailed jackrabbit. Although vehicle impacts have been considered a minor threat in the past (N. Moore-Craig, personal communication, 1992), the pronounced increase in illegal activity and traffic along the U.S.-Mexico border in recent years may be affecting this species, and plans to develop improved fencing on the border may have adverse effects to the habitat of this hare in the southern Animas Valley. Indiscriminate shooting of white-sided jackrabbits could threaten this species; however, Bednarz (1977) found no evidence of shooting during his study.

Recommendations: No change in the current listing status for white-sided jackrabbit is recommended. NMDGF should re-initiate regular surveys to assess population status and trends using a standardized protocol based on

earlier efforts, if access permission can be obtained from landowners in the Animas and Playas valleys. Private landowners are encouraged to employ non-detrimental livestock grazing practices within white-sided jackrabbit habitat and to employ shrub control where appropriate to maintain the grassland habitat needed by this species. A completed Habitat Conservation Plan (HCP) for range management on private lands in the Animas Valley, among other areas, includes consideration of this species in New Mexico. NMDGF supports management efforts proposed in the HCP that are expected to improve grassland conditions in the southern Animas Valley and thereby benefit this species. Coordination with U.S. Department of Homeland Security, particularly in relation to any future border fence development, is also needed to address concerns related to this and other wildlife species. The relationship between U.S. and Mexican populations of the species and population status in other portions of its range should be investigated.

Literature Cited:

- Anderson, S. and A. S. Gaunt. 1962. A classification of the white-sided jackrabbits of Mexico. *American Museum Novitates*. 2088:1-16.
- Baker, R. H. 1977. Mammals of the Chihuahuan Desert region - future prospects. Pp. 221-225 in R.H. Wauer and D.H. Riskind (eds.), *Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region – United States and Mexico*. Sul Ross State University, Alpine, Texas, 17-18 October 1974. National Park Service, *Transactions and Proceedings Series No. 3*.
- Bednarz, J. 1977. The white-sided jackrabbit: distribution, numbers, and biology in the grasslands of Hidalgo County. Final report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 519-64-25. 33 pp.
- Bednarz, J. C. and J. A. Cook. 1984. Distribution and number of the white-sided jackrabbit (*Lepus callotis gaillardi*) in New Mexico. *Southwestern Naturalist* 29:358-360.
- Best, T. L. 1999. White-sided jackrabbit, *Lepus callotis*. Pp. 701-702 in D.E. Wilson and S. Ruff (eds.), *The Smithsonian Book of North American Mammals*. Smithsonian Institution Press, Washington D.C. xxvi +750 pp.
- Bogan, M. A. and C. Jones. 1975. Observations of *Lepus callotis* in New Mexico. *Proceedings of the Biological Society of Washington* 88:45-50.
- Conley, W. and W. C. Brown. 1977. Habitat partitioning between the jackrabbits *Lepus callotis* and *L. californicus*. Final report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 51665-23. 9 pp.
- Conway, M. C. 1975. A rare hare. *New Mexico Wildlife* 21(2):45-50.
- Cook, J. A. 1981a. Distribution and numbers of white-sided jackrabbits (*Lepus callotis*) in the Animas Valley in summer 1991. Final report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 519-69-04. 13 pp.
- Cook, J. A. 1981b. Distribution and numbers of white-sided jackrabbits (*Lepus callotis*) in the Animas Valley in summer 1991. Addendum to final report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 519-69-04. 8 pp.
- Desmond, M. J. 2004. Habitat associations and co-occurrence of Chihuahuan Desert hares (*Lepus californicus* and *L. callotis*). *American Midland Naturalist* 151:414-419.
- Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. *Mammals of New Mexico*. University of New Mexico Press, Albuquerque, NM. xxii + 360 pp.
- Hall, E. R. 1981. *The Mammals of North America*. John Wiley & Sons, New York, 2nd ed., 1:xv +1-600 + 90.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. *Life Among the Muses: Papers in Honor of James S. Findley*. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Matson, J. O., and R. H. Baker. 1986. *Mammals of Zacatecas*. The Museum, Texas Tech University, Special Publications 24:1-88.
- Mearns, E. A. 1896. Preliminary description of a new subgenus and six new species and subspecies of hares, from the Mexican border of the United States. *Proceedings, U. S. National Museum* 17:551-565.
- Mehlhop, P. 1995. Status of the white-sided jackrabbit in New Mexico with recommendations for a monitoring protocol. Final report, Share With Wildlife Program, New Mexico Dept. Game and Fish, Santa Fe, NM, contract 95-516-32. 42 pp.
- Traphagen, M. B. 2002. Buffalograss (*Buchloe dactyloides*): an important grass species for predicting the presence of the white-sided jackrabbit (*Lepus callotis*) in southern New Mexico. Final report, New Mexico Dept. Game and Fish, Santa Fe, NM, contract 02-515-43. 19 pp. + appendices.

- Traphagen, M.B. 2011. Final report on the status of the white-sided jackrabbit (*Lepus callotis gaillardi*) in New Mexico. Final report to the Share With Wildlife Program, New Mexico Dept. Game and Fish, Santa Fe. 22 pp.
- U.S. Fish and Wildlife Service (USFWS). 2010. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the white-sided jackrabbit as threatened or endangered. Fed. Reg. 75(169):53615-53629 (Sep 1).
- WildEarth Guardians 2008. Petition to list the white-sided jackrabbit (*Lepus callotis*) under the U.S. Endangered Species Act. Report submitted to U.S. Fish Wildlife Service from WildEarth Guardians, Santa Fe, NM.

(Organ Mountains) Colorado chipmunk, *Tamias quadrivittatus australis* (including Oscura Mountains population)

Distribution: The Colorado chipmunk (*Tamias quadrivittatus*) is widely distributed across five western states, including southern Colorado, eastern Utah, northeastern Arizona, the extreme western portion of the Oklahoma Panhandle, and northern and central New Mexico (Durrant, 1952; Findley et al., 1975; Hall, 1981; Hoffmeister, 1986; Caire et al., 1989; Fitzgerald et al., 1994). In New Mexico, the Colorado chipmunk is known to inhabit the Chuska, Zuni, San Mateo, Jemez, Gallinas, Sangre de Cristo, Sandia, and Manzano mountain ranges. The species also occurs in piñon-juniper woodlands from Johnson Mesa to the Canadian River Canyon (Findley et al., 1975). Southern populations in New Mexico (Organ and Oscura mountains) are isolated from populations in the northern half of the state, and from each other, and are currently recognized as two distinct subspecies: Organ Mountains chipmunk (*T. q. australis*) and Oscura Mountains chipmunk (*T. q. oscuraensis*).

Chipmunks were discovered in the Organ Mountains in 1903 by O. B. Metcalf (Bailey, 1932), and were initially regarded as a subspecies of gray-collared chipmunk, *Tamias cinereicollis cinereus* by Howell (1929) and Bailey (1932). Findley et al. (1975) regarded chipmunks from the Organ Mountains to be gray-collared chipmunks (*T. cinereicollis*). A morphological study indicated a close phyletic relationship between the Organ Mountains chipmunks and northern populations of *T. q. quadrivittatus* (Patterson, 1980). As a result of this work, the Organ Mountains chipmunk was described as the subspecies *T. q. australis* (Patterson, 1980). Chipmunks were discovered in the Oscura Mountains in 1977 (Patterson, 1980) and, although considered a form of Colorado chipmunk, were not formally described as a new subspecies for almost 20 years (Sullivan, 1996).

The distribution of the Organ Mountains chipmunk is limited to the Organ Mountains in southern New Mexico (Patterson, 1980; Frey, 2012). Most habitat for this subspecies is found on the north-facing slopes in the vicinity of Aguirre Springs, and is characterized by ponderosa pine (*Pinus ponderosa*), oaks (*Quercus* spp.), junipers (*Juniperus* spp.), Apache plume (*Fallugia paradoxa*), and sumac (*Rhus* spp.) at elevations between 6000 and 7300 ft (Patterson 1980). A habitat suitability model has been developed for this subspecies in the Organ Mountains (Frey and Kopp, 2013) which indicates that chipmunks are primarily associated with lower montane riparian habitat and landcover types characterized by conifer trees.

The distribution of the Oscura Mountains chipmunk is limited to the Oscura Mountains at the northern end of the Tularosa Basin on White Sands Missile Range in south-central New Mexico (Sullivan, 1996). Habitat for this species is restricted to northwest-facing limestone cliff edges in pinyon-juniper-oak communities, which are characterized by pinyon (*Pinus edulis*), one-seed juniper (*J. monosperma*), mountain mahogany (*Cercocarpus montanus*), antelope brush (*Pursia tridentata*), four-wing salt bush (*Atriplex canescens*), and oaks (*Quercus* spp.). Open areas are variously covered with side-oats grama (*Bouteloua curtipendula*), black grama (*B. eriopoda*), blue grama (*B. gracilis*), Chihuahuan love-grass (*Eragrostis erosa*), and soaptree yucca (*Yucca elata*) (Sullivan, 1996). Perkins-Taylor (2017) found that pinyon woodland and proximity to an escarpment are important predictors of suitable habitat for this subspecies.

Colorado chipmunks from more northerly locales generally breed in late spring (Bailey, 1932; Patterson, 1980); however, Oscura Mountains chipmunks appear to breed in early spring (Sullivan, 1996). Lactating females and juvenile animals were observed in mid-September, and females with embryos were collected in early April. The Oscura Mountains chipmunk appears to have a reproductive pattern intermediate between the Colorado chipmunk in northern New Mexico and the Organ Mountains chipmunk (Patterson, 1980; Sullivan, 1996). The early spring

conception pattern of the Oscura Mountains chipmunk (Sullivan, 1996) is similar to that reported for the Organ Mountains chipmunk (Patterson, 1980) and appears to coincide with periods of reduced water stress and increased food production.

Both subspecies, similar to other chipmunks, are adept tree climbers but spend much of their time in and on brushy vegetation, limestone ledges, cliffs, woody debris, and rockpiles. They tend to be most active in early morning and late afternoon, especially during the hotter months of the year.

Current Status: The Organ Mountains chipmunk was approved for listing as threatened by the New Mexico State Game Commission in 1983 (Jones and Schmitt, 1997). In 1987, NMDGF proposed the addition of the Oscura Mountains population of Colorado chipmunks based on a study by Sullivan and Yates (1987) that indicated the Oscura Mountains chipmunks were most closely related to chipmunks in the Organ Mountains. The Oscura Mountains population was included within the listing of the Organ Mountains subspecies in 1988 (Jones and Schmitt, 1997) as an undescribed subspecies under the Organ Mountains chipmunk. The Oscura Mountains population was later described as a new subspecies, *T. q. oscuraensis*, by Sullivan (1996).

The Organ Mountains population of chipmunks was estimated at 1,000 to 2,000 by Patterson (1980). No estimates have been attempted for the Oscura Mountains population, but periodic surveys conducted since 2004 suggest a small population that might be more widely distributed in this mountain range than previously believed (T. Griffin, pers. comm., 2005; D. Burkett, pers. comm., 2010). Surveys of both populations were conducted by Riviuccio et al. (2003) using auditory detection. Informal visual surveys conducted in both mountain ranges since 2005 indicate continued persistence of these chipmunks at historic sites (NMDGF files). Perkins-Taylor (2017) recently completed a study of the population in the Oscura Mountains focused on occupancy patterns and habitat use of chipmunks using camera traps.

Threats: These small, isolated chipmunk populations are extremely vulnerable to habitat loss or alteration. Disease (i.e., sylvatic plague) may also pose threats to these populations. The mosaic of piñon-juniper-oak woodland habitats of the Oscura Mountains chipmunk and the broken topography with limestone cliffs and ledges has a patchy distribution and is largely restricted to the west and northwest cliffs in the Oscura Mountains (Sullivan, 1996). Because of the localized and patchy distribution of this habitat, the most immediate threat to this subspecies is destruction of natural habitat by human activities and wildfire.

Recommendations: No change in the listing status of the Organ Mountains Colorado chipmunk (considered here to also include the Oscura Mountains population) is recommended. Frey (2011, 2012) and Frey and Kopp (2013) developed monitoring recommendations for populations in the Organ Mountains that include use of an occupancy model approach and non-invasive techniques (e.g., visual and auditory detection). Coordination with the U.S. Bureau of Land Management, White Sands Missile Range, and Fort Bliss Military Reservation for monitoring of the Organ Mountains populations should be initiated. A radiotelemetry study of the Organ Mountains population was initiated in 2018 to better define the natural history and habitat requirements of this subspecies which will inform future recommendations for management (J.K. Frey, pers. comm.). NMDGF will continue to evaluate the need to implement procedures under the WCA to list the Oscura Mountains chipmunk, *T. q. oscuraensis*, as a threatened subspecies instead of continuing to include it as an undescribed form under the Organ Mountains subspecies of Colorado chipmunk. Although the genus *Tamias* has been applied for all chipmunk species in New Mexico to conform with recent taxonomic information (Thorington and Hoffmann, 2005; Bradley et al. 2014), a more recent study by Patterson and Norris (2016) proposes the use of *Neotamias* for all western North American species. We retain *Tamias* for the time being, pending evaluation of this taxonomic change.

Literature Cited:

- Bailey, V. 1932. Mammals of New Mexico. North American Fauna 53:1-412.
- Bradley, R.D., L.E. Ammerman, R.J. Baker, L.C. Bradley, J.A. Cook, R.C. Dowler, C. Jones, D.J. Schmidly, F.B. Stangl, Jr., R.A. Van Den Bussche, and Würsig. 2014. Revised checklist of North American mammals north of Mexico, 2014. Occasional Papers of the Museum of Texas Tech University (327):1-27.
- Caire, W., J. D. Tyler, B. P. Glass, and M. A. Mares. 1989. Mammals of Oklahoma. University of Oklahoma Press, Norman, OK. 567 pp.
- Durrant, S.D. 1952. Mammals of Utah: taxonomy and distribution. Univ. Kansas Publ., Mus. Nat. Hist., 6:1-519.

- Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM. xxii + 360 pp.
- Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado, Niwot, CO. 467 pp.
- Frey, J.K. 2011. Development of non-invasive monitoring protocols for the Organ Mountains chipmunk. Final report to Share With Wildlife Program, New Mexico Department of Game and Fish, Santa Fe. 41 pp.
- Frey, J.K. 2012. Surveillance monitoring and habitat suitability model for the Organ Mountains chipmunk. Report to Share With Wildlife Program, New Mexico Department of Game & Fish. 5 pp.
- Frey, J.K. and D.A. Kopp. 2013. Habitat suitability model for the Organ Mountain Chipmunk. Report to Share With Wildlife Program, New Mexico Department of Game and Fish, Santa Fe.
- Hall, E. R. 1981. The Mammals of North America. John Wiley & Sons, New York, NY, 2nd ed., 1:xv +1-600 + 90.
- Hoffmeister, D. F. 1986. Mammals of Arizona. The University of Arizona Press and Arizona Game and Fish Department. 602 pp.
- Howell, A. H. 1929. Revision of the American chipmunks (genera *Tamias* and *Eutamias*). North American Fauna 52:1-157.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Patterson, B. D. 1980. A new subspecies of *Eutamias quadrivittatus* (Rodentia: Sciuridae) from the Organ Mountains, New Mexico. Journal of Mammalogy, 61:455-464.
- Patterson, B.D. and R.W. Norris. 2016. Towards a uniform nomenclature for ground squirrels: the status of Holarctic chipmunks. Mammalia 80:241-251.
- Perkins-Taylor, I. 2017. Using occupancy and species distribution models to identify the distribution and key habitat features of the Oscura Mountains chipmunk and guide monitoring efforts. Unpublished M.S. thesis, New Mexico State University, Las Cruces. 182 pp.
- Rivieccio, M., B.C. Thompson, W.R. Gould, and K.G. Boykin. 2003. Habitat features and predictive habitat modeling for the Colorado chipmunk in southern New Mexico. Western North American Naturalist 63:479-488.
- Sullivan, R. M. 1996. Genetics, ecology, and conservation of montane populations of Colorado chipmunks (*Tamias quadrivittatus*). Journal of Mammalogy 77:951-975.
- Sullivan, R. M. and T. L. Yates. 1987. Results of the protein electrophoretic analysis of the Organ Mountain chipmunk (*Eutamias quadrivittatus australis*) relative to other populations of *E. quadrivittatus* in New Mexico. Progress report, New Mexico Department of Game and Fish, Santa Fe, NM, contract 515.6-75-01. 6 pp.
- Thorington, R. W., Jr., and R. S. Hoffmann. 2005. Family Sciuridae. Pp. 754-818 in D.E. Wilson and D.M. Reeder (eds.), Mammal Species of the World: A Taxonomic and Geographic Reference, 3rd ed. Johns Hopkins Univ. Press, Baltimore. 2 vols., xxxviii+2142 pp.

Southern pocket gopher, *Thomomys umbrinus*

Distribution: The known distribution of the southern pocket gopher in the United States is restricted to a few mountain ranges in southeastern Arizona and the Animas Mountains in New Mexico; most of the species' range is in Mexico (Findley et al., 1975; Hinesley and Thaeler, 1977; Cook, 1982, 1986; Hoffmeister, 1986; Mathis et al., 2014). In New Mexico, the species has been found mostly at elevations above 7200 ft in the Animas Mountains as well as at lower elevations along creeks in that area (Hinesley and Thaeler, 1977; Cook, 1982, 1986). The Animas Mountains population was formerly recognized as a distinct and isolated subspecies (*T. u. emotus*), but was re-assigned to the more widespread geographic race, *T. u. intermedius*, by Mathis et al. (2014). A survey for this species or other pocket gophers in the Big Hatchet Mountains, east of the Animas Mountains, was unsuccessful in detecting southern pocket gophers (Geluso, 2006).

Pocket gophers are fossorial (i.e., live primarily underground) and eat roots of various plant species that are encountered as they dig their burrow systems. The presence of pocket gophers is typically evidenced by mounds of fresh soil which are pushed out of their burrows. They are generally not social, and the only time that individuals coexist in the same burrow system occurs when females are caring for their young. They are polygamous and

breeding may occur more than two times in a year (Hall, 1981). Cook (1982, 1986) found pregnant females between mid-March and early April, with 2-3 embryos in each specimen.

Current Status: The New Mexico State Game Commission approved the listing of the southern pocket gopher as endangered in 1975 (Jones and Schmitt, 1997). The primary reasons for listing the species were endemism and its very restricted distribution in New Mexico. The species is difficult to survey because of its fossorial nature, the relative inaccessibility of its habitat, and its co-occurrence with a closely-related species (Botta's pocket gopher, *Thomomys bottae*) in parts of its range. Part of its range in the Animas Mountains was affected by the Adobe Fire in May-June 2006, although active burrow mounds in partially burned areas and in post-fire debris flows were noted in October 2006 (J. Stuart, pers. observ.). There are no population estimates for this species in New Mexico.

Threats: The species is restricted to a remote area of private land and is not threatened by habitat development or other human activities. Wildfire likely poses the greatest threat to persistence in the Animas Mountains, although the species is likely resilient in this regard. At present, the area of occurrence in New Mexico appears to be secure.

Recommendations: No change in the current listing status of the southern pocket gopher is recommended. With landowner permission, periodic surveys (every 5-10 years) are warranted in the Animas Mountains to determine distribution and population status. Additional surveys in the Peloncillo and Big Hatchet mountains also may be warranted to determine if the species is more widespread than currently known.

Literature Cited:

- Cook, J. A. 1982. The mammals of the Animas Mountains, Hidalgo County, New Mexico, with notes on the effects of fire on mammals of a sacaton grassland. M.S. thesis, University of New Mexico, Albuquerque, NM.
- 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, NM. xxii + 360 pp.
- Geluso, K. 2006. A mountain range (Big Hatchet Mountains) in southern New Mexico without pocket gophers at high elevations? Final report to Endangered Species Prog., New Mexico Dept. Game and Fish, Santa Fe, contract 05-516.53. 13 pp.
- Hall, E. R. 1981. The Mammals of North America. John Wiley & Sons, New York, NY, 2nd ed., 1:xv +1-600 + 90.
- Hinesley, L. L. and C. S. Thaeler, Jr. 1977. Karyotype and distribution of the southern pocket gopher, *Thomomys umbrinus emotus* Goldman. Journal of Mammalogy 58:235-237.
- Hoffmeister, D. F. 1986. Mammals of Arizona. The University of Arizona Press and Arizona Game and Fish Department. 602 pp.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 in T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. Museum of Southwestern Biology, University of New Mexico. 290 pp.
- Mathis, V.L., M.S. Hafner, and D.J. Hafner. 2014. Evolution and phylogeography of the *Thomomys umbrinus* species complex (Rodentia: Geomyidae). Journal of Mammalogy 95:754-771.

Pacific marten, *Martes caurina*

Distribution: The Pacific marten, formerly included in the species American marten (*Martes americana*) and also commonly known as pine marten, is widely distributed in western North America from Alaska to California and New Mexico (Hall, 1981). In New Mexico, the species is known only from the north-central mountains including the San Juan and Sangre de Cristo ranges (Findley et al. 1975). Reports of martens in the Jemez Mountains have not been substantiated, despite recent efforts including the use of camera traps (Long et al. 2015; B. Long, pers. comm.). Habitat in New Mexico includes mature, high elevation spruce-fir (*Picea-Abies*) forests (Bailey, 1932; Findley et al., 1975). Mature/old-growth spruce-fir forests with greater than 30% canopy cover and abundant coarse woody debris (i.e., snags, down fall, etc.) have been identified as preferred marten habitat throughout the range of the species (Clark and Stromberg, 1987). A GIS model for New Mexico indicates that elevation, topographic ruggedness, the availability of voles (important prey), and forest height are the most important variables in predicting suitable

marten habitat, especially combined with snow depth (Menke and Perry, 2009). Martens may avoid large clearings such as clear cuts or burned areas (Koehler and Hornocker, 1977; Soutiere, 1979).

The summer diet of martens is varied and includes small mammals, birds, eggs, insects, some plant fruits, and occasionally carrion (Buskirk and Ruggiero, 1994). Soft mast and berries are eaten in the fall, and small mammals, including voles (*Microtus* spp., *Myodes* sp.), golden-mantled ground squirrels (*Callospermophilus lateralis*), and red squirrels (*Tamiasciurus* spp.) comprise the majority of their winter diet (Buskirk and Ruggiero, 1994). Female martens reach sexual maturity at about 15 months and produce a single litter of 3-4 in spring (Clark and Stromberg, 1987). The gestation period of 8-9 months is long due to delayed implantation.

Current Status: The Pacific marten (as American marten) was approved for listing as threatened by the New Mexico State Game Commission in 1975 (Jones and Schmitt, 1997). Martens reach the southern limit of their geographic distribution in New Mexico, where they are considered to be an uncommon resident species. The presence of this species in the Sangre de Cristo Range in Taos County and San Juan Mountains in Rio Arriba County was reconfirmed in the 1990s through the collection of road-killed specimens; the species was also reported from the Taos Ski Valley during 1997-1999 (NMDGF, unpublished data). Surveys conducted since 1999 have found marten in the Sangre de Cristo Range in the vicinity of Taos and Pecos, and in the San Juan Mountains near Chama (Long, 1999, 2001, 2002, 2009). In 2003, Department personnel captured and radio-collared several marten in the vicinity of Taos Ski Valley (Long, 2003). Results from monitoring efforts suggest that there is a small resident population in this area, but it remains unclear as to whether this population is isolated from other populations in the Sangre de Cristos. In this study, radio-collared martens used mature spruce-fir forest and talus slopes at elevations between 10,000 and 11,500 ft in elevation. Surveys in the Sangre de Cristo and Jemez mountains during 2015 (Long et al., 2015), along with verified reports from the public since 2014 (NMDGF, unpublished data), indicate that martens persist in several areas of the Sangre de Cristos, including some historic localities, but have not yet been verified in the Jemez. Their current status in the San Juan Mountains of New Mexico, where the range is apparently not as extensive as in the Sangre de Cristos, is not known.

Threats: Pacific martens in New Mexico are vulnerable to habitat degradation or fragmentation through timber harvesting in mature/old-growth forests, removal of downed timber as part of fuels reduction projects or as firewood, and catastrophic wildfire within the species' range. Catastrophic wildfire likely poses the greatest threat under present conditions in the state. Marten are also very susceptible to trapping, although there is currently no open season for this furbearer in New Mexico. Illegal take of marten may pose a minor threat in some areas. Marten have been killed by vehicle impacts in New Mexico, but this is likely a minor threat in most areas of occurrence.

Recommendations: No change in the current listing status of the Pacific marten is recommended. Studies to better determine distribution, habitat use, population status, and population isolation in New Mexico are needed to inform forest management practices and other actions that might affect the species.

Literature Cited:

- Bailey, V. 1932. Mammals of New Mexico. North American Fauna 53:1-412.
- Bradley, R.D., L.E. Ammerman, R.J. Baker, L.C. Bradley, J.A. Cook, R.C. Dowler, C. Jones, D.J. Schmidly, F.B. Stangl, Jr., R.A. Van Den Bussche, and B. Würsig. 2014. Revised checklist of North American mammals north of Mexico, Occasional Papers of the Museum of Texas Tech University (327):1-27.
- Buskirk, S. W. and L. F. Ruggiero. 1994. American Marten. *In* The scientific basis for conserving forest carnivores American marten, fisher, lynx, and wolverine in the western United States. L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, eds. U.S.D.A. Forest Service. General Technical Report RM-254: 7-37.
- Clark, T. W. and M. R. Stromberg. 1987. Mammals in Wyoming. Lawrence, Kansas, University of Kansas Press. 314 pp.
- Findley, J. S., A. H. Harris, D. E. Wilson, and C. Jones. 1975. Mammals of New Mexico. University of New Mexico Press, Albuquerque, NM. xxii + 360 pp.
- Hall, E. R. 1981. The Mammals of North America. John Wiley & Sons, New York, NY, 2nd ed. 2:601-1181+90.
- Jones, C. and C. G. Schmitt. 1997. Mammal species of concern in New Mexico. Pages 179-205 *in* T. L. Yates, W. L. Gannon, & D. E. Wilson, eds. Life Among the Muses: Papers in Honor of James S. Findley. Museum of Southwestern Biology, University of New Mexico. 290 pp.

- Koehler, D. M. and M. G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitterfoot Wilderness. *Journal of Wildlife Management* 41:500-505.
- Long, B.J. 1999. Detection surveys for American Marten (*Martes americana*) in the Rio Hondo drainage, Taos Co., N.M. Final report to T and E Inc., Las Cruces, New Mexico and Share With Wildlife Program, New Mexico Department of Game and Fish, Santa Fe. 22 pp.
- Long, B.J. 2001. The distribution of American Marten in northern New Mexico: the combined result of track-plate and snow-tracking surveys, June 1997 through June 2001. Final report submitted to Share With Wildlife Program, New Mexico Department of Game and Fish, Santa Fe and The Turner Foundation.
- Long, B.J. 2002. Detection surveys for American Marten (*Martes americana*) on the Valles Caldera National Preserve, Jemez Mountains, New Mexico. Report to Valles Caldera National Preserve, Jemez Springs, NM. 6 pp.
- Long, B.J. 2003. Winter and spring home ranges of American marten in northern New Mexico, along with observations on rest site and den site characteristics. Final report to Share With Wildlife Program, New Mexico Department of Game and Fish, Santa Fe; T&E Inc., Cortaro, Arizona; and U.S. Forest Service, Carson National Forest, Questa, New Mexico. 9 pp.
- Long, B.J. 2009. American marten survey report. Final report to Share With Wildlife Program, New Mexico Department of Game and Fish, Santa Fe. 10 pp.
- Long, B., M. East, and J. Klingel. 2015. Snow-tracking surveys and camera trapping for American marten in the Pecos Wilderness and San Pedro Parks Wilderness areas, in north-central New Mexico, USA. Report to Share With Wildlife Prog., New Mexico Dept. Game and Fish, Santa Fe.
- Menke, K.A. and T.W. Perry. 2009. Determining suitable habitat for American Marten (*Martes americana*) using a Geographic Information System (GIS). Final report to Share With Wildlife Prog., New Mexico Dept. Game and Fish, Santa Fe.
- Soutierre, E. C. 1979. The effects of timber harvesting on the marten. *Journal of Wildlife Management* 43:850-860.

BIRDS

ENDANGERED

Brown Pelican, *Pelecanus occidentalis*

Distribution: This coastal marine and estuarine species breeds from California and the mid-Atlantic states southward to South America (AOU 1998). Brown Pelicans are rare/accidental visitors inland to New Mexico; they can occur during all seasons, but are most frequently observed during summer through fall. Most reports are from large lakes/reservoirs or along major rivers, including the San Juan, Rio Grande, Canadian, Gila, and Pecos drainages. Most Brown Pelicans that occur in New Mexico are the Pacific subspecies, *P. o. californicus*, although the eastern *P. o. carolinensis* may also occur.

Current Status: The Brown Pelican was listed as federally endangered throughout its range under the precursor of the Endangered Species Act (ESA) in 1970 (United States Code of Federal Regulations 1970). Another success story of the ESA, Brown Pelicans in Florida and Alabama and in coastal states along the Atlantic Coast were removed from the Federal List of Endangered and Threatened Wildlife in 1985 (USFWS 1985). The Brown Pelican has similarly recovered throughout the remainder of its range in North, Central, and South America and in the Caribbean, and all populations within the United States were removed from the Federal List of Endangered and Threatened Wildlife in 2009 (USFWS 2009). In New Mexico, the Brown Pelican was listed first as threatened in 1983 and then was reclassified as endangered in 1990 as the extent of its occurrence in New Mexico became better understood. Brown Pelicans were recorded annually (averaging fewer than 15 individuals per year) in New Mexico during the fifteen-year period from 2001-2015; observations, including some repeat observations, of 1-3 individuals were recorded across the state at large reservoirs from 2016 – 2018 (eBird 2018).

Threats: An important factor in the decline of the species was pesticide contamination of its prey base (fish), leading to impaired reproduction and direct mortality (USFWS 1985, Johnsgard 1993, Shields 2002). Current threats

include loss of breeding areas (e.g., due to oil spills and tropical storm events), ocean conditions/prey species abundance, illegal killing, and competition with commercial fisheries. Current threats are not amenable to management actions in New Mexico due to the general lack of appropriate habitat/geographic range of this species. As a federally recovered rare/accidental inland visitor, there are no ongoing or future management plans to specifically benefit Brown Pelicans in New Mexico.

Recommendations: Brown Pelicans are federally protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703-712; Ch. 128; July 3, 1918; 40 Stat. 755), as amended; strict enforcement of laws against harming and disturbing all Brown Pelicans is essential in protecting the few individuals that occur in New Mexico. No change in status is recommended.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Cornell Lab of Ornithology. eBird Range Map - Brown Pelican. Available online: <https://ebird.org/map/brnpel?neg=true&zh%20%20=true&gp=false&ev=Z&mr=112&bmo=1&emo=12&hstc=75100365.4e71a68d473fbc60786697b79da80e50.1528149905924.1529598177586.1529606232667.22&hssc=75100365.5.1529606232667&hsfp=468739674%20-%20ga=2.38092390.435631338.1529533773-578635738.1528149904>. Accessed 21 June 2018.
- Johnsgard, P. A. 1993. Cormorants, darters, and pelicans of the world. Washington, D.C.: Smithsonian Press. 445 p.
- Shields, M. 2002. Brown pelican (*Pelecanus occidentalis*). In The birds of North America, No. 609 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- United States Code of Federal Regulations. 1970. Title 50 CFR Part 17 – conservation of endangered species and other fish or wildlife. Federal Register 35:8491-8497; 16047-16048.
- United States Fish and Wildlife Service (USFWS). 1985. Removal of the Brown Pelican in the southeastern United States from the list of endangered and threatened wildlife; final rule. Federal Register 50:4938-4945.
- United States Fish and Wildlife Service (USFWS). 2009. Endangered and threatened wildlife and plants; removal of the Brown Pelican (*Pelecanus occidentalis*) from the Federal List of Endangered and Threatened Wildlife. Federal Register 74:59444-59472.

Aplomado Falcon, *Falco femoralis*

Distribution: This grassland raptor occurs from the southwestern United States to southern South America (AOU 1998, Keddy-Hector 2000). The historical range in New Mexico included desert grasslands across the southern one-third of the state and across the central region north to Socorro County (Hector 1987, Keddy-Hector 2000, Meyer and Williams 2005). The species requires extensive, contiguous desert grasslands characterized by relatively tall, dense grass cover and scattered yucca (*Yucca* spp.) and mesquite (*Prosopis glandulosa*) (Montoya et al. 1997, Young et al. 2002).

Current Status: The northern subspecies, *F. f. septentrionalis*, is federally-listed as endangered (USFWS 1986) with a nonessential experimental population designation for all populations in New Mexico and Arizona (USFWS 2006). The subspecies was listed by New Mexico as endangered in 1990. Following a documented nesting in southern New Mexico in 1952 (Ligon 1961), the subspecies was very rarely reported in the state from the 1960s through the 1980s (Meyer and Williams 2005). Coincident with the 1992 discovery of thriving populations in nearby Chihuahua, Mexico (Montoya et al. 1997), an increased presence of Aplomado Falcons in New Mexico became apparent by the early 1990s, which raised hopes that natural recolonization of the historical range was underway (Williams 1997). Extensive surveys and studies in adjacent Chihuahua, Mexico better clarified the extent of the distribution there, and indicated that falcons in northern Chihuahua and southern New Mexico should be considered a single interacting population (Young et al. 2004). Overall, the decade 1990-1999 produced 24 credible reports involving 26-31 falcons in southern New Mexico (Meyer and Williams 2005). That trend continued into 2006, with multiple reports throughout the historical New Mexico range, including observations of pairs. One pair occupied a territory for at least two years (2001 and 2002) and fledged young, which was the first successful nesting by native Aplomado Falcons in the United States in half a century (Meyer and Williams 2005). Between 2006 and 2012, The Peregrine Fund released 337 captive-bred Aplomados fledglings of tropical southern Mexico origin at five New

Mexico hack sites in an attempt to reestablish a breeding population. Eleven captive-bred birds were released in 2006, 39 birds were released in 2007, 70 birds were released in 2008, 70 birds were released in 2009, 67 were released in 2010, 46 were released in 2011, and 32 were released in 2012 (Hunt et al. 2013). In contrast to previous years, no naturally-occurring Aplomado Falcons were reported in 2007. Although unmarked birds were observed in 2008, 2009, and 2011, their origin could not be determined owing to the dispersal of unbanded progeny of Aplomado Falcons released into New Mexico since 2006. Dispersal and distribution surveys have not been completed across the state, but based on the small numbers of individuals remaining at the release sites during the following years, it appears that the majority of released Aplomados either dispersed to unknown areas or perished, mostly due to predation, though a single bird was reportedly shot in January 2011 in the Uvas Valley, Doña Ana County. On 20 March 2009, a second-year female was observed in Luna County, 80 miles from where it was released on 22 July 2008, indicating that released birds can range widely. Surveys in 2011 revealed only one surviving pair that fledged three young, and a 2012 survey revealed only one adult. In 2013 surveys, one individual was found on the Armendaris Ranch, and one pair was unsuccessful in a nesting attempt in Southwestern New Mexico. Because of low survival attributed to persistent drought, reduction in prey densities, and high mortality of released falcons, the Peregrine Fund announced it was discontinuing release efforts in New Mexico and West Texas in 2013 (Hunt et al. 2013). Recovery efforts are now focused in South Texas (Mutch 2013); the population of 33 breeding pairs in South Texas appears to be self-sustaining (The Peregrine Fund 2016). Future efforts to monitor natural reestablishment in New Mexico may be difficult, as all offspring of captive-bred birds breeding in the wild are not banded and, thus, cannot be differentiated in the field from naturally-occurring Aplomado Falcons. Additionally, natural recolonization from the Chihuahuan population appears less likely due to population declines. Monitoring of the native population in Chihuahua, Mexico grasslands indicated declining nest success during the early 2000s along with extensive conversion of suitable habitat to agricultural colonies; recent territory occupancy trends suggest a decline and researchers estimate that there may be as few as 10 pairs remaining in central Chihuahua (Marcias-Durante et al. 2016).

Threats: The primary causes for decline of the Northern Aplomado Falcon are loss and degradation (e.g., shrub encroachment and loss of grass cover) of required grassland habitat from excessive grazing, control of range fires, and conversion of grasslands to agricultural lands (Hector 1987; USFWS 1986, 1990). There is also evidence of continued contamination of the Aplomado Falcon's prey by organochlorine pesticides and toxic heavy metals such as mercury and lead (Keddy-Hector 2000).

Recommendations: No change in status is recommended. All agencies and organizations should continue to work cooperatively to protect native Aplomados, and should encourage continued natural recolonization by maintaining and improving grassland habitat. This cooperative effort will be particularly important given the United States Fish and Wildlife Service's designation of the entire state of New Mexico as a nonessential experimental population area for the Aplomado Falcon, and the resulting removal of requirements for Aplomado habitat conservation measures that had resulted from previous Biological Opinions.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Hector, D. P. 1987. The decline of the Aplomado Falcon in the United States. *Am. Birds* 41:381-389.
- Hunt, W. G., J. L. Brown, T.J. Cade, J. Coffman, M. Curti, E. Gott, W. Heinrichy, J. P. Jenny, P. Juergens, A. Macias-Duarte, A. B. Montoya, B. Mutch, and C. Sandfort. 2013. Restoring Aplomado Falcons to the United States. *Journal of Raptor Research* 47(4):335-351. Available online: <http://www.bioone.org/doi/pdf/10.3356/JRR-12-52.1>. Accessed 2 July 2018.
- Keddy-Hector, D. P. 2000. Aplomado Falcon. *In* The birds of North America, No. 549 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Ligon, J. S. 1961. New Mexico birds. Albuquerque, NM: Univ. New Mexico Press. 360 p.
- Meyer, R. A., and S. O. Williams III. 2005. Recent nesting and current status of Aplomado Falcon (*Falco femoralis*) in New Mexico. *N. Am. Birds* 59:352-356.
- Marcias-Durante, A., A. B. Montoya, J. R. Rodriguez-Salazar, A. O. Panjabi, P. A. Calderon-Dominguez, and W. G. Hunt. 2016. The Imminent Disappearance of the Aplomado Falcon from the Chihuahuan Desert. *Journal of Raptor Research* 50(2):211-216.

- Montoya, A. B., P. J. Zwank, and M. Cardenas. 1997. Breeding biology of Aplomado Falcons in desert grasslands of Chihuahua, Mexico. *J. Field Ornithol.* 68:135-143.
- Mutch, B. 2013. Northern Aplomado Falcon restoration report. Boise, ID: The Peregrine Fund. 12p.
- The Peregrine Fund. 2016. Aplomado Falcon Restoration. Available online: <https://www.peregrinefund.org/projects/aplomado-falcon>. Accessed 23 July 2018.
- United States Fish and Wildlife Service (USFWS). 1986. Final rule: determination of the Northern Aplomado Falcon to be an endangered species. *Federal Register* 51:6686-6690.
- United States Fish and Wildlife Service (USFWS). 1990. Northern Aplomado Falcon recovery plan. Albuquerque, NM: United States Fish and Wildlife Service. 58 p.
- United States Fish and Wildlife Service (USFWS). 2006. Final rule: establishment of a nonessential experimental population of Northern Aplomado Falcons in New Mexico and Arizona. *Federal Register* 71:42298-42315.
- Williams, S. O., III. Recent occurrences of Aplomado Falcons in New Mexico; is natural recolonization of historical range underway? *New Mexico Ornithological Society Bull.* 25:39.
- Young, K. E., B. C. Thompson, D. M. Browning, Q. H. Hodgson, J. L. Lanser, A. Lafon Terrazas, W. R. Gould, and R. Valdez. 2002. Characterizing and predicting suitable Aplomado Falcon habitat for conservation planning in the northern Chihuahuan Desert. Las Cruces, NM: New Mexico Cooperative Fish and Wildlife Research Unit. 210 p.
- Young, K. E., B. C. Thompson, A. Lafon Terrazas, A. B. Montoya, and R. Valdez. 2004. Aplomado Falcon distribution and abundance in the northern Chihuahuan Desert of Mexico. *J. Raptor Research* 38:107-117.

White-tailed Ptarmigan, *Lagopus leucura*

Distribution: This alpine grouse occurs from Alaska and the Yukon south through the Rocky Mountains, reaching its southernmost limits in New Mexico (AOU 1998, Martin et al. 2015). In New Mexico, the species occurred historically in unknown numbers on most high peaks (above treeline) of the Sangre de Cristo Mountains, from the vicinities of Lake Peak and Pecos Baldy northward to the Colorado line (Bailey 1928, Ligon 1961, Braun and Williams 2015).

Current Status: The U.S. Fish and Wildlife Service has undertaken a Species Status Assessment of the Southern White-tailed Ptarmigan (*L. l. altipetens*) in response to a petition to list it as threatened under the U.S. Endangered Species Act (CBD 2010, USFWS 2015). The species was state-listed as endangered by New Mexico in 1975, and the Department completed a recovery plan in 2017 (Bulger 2017). By the mid-1900s, much of its habitat had become degraded from sheep grazing, and it was thought to be restricted to only a few peaks in the northernmost portions of its former range in New Mexico (Ligon 1961, Braun and Williams 2015). In 1981, 43 ptarmigan from central Colorado were translocated to Santa Barbara Ridge, Pecos Wilderness Area, in an attempt to substantially augment or re-establish the population at its southern extent in New Mexico. Surveys undertaken in recent years by Wolfe (2011, 2014), Braun (Braun and Williams 2015), and NMDGF (ongoing) have documented the persistent presence of small populations of White-tailed Ptarmigan in Pecos Wilderness, Wheeler Peak Wilderness, and the Culebra Range. Other alpine areas in the Sangre de Cristo Mountains lack sufficient suitable habitat to support breeding populations (Wolfe and Larsson 2018). These sites, which may be seasonally occupied by a few individuals or used as stopover points by dispersing birds, include the Latir Peak Wilderness, Little Costilla Peak, Gold Hill, and much of the high alpine zone of the Pecos Wilderness from Truchas Peaks south to Pecos Baldy and Lake/Deception Peak. Recent surveys conducted by NMDGF indicate that fewer than 50 adult White-tailed Ptarmigan currently reside in New Mexico .

Threats: Initial declines were attributed to habitat degradation from intensive grazing, particularly by domestic sheep, combined with unrestricted hunting by sheepherders and miners (Bailey 1928, Ligon 1961, Lee 1967, Hubbard 1970). Threats to the state's remnant ptarmigan population may include use of New Mexico's limited alpine tundra habitat by livestock, growing numbers of elk and bighorn sheep (which may compete with ptarmigan for winter forage), heavy recreational use of alpine meadows, unleashed dogs accompanying hikers, and ski area development (Hoffman 2006, Wolfe et al. 2011, Martin et al. 2015). Climate change in particular has significant potential to negatively impact this species in New Mexico, as ptarmigan are highly intolerant to heat stress and are dependent on alpine vegetation and remnant snowfields in summer, and soft snow for roosting in winter (Hoffman 2006, Martin et al. 2015)

Recommendations: No change in status is recommended. NMDGF should work with land managers to protect alpine and timberline habitats for this species, and should attempt to increase population sizes at the primary occupied sites..

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Bailey, F. M. 1928. Birds of New Mexico. Santa Fe, NM: New Mexico Department of Game and Fish. 807 p.
- Braun, C.E., and S.O. Williams III. 2015. History and status of the White-tailed Ptarmigan in New Mexico. *Western Birds* 46: 233-243.
- Bulger, J. White-tailed Ptarmigan (*Lagopus leucura*) recovery plan. January 12, 2017. New Mexico Department of Game and Fish, Santa Fe, NM. 32 p.
- CBD (Center for Biological Diversity). August 24, 2010. Petition to list the White-tailed Ptarmigan (*Lagopus leucura*) as threatened under the Endangered Species Act. Available: https://www.biologicaldiversity.org/species/birds/white-tailed_ptarmigan/pdfs/WTP_Petition.pdf.
- Hoffman, R.W. 2006. White-tailed Ptarmigan (*Lagopus leucura*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. Available: <http://www.fs.fed.us/r2/projects/scp/assessments/whitetailedptarmigan.pdf>
- Hubbard, J. P. 1970. Check-list of the birds of New Mexico. New Mexico Ornithological Society Publ. No. 3. 108 p.
- Lee, L. 1987. White-tailed Ptarmigan. *In* New Mexico wildlife management. Santa Fe, NM: New Mexico Department of Game and Fish. 250 p.
- Ligon, J. S. 1961. Albuquerque, NM. New Mexico birds. Univ. New Mexico Press. 360 p.
- Martin, K., L.A. Robb, S. Wilson, and C.E. Braun. 2015. White-tailed Ptarmigan (*Lagopus leucura*). *In* The Birds of North America Online (A. Poole, Ed.). Available: <http://bna.birds.cornell.edu/bna/species/068>.
- USFWS (U.S. Fish & Wildlife Service). 2015. 90-day finding on a petition to list the southern white-tailed ptarmigan and the Mt. Rainier white-tailed ptarmigan as threatened with critical habitat. FR 77(108): 33143-33155.
- Wolfe, D.H., and L.C. Larsson. 2018. White-tailed ptarmigan alpine willow distribution in the Sangre de Cristo Mountains, New Mexico. Final Report, 22 February 2018. Professional Services Contract 17-516-0000-00026, New Mexico Department of Game and Fish, Santa Fe.
- Wolfe, D.H., L.C. Larsson, J.R. Oldenettel, H.A. Walker, and M.A. Patten. 2011. Status of populations of the White-tailed Ptarmigan at the southern edge of its range. Pp. 247-258 *in* R.T. Watson, T.J. Cade, M. Fuller, G. Hunt, and E. Potapov (Eds). Gyrfalcons and Ptarmigan in a Changing World, Volume I. The Pergerine Fund, Boise, Idaho.
- Wolfe, D.H., L.C. Larsson, S.J. Oyler-McCance, and M.A. Patten. 2014. Status, distribution, ecology, and genetics of the White-tailed Ptarmigan (*Lagopus leucura*) in New Mexico. 2013 Final Report (dated 27 February 2014). George M. Sutton Avian Research Center, University of Oklahoma, Bartlesville, OK.

Whooping Crane, *Grus americana*

Distribution: Formerly widespread in North America, the species declined to a single flock of about 16 individuals migrating between Canada and coastal Texas by 1941 (Lewis 1995). Natural occurrence of the species in New Mexico is unproven; unverified sightings from the Hatch and Portales areas in the 1850s and 1930s, respectively, might have been of this species (Allen 1952). Until 2002, Whooping Cranes were infrequently reported wintering in the middle Rio Grande Valley of New Mexico; these birds were members of an experimental population from a 1975-1989 recovery effort in Idaho which used Sandhill Cranes (*G. canadensis*) as foster parents for young Whooping Cranes. More recent records have not been confirmed, and are thus unreliable.

Current Status: The Whooping Crane was federally listed as endangered under the precursor of the Endangered Species Act in 1967 with a non-essential, experimental population designation in New Mexico in 1997 (USFWS 1997). In New Mexico, it was first listed as threatened in 1975 and then reclassified as endangered in 1990. After being on the brink of extinction, the species is now an enduring symbol of national and international efforts to recover endangered species as recovery efforts appear to be achieving some success range-wide. According to the United States Fish and Wildlife Service, there were 329 individuals in the only naturally occurring wild flock of whooping cranes in 2016 (Harrell et al. 2016). This population has a long-term increasing trend of approximately

4% per year. The estimated abundance during winter surveys in 2016-2017 was 431 Whooping Cranes; researchers noted that the significant increase in the population was primarily due to improved visibility with a switch in survey aircraft (Butler and Harrel 2017). Because of high mortality rates and lack of pairing and reproduction, all efforts to establish a viable Rocky Mountain flock were terminated in the West, with the remaining birds in the wild being reclassified as “experimental, nonessential” and all critical habitat designations within New Mexico being removed (USFWS 1997). Two captive-bred Whooping Cranes wintered in New Mexico in 2000-2001; one, an 18-year-old individual, survived to winter here in 2001-2002. After migrating north from New Mexico in spring 2002, it was never seen again and presumably died, thereby signaling the end of this experimental population. Unconfirmed reports from Roosevelt County, New Mexico suggest that migrants might reoccur in this area as the wild flock that migrates between Canada and Texas continues to recover (Williams 2007).

Threats: Overall declines in the species are attributed to anthropogenic habitat loss and degradation from draining of freshwater wetlands, fencing, and destruction of tall- and mixed- grass prairie. Once reduced in numbers, populations are more vulnerable to losses from killing, disease, and collision with human-made objects, such as power lines (Lewis 1995). Other threats include limited genetic diversity of the population, loss and degradation of migration stopover habitat, degradation of coastal ecosystems, and threats of chemical and oil spills in Texas (CWS and USFWS 2007).

Recommendations: The continued lack of proof of natural occurrence of the species in the state has complicated NMDGF considerations of whether the species should be removed from New Mexico’s list of threatened and endangered species. Verifiable evidence of naturally occurring Whooping Cranes in Roosevelt County is critical to understanding this species’ future in the state. Whooping Cranes are federally protected under the Migratory Bird Treaty Act (MBTA) of 1918 16 U.S.C. 703-712; Ch. 128; July 3, 1918; 40 Stat. 755), as amended; strict enforcement of laws against harming and disturbing all Whooping Cranes remains essential in protecting those few individuals that might occur in New Mexico.

Literature Cited:

- Allen, R. P. 1952. The Whooping Crane. New York, NY: National Audubon Society Research Report No. 3. 246 p.
- Butler, M. J. and W. Harrell. 2017. Whooping Crane Survey Results 2016-2017. United States Fish and Wildlife Service. Available online: https://www.fws.gov/uploadedFiles/Region_2/NWRS/Zone_1/Aransas-Matagorda_Island_Complex/Aransas/Sections/What_We_Do/Science/Whooping_Crane_Updates_2013/W_HCR_Update_Winter_2016-2017.pdf. Accessed 3 July 2018.
- Canadian Wildlife Service (CWS) and United States Fish and Wildlife Service (USFWS). 2007. International recovery plan for the whooping crane. Ottawa: Recovery of Nationally Endangered Wildlife (RENEW), and Albuquerque, New Mexico: United States Fish and Wildlife Service.
- Harrell, W. and M. Butler. 2016. Whooping Crane Survey Results Winter 2015-2016. U.S. Fish and Wildlife Service. 4p.
- Lewis, J. C. 1995. Whooping Crane. *In* The birds of North America, No. 153 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- United States Fish and Wildlife Service (USFWS). 1997. Designation of the Whooping Cranes of the Rocky Mountains as experimental nonessential and to remove Whooping Crane critical habitat designations from four locations. Federal Register 62:38932-38939.
- Williams, S. O., III. 2007. New Mexico, fall season 2006. *North American Birds* 61:115-118.

Least Tern, *Sternula antillarum*

Distribution: The Least Tern breeds from California, the Dakotas, and Maine south to southern Mexico and the Caribbean; the Interior Least Tern (*S. a. athalassos*) subspecies breeds and nests along interior rivers and other water bodies across the Great Plains and Lower Mississippi Valley (Sidle et al. 1988, AOU 1998). In New Mexico, this summer resident is an occasional visitor to wetlands in at least 18 New Mexico counties, but is only known to breed at Bitter Lake National Wildlife Refuge (NWR) in Chaves County and farther south in the Pecos Valley at Brantley Reservoir in Eddy County. For many years, the only known nesting site in the state was Bitter Lake NWR (Hubbard 1978), but Least Terns were found summering at Brantley Reservoir starting in 2002.

Current Status: The Interior Least Tern was federally listed as endangered in 1985 (USFWS 1985). In New Mexico, this subspecies was listed as endangered in 1976. The state's breeding population is quite small, and reproductive success has typically been poor. During the 10-year period from 1990 to 1999, the annual breeding population averaged only about 6 pairs, with productivity averaging less than 0.6 fledged young produced per pair. In the six-year period from 2000-2005, the population at Bitter Lake increased steadily, to 14 pairs by 2005, and remarkably high productivity was achieved, averaging 1.17 young fledged per pair. After a very poor reproductive year in 2006, when only 2 birds were successfully produced from nesting attempts of 12 pairs, 11 pairs fledged 11 young in 2007. From 2008-2010, the annual breeding population hovered around 7 pairs with annual productivity of approximately 1 young fledged per pair. 2011 was once again a poor reproductive year, with only a single successful young observed from a total of 5-6 nesting pairs. In 2013, approximately 7 pairs hatched 7 chicks, of which 3 were observed as fledglings. The years 2014 and 2015 were poor in terms of production; in 2014, five pairs made eight nesting attempts that resulted in only one fledgling, and in 2015, five pairs made six nesting attempts that resulted in zero fledglings. Two nesting pairs initiated two nesting attempts in both 2016 and 2017 (nest fates not reported; USBOR 2017). Nesting attempts at Brantley Reservoir were first documented in 2004, with conflicting reports of seven to eleven pairs, six or seven nests, and two successful nests with six fledged chicks. In 2006, the Bureau of Reclamation, under a Biological Opinion issued by the United States Fish and Wildlife Service, began to implement actions in order to promote successful nesting at Brantley Reservoir. These actions included the creation of tern nesting and brood-rearing habitats through clearing of exotic vegetation along the shoreline of the reservoir, finely raking some cleared areas to simulate nesting substrate, and leaving other cleared areas with mix of woody debris and sparse vegetation to serve as brood-rearing habitat. In addition, the Bureau of Reclamation worked with NMDGF and United States Fish and Wildlife Service to contract the construction of a floating nesting platform that was launched on 23 June 2009 on Brantley Reservoir, but was damaged by strong winds and resultant waves on the reservoir in 2010. As of 2016, nesting terns have not used these created habitats at Brantley Reservoir; no monitoring of created habitats occurred in 2017. Between 2005 and 2017, there were 16 nesting attempts at Brantley Reservoir; 13 nests were inundated, one was depredated, and two were abandoned. Two eggs were transferred to the Desert Willow Wildlife Rehabilitation Center in 2016 due to imminent inundation of the nest, and 2 hand-reared fledglings were released at Bitter Lake NWR in September; in 2016, two single eggs from two nests were transferred to the rehabilitation facility in 2017, but these efforts were unsuccessful. A protocol for Least Tern monitoring and egg salvage at Brantley Reservoir was established in 2017. Under this protocol, the BOR will: complete surveys for Least Terns, report observations to the USFWS, monitor nests and potential threats, and establish a 400-meter disturbance buffer at active nests; under certain conditions, nests may be relocated to a safer location, and as a last resort (imminent inundation or natural abandonment) eggs may be collected and transported to a rehabilitator (USFWS 2017).

In 2013, the U.S. Fish and Wildlife Service conducted a 5-year review of the Interior Least Tern and found range-wide population persistence and exceedance of numerical recovery goals for 18 years. Based on this status review, the USFWS recommended that the interior population of Least Terns be delisted due to recovery, however, initiation of a delisting proposal was not recommended until: (1) the range-wide population model can be completed and reviewed to confirm status and trends assessments, (2) conservation agreements are in place to maintain management, and (3) a range-wide monitoring strategy and plan is prepared (USFWS 2013).

Threats: The Interior Least Tern has been threatened by human disturbance at nesting beaches and flats, chemical contamination of the prey base, and loss and degradation of riverine habitats from altered flow regimes and channelization (USFWS 1990, Thompson et al. 1997). The Bitter Lake NWR population might be jeopardized by oil and gas development, lowered water tables, contamination, and predation (e.g., by coyotes). The struggling Brantley Reservoir population is threatened by ill-timed changes to water levels and by human disturbance to the limited sand flat habitat.

Recommendations: No change in status is recommended. NMDGF should continue to cooperate with the United States Fish and Wildlife Service, the United States Bureau of Reclamation, and other agencies, to monitor the known nesting populations and manage habitat to benefit this species. Flexible water management at Brantley Reservoir should be considered where possible to minimize likelihood of inundating nests and to increase the potential that appropriate habitats (such as created or managed habitats) are utilized by the species.

Literature Cited:

- American Ornithologist's Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Hubbard, J. P. 1978. Revised check-list of the birds of New Mexico. New Mexico Ornithological Society Publ. No. 6. 110 p.
- Moore, D. and D. Ahlers. 2014. Interior Least Tern monitoring results, 2013 Brantley Lake, New Mexico. Albuquerque, NM: United States Department of the Interior Bureau of Reclamation, Albuquerque Area Office. 25p.
- Sidle, J. G., J. J. Dinan, M. P. Dryer, J. P. Rumancik, Jr., and J. W. Smith. 1988. Distribution of the Least Tern in interior North America. *Am. Birds* 42:195-201.
- Thompson, B. C., J. A. Jackson, J. Burger, L. A. Hill, E. M. Kirsch, and J. L. Atwood. 1997. Least Tern. *In* The birds of North America, No. 290 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- United States Department of the Interior Bureau of Reclamation (USBOR). 2007. Interior Least Tern monitoring results 2007 Brantley Lake, New Mexico. Albuquerque, NM: United States Department of the Interior Bureau of Reclamation, Albuquerque Area Office.
- United States Department of the Interior Bureau of Reclamation (USBOR). 2017. Interior Least Tern monitoring results 2017: Brantley Reservoir, New Mexico. Albuquerque, NM: United States Department of the Interior Bureau of Reclamation, Albuquerque Area Office. Available online: https://www.usbr.gov/tsc/techreferences/env/2017InteriorLeastTernReport-FINAL_508.pdf. Accessed 3 July 2018.
- United States Fish and Wildlife Service (USFWS). 1985. Interior population of the Least Tern determined to be endangered. *Federal Register* 50:21784-21792.
- United States Fish and Wildlife Service (USFWS). 1990. Recovery plan for the interior population of the Least Tern, *Sterna antillarum*. Twin Cities, MN: United States Fish and Wildlife Service. 90 p.
- United States Fish and Wildlife Service (USFWS). 2013. Interior Least Tern (*Sternula antillarum*) 5-Year Review: Summary and Evaluation. 75 p.
- United States Fish and Wildlife Service (USFWS). 2017. Summary Biological Opinion on the Carlsbad Project Water Operations and Water Supply Conservation – Consultation Number 02ENNM00-2016-F-0506. Available online: https://www.fws.gov/southwest/es/newmexico/documents/BO/2016-F-0506_Carlsbad_Project_Water_Operations_BiOp_Final.pdf. Accessed 3 July 2018.

Common Ground-Dove, *Columbina passerina*

Distribution: This small dove occurs from the southernmost United States, including southern New Mexico, south into Latin America (AOU 1998, Bowman 2002). Within New Mexico, it occurs primarily across the southern counties that border Mexico. This low elevation species prefers brushy, well-watered valleys, and frequents riparian woodlands and shrublands, especially mesquite thickets along streams and canyon bottoms.

Current Status: This species was listed by New Mexico as endangered in 1983. It was formerly year-round resident in southern New Mexico (Ligon 1961), but was only a rare visitor by the 1980s. During the 10-year period from 1990 to 1999, an average of less than 5 birds per year, were reported in New Mexico, with no documented nesting. Documented occurrences increased from 2000 to 2012, averaging about 15 birds per year, with birds reported in 11 counties, primarily in the southwestern counties of Doña Ana, Grant, Hidalgo, and Luna. Birdwatchers reported 7 sightings in 2012, 13 in 2013, 10 in 2014, and 25 in 2016; it should be noted, however, that some of these sightings may be of the same individuals.

Threats: Declines in this species are likely in response to loss and degradation of native shrublands in lowland riparian areas, through clearing, burning, excessive grazing, and land conversion.

Recommendations: No change in listing status is recommended. Protection and enhancement of shrubby riparian habitats and provision of surface water in such habitats should be encouraged.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.

- Bowman, Reed. 2002. Common Ground-Dove (*Columbina passerina*). In *The birds of North America*, No. 645 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Ligon, J. S. 1961. Albuquerque, NM: New Mexico birds. Univ. New Mexico Press. 360 p.

Buff-collared Nightjar, *Anstromus ridgwayi*

Distribution: This nocturnal species occurs primarily from western and southern Mexico south into Nicaragua. It reaches its northernmost geographic limits in southeastern Arizona and southwestern New Mexico (AOU 1998), where it summers in low-elevation desert canyons characterized by thickets of mesquite, acacia, hackberry, and other brush with scattered junipers on adjacent slopes. Most New Mexico reports are from Guadalupe Canyon, Hidalgo County, with single reports from Doña Ana and Grant counties.

Current Status: This species was listed by New Mexico as endangered in 1975. It was first discovered in the United States in Guadalupe Canyon, Hidalgo County (Johnson and Hardy 1959), but it has not been reported there since 1985; NMDGF surveys for listed bird species failed to detect this species from 1987 to 2004, and no birds were detected during NMDGF play-back surveys conducted in 2008 (Walker 2009). There has been only a single report of the species in the state since 1985: an unconfirmed occurrence of one heard at Redrock, Grant County on 30 May 1999 (Williams 1999). The species is rare but regular in occurrence in southern Arizona (Bowers and Dunning 1997, Corman and Wise-Gervais 2005).

Threats: Loss of native habitat in brushy desert canyons, through vegetation clearing, burning, overgrazing, or water table reduction threatens this species at the northern fringe of its range. Human disturbance, including bird watchers, could likewise jeopardize small populations by disrupting breeding activity.

Recommendations: No change in listing status is recommended. NMDGF should continue to work with public and private land managers to protect and enhance Guadalupe Canyon and similar habitats for native species such as this nightjar.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington D.C.: American Ornithologists' Union. 829 p.
- Bowers, R. K., Jr., and J. B. Dunning, Jr. 1997. Buff-collared Nightjar. In *The birds of North America*, No. 267 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Corman, T. E., and C. Wise-Gervais, eds. 2005. Arizona breeding bird atlas. Albuquerque, NM: Univ. New Mexico Press. 636 p.
- Johnson, R. F., and J. W. Hardy. 1959. The Ridgway Whip-Poor-Will and its associated avifauna in southwestern New Mexico. *Condor* 61:206-209.
- Walker, H. A. October 2009. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.
- Williams, S. O., III. 1999. New Mexico, spring season 1999. *N. Am. Birds* 53:312-314.

Elegant Trogon, *Trogon elegans*

Distribution: This primarily Mexican species reaches the northern limit of its range in southeastern Arizona and southwestern New Mexico (AOU 1998, Kunzmann et al. 1998), where it is a rare summer resident of riparian habitats in montane canyons (Hall and Karubian 1996). In New Mexico, it is found almost annually in the Peloncillo Mountains in Hidalgo County. Non-breeding vagrants rarely occur elsewhere in other mountain ranges of southern Hidalgo County (9 May 2009), and in Doña Ana (the first and only on 13 February 2011), Catron, Grant, Otero, and Sierra counties.

Current Status: The species is listed by the United States Fish and Wildlife Service as a species of special concern (USFWS 2002), and it was listed as endangered by New Mexico in 1975. It became one of the first non-game birds in the United States to receive special protection when it was protected from all forms of collecting by Arizona in about 1940. The Elegant Trogon was only known to breed in New Mexico in a single canyon in the Peloncillo Mountains, where NMDGF and cooperators had documented one to two pairs annually from 1991 through 2006. In July 2006, a second breeding site in another canyon of the Peloncillo Mountains was discovered. The pair again nested in the newly-discovered breeding site in 2007, but nesting has not been documented at either locale in subsequent years. Surveys in the primary nesting site has been limited in recent years due to restricted access, but a recent fire in the canyon might have significantly reduced habitat availability. The Elegant Trogon was not detected during surveys conducted for the species in 2008 (Walker 2009), but there was an unconfirmed report of a male at the second breeding site on the morning of 5 July 2008. In 2009, trogons were not found at either of the previously known breeding sites, but one Elegant Trogon was vocal in a new Peloncillo Mountains locale on 9 May 2009. A single male was seen and heard on 2 July 2010 in the second breeding site, but no nesting was documented in that year. Nesting was not documented in 2011, but interestingly, two wintering birds were reported: one from the Organ Mountains in Doña Ana County on 13 February 2011 and another from Guadalupe Canyon, Hidalgo County on 20 February 2011. Birdwatchers did not report any sightings from 2012 to 2015, and official surveys were not conducted during 2012-2018.

Threats: The species is threatened by loss of limited breeding habitat (including large trees with suitable nesting cavities) and foraging habitat (including fruiting shrubs) from fire, wood-cutting, excessive grazing, lowering of water tables, road construction, and other development. Disturbance of nesting birds by humans (including photographers and bird watchers using recorded vocalizations to attract birds) is also a threat.

Recommendations: No change in status is recommended. Preservation and enhancement of mid-elevation montane riparian habitats in the Peloncillo Mountains and similar ranges is necessary, including maintaining water tables in canyons sufficient to support sycamores. Protection of breeding territories and nesting birds from human disturbance is also a priority.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Hall, L. S., and J. O. Karubian. 1996. Breeding behavior of Elegant Trogons in southeastern Arizona. *Auk* 113:143-150.
- Kunzmann, M. R., L. S. Hall, and R. R. Johnson. 1998. Elegant Trogon (*Trogon elegans*). In the birds of North America, No. 357 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Walker, H. A. April 2009. 2008 field notes on bird species of the Peloncillo Mountains. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Coronado National Forest, Douglas, AZ.
- United States Fish and Wildlife Service (USFWS). 2002. Birds of conservation concern 2002. Arlington, VA: United States Fish and Wildlife Service. 99 p.

Northern Beardless-Tyrannulet, *Camptostoma imberbe*

Distribution: This Neotropical flycatcher occurs from Costa Rica north through Mexico, reaching its northernmost geographic limits in southern Texas, southeastern Arizona, and southwestern New Mexico (Tenney 2000). In New Mexico, it summers regularly only in Guadalupe Canyon, Hidalgo County (AOU 1998). This is a low-elevation riparian species that prefers dense thickets of mesquite, acacia, hackberry, and similar vegetation, typically along stream courses (Phillips et al. 1964, Oberholser 1974).

Current Status: The species was listed as endangered by New Mexico in 1975. It is also listed as threatened in Texas. This small flycatcher was detected on NMDGF surveys of New Mexico's Guadalupe Canyon each year from 1987 to 2004 and again in 2008 and 2009, with nesting documented in 2002, 2003, 2008, and 2009. Incidental sightings from birdwatchers provided evidence that the Northern Beardless-Tyrannulet was also present in the canyon in 2010 and 2011. The number of detected territories in the canyon averaged 3.2 territories annually from 1987 to 1996, indicating that the species might have benefited from the exclusion of livestock and improved habitat

conditions there since the late 1980s. However, numbers dropped following human-caused fire there in the mid-1990s and the onset of drought in the late 1990s; following these occurrences, an annual average of only 1.4 territories was documented from 1997 to 2004 and 2 territories were documented in both 2008 and 2009 (Walker 2009). Birdwatchers reported about 5 territories in 2010 and 3 territories in 2011. In 2012, birdwatchers reported 2 sightings. There were no reports from birdwatchers in 2013. In 2014 birdwatchers reported four sightings, and in 2015 they reported 13 sightings. It should be noted, however, that many of these sightings could be of the same individuals.

Threats: The very small and localized New Mexico population is vulnerable to loss of required habitat from burning, clearing, lowering of water tables, and excessive grazing.

Recommendations: No change in status is recommended. The preservation and enhancement of native riparian and associated habitats in Guadalupe Canyon and elsewhere in southwestern New Mexico are essential for maintaining this species in the state. Human disturbance at nest and roost sites needs to be minimized.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Oberholser, H. C. 1974. Austin, TX: The bird life of Texas. Univ. Texas Press. 1069 p.
- Phillips, A. R., J. Marshall, and G. Monson. 1964. The birds of Arizona. Tucson, AZ: Univ. Arizona Press. 212 p.
- Tenney, C. R. 2000. Northern Beardless-Tyrannulet (*Camptostoma imberbe*). In the birds of North America, , No. 519 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Walker, H. A. October 2009. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.

(Southwestern) Willow Flycatcher, *Empidonax traillii extimus*

Distribution: *Empidonax traillii* breeds from southern Canada to the southern United States, and winters from southern Mexico to Panama (AOU 1998). The southwestern subspecies, *E. t. extimus* (Phillips 1948), breeds primarily in New Mexico, Arizona, and southern California (Hubbard 1987, Unitt 1987); it is restricted to dense streamside vegetation that is typically comprised of mid-seral willows (*Salix* spp.) and/or tamarisk (*Tamarix ramosissima*). Within New Mexico, significant populations occur along the Rio Grande and Gila River drainages, with much smaller populations at isolated locales in the San Juan, upper Canadian, Zuni, San Francisco, Mimbres, and Pecos River drainages (USFWS 2014, Durst 2017).

Current Status: Due primarily to habitat loss and modification over much of its range, the Southwestern Willow Flycatcher was federally listed as endangered in 1995 (USFWS 1995, 2002, 2013). In New Mexico, it was initially listed as threatened under the Wildlife Conservation Act in 1988, and was then reclassified as endangered in 1996. Estimated numbers of Southwestern Willow Flycatcher territories (defined by a singing male present during the breeding season) detected has increased significantly from when standardized statewide surveys were initiated in 1993 (n = 32) to 2012 (n = 702), due both to increased survey effort and increases in population numbers, particularly along the Gila and middle Rio Grande rivers (Durst 2017, Moore and Ahlers 2017). The majority (89%) of the state's known population is currently found at three sites – the Cliff-Gila Valley, the Lower Gila Box, and the Rio Grande River at the upstream side of Elephant Butte Reservoir, while the remaining 11% of the population is spread out among approximately 27 sites, the majority of which are small, averaging fewer than 5 territories each (Durst 2107).

Threats: Despite the documentation of increasing numbers of breeding territories in some areas, several ongoing threats have been identified as contributing to the continued endangered status of the Southwestern Willow Flycatcher (USFWS 2014, 2017). These threats which are often interrelated, include: habitat alteration, fragmentation, or loss; water manipulation activities (diversion, impoundment, pumping, and flood control); excessive livestock grazing; climate change; fire; localized brood parasitism by Brown-headed Cowbirds (*Molothrus ater*); and localized high nest predation rates. The continuing invasion of the tamarisk leaf beetle (*Diorhabda* spp.)

into New Mexico may also further threaten the state's flycatcher populations, due to the beetle's ability to defoliate large stands of tamarisk during the flycatcher's breeding season. From 2007 to 2017, *Diorhabda* spp. were detected nearly statewide (Tamarisk Coalition), with the notable exception of the Gila River area (Tamarisk Coalition 2018). Efforts to eradicate tamarisk and other exotic plants that do not involve concurrent restoration of native vegetation also jeopardize this flycatcher.

Recommendations: No change in listing status is recommended. Uncertainties with regard to future water management activities on the Rio Grande (Moore and Ahlers 2017) and Gila (Bureau of Reclamation 2018) rivers combined with potential climate change effects and the continued spread of the leaf beetle dictate that the Department maintains a conservative outlook regarding near-term prospects for the flycatcher's recovery in the state.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Bureau of Reclamation. 2018. Notice of intent to prepare an environmental impact statement, New Mexico Unit of the Central Arizona Project; Catron, Grant, and Hidalgo Counties, New Mexico. Federal Register 83(113): 27347-27349.
- Durst, S.L. 2017. Southwestern Willow Flycatcher breeding site and territory summary – 2012. U.S. Fish and Wildlife Service, New Mexico Ecological Services Field Office, Albuquerque, NM. 40 p.
- Hubbard, J. P. 1987. The status of the Willow Flycatcher in New Mexico. Report to New Mexico Department of Game and Fish. Santa Fe, NM. 29 p.
- Moore, D., and D. Ahlers. 2017. 2016 Middle Rio Grande Southwestern Willow Flycatcher study results – selected sites along the Rio Grande from Bandelier National Monument to Elephant Butte Reservoir, New Mexico. Bureau of Reclamation, Technical Service Center, Fisheries and Wildlife Resources. Denver, CO. 73 p. + appendix.
- Phillips, A. R. 1948. Geographic variation in *Empidonax traillii*. Auk 65:507-514.
- Tamarisk Coalition. 2018. Yearly distribution (2007-2017) of tamarisk leaf beetle (*Diorhabda spp.*). Tamarisk Coalition, Grand Junction, Colorado. Accessed August 2018 at: https://riversedgewest.org/sites/default/files/images/2017_Beetle_Map_12_28.png
- Unitt, P. 1987. *Empidonax traillii extimus*: an endangered subspecies. Western Birds 18:137-162.
- U.S. Fish and Wildlife Service (USFWS). 1995. Final rule determining endangered status for the Southwestern Willow Flycatcher. Federal Register 60:10694-10715.
- U.S. Fish and Wildlife Service (USFWS). 2002. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) final recovery plan. USFWS Division of Ecological Services, Albuquerque, NM. 210 p. + appendices.
- U.S. Fish and Wildlife Service (USFWS) 2013. Designation of critical habitat for Southwestern Willow Flycatcher. Federal Register 78 (2): 344-534.
- U.S. Fish and Wildlife Service (USFWS). 2014. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) 5-year review: Summary and evaluation. USFWS Arizona Ecological Services, Phoenix, AZ. 102 p.
- U.S. Fish and Wildlife Service (USFWS). 2017. 12-month findings on petitions to list a species and remove a species from the federal lists of endangered and threatened wildlife and plants. Federal Register 82 (249): 61725-61727.

Thick-billed Kingbird, *Tyrannus crassirostris*

Distribution: This Neotropical flycatcher of western Mexico and Guatemala reaches its northern geographic limits in southeastern Arizona, southwestern New Mexico, and the Big Bend region of western Texas (AOU 1998). In New Mexico, it summers regularly only in Guadalupe Canyon, Hidalgo County. It was first discovered in Guadalupe Canyon in 1958 (Levy 1959) and nesting was documented in New Mexico in 1959 (Zimmerman 1960). In New Mexico, the species requires native broadleaf riparian habitats characterized by mature cottonwoods and sycamores; to date, all New Mexico nests have been located in tall sycamores.

Current Status: The species was listed by New Mexico as threatened in 1975 and then was reclassified as endangered in 1990. The species is listed by Texas as threatened. NMDGF surveys along a two-mile transect in Guadalupe Canyon documented an annual average of 2.4 territories from 1987 to 2001. However, only one territory

was found during surveys in both 2002 and 2003, and none was found in 2004, 2006, and 2008 (Walker 2009). Only a single bird was reported (incidental to surveys) in both 2005 and 2007. In 2009, the species was again found nesting in the New Mexico portion of the canyon, with a pair and their nest discovered on 8 July (NMDGF unpubl. data). Birdwatchers reported 0-5 sightings each year from 2009 to 2015, but it should be noted that some of these sightings are likely of the same individuals.

Threats: The small and localized New Mexico population is threatened primarily by loss of mature broadleaf riparian woodlands, especially large cottonwoods and sycamores, from fire (prescribed or otherwise), tree cutting, lowering of water tables, and excessive grazing.

Recommendations: No change in status is recommended. New Mexico Department of Game and Fish should encourage public and private land managers to protect and enhance native broadleaf riparian habitats in Guadalupe Canyon and elsewhere in southwestern New Mexico. In particular, fires in riparian areas that kill large trees should be discouraged, as should activities that result in lowered water tables.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Levy, S. H. 1959. Thick-billed Kingbird in the United States. *Auk* 76:92.
- Zimmerman, D. A. 1960. Thick-billed Kingbird nesting in New Mexico. *Auk* 77:92-94.
- Walker, H. A. October 2009. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.

(Arizona) Grasshopper Sparrow, *Ammodramus savannarum ammoregus*

Distribution: This unique, local subspecies of the widespread Grasshopper Sparrow is restricted to grasslands in southeastern Arizona, extreme southwestern New Mexico, and immediately adjacent areas of northern Sonora and Chihuahua, Mexico. The known range in New Mexico is limited to two breeding populations in southern Hidalgo County, one in the Animas Valley, and one in the Playas Valley (Williams 1991, 2006, 2007). It is unknown whether individuals of this subspecies remain in New Mexico during the winter months or migrate out of the state to winter elsewhere. This sparrow requires extensive, well developed desert grasslands characterized by grama and other bunchgrasses and generally lacking woody vegetation; abundant thatch and dry grasses are needed for cover.

Current Status: The subspecies was listed as threatened by New Mexico in 1990 and then uplisted to endangered in 2006. NMDGF breeding bird surveys were initiated in June 1987 in the Animas Valley specifically for this sparrow. In June 1992, the Animas Valley transect was expanded and a new transect was established in the Playas Valley. Data were consistently gathered along both transects for 15 years (1992-2006); numbers recorded on each transect have shown year-to-year variation (Williams 1997), which might be in response to precipitation, local fire events, or grazing practices. No data were collected in 2007, and only a subset (19 of 46) of transect points in the Animas Valley were sampled from 2008-2011. In 1992, 109 sparrows were detected on the Animas transect and 41 were detected on the Playas transect. Both transects showed persistent, statistically significant long-term declines over the 15-year survey period. By 2004, the Animas transect had declined 88% (to 21 sparrows), while the Playas transect declined 100% (to 0 sparrows). In 2005, both transects yielded slight increases from 2004 – the total birds detected went up from 21 to 26 on the Animas route and from 0 to 2 birds on the Playas route (Williams 2006). Similarly, the Animas Valley transect showed continued improvement in 2006, with 47 sparrows detected (Williams 2007), as well as in 2008 and 2009 when only a portion of the transect was surveyed, with 40 and 65 sparrows detected, respectively. However, numbers were down again in subsequent years, with only 21 and 27 birds detected in 2010 and 2011, respectively. The Playas transect showed no improvement in 2006, as no sparrows were detected (Williams 2007), indicating that the Playas population was at or near extirpation. However, the current status of the Playas population is unknown as no recent surveys have been completed there due to restricted access to private lands. No surveys were conducted, in any of the population areas, from 2012 to 2018, due to limited private lands access and limited staff.

Threats: The main threat to this subspecies' continued survival in southern Hidalgo County is loss, degradation, and fragmentation of its native grassland habitat, primarily from excessive grazing that leads to reduced grass cover and increased brush encroachment. Ill-timed fires (especially those occurring during late spring-early summer) can severely depress recruitment.

Recommendations: No change in status is recommended. NMDGF should encourage grazing management practices and burning programs that perpetuate suitable grasslands for this unique subspecies. In particular, consideration should be given to grass banking or other means of reducing stocking rates in times of drought.

Literature Cited:

- Williams, S. O., III. 1991. Discovery and status of the Arizona Grasshopper Sparrow in New Mexico. New Mexico Ornithological Society Bull. 19:32.
- Williams, S. O., III. 1997. Trends in Arizona Grasshopper Sparrow breeding populations in New Mexico: value of long-term studies. New Mexico Ornithological Society Bull. 25:35.
- Williams, S. O., III. 2006. Trends in Arizona Grasshopper Sparrow populations on the Diamond A (Gray) Ranch, Hidalgo County, New Mexico. Report to New Mexico Department of Game and Fish, Santa Fe, NM. 2 p.
- Williams, S. O., III. 2007. Status of the Arizona Grasshopper Sparrow on the Diamond A (Gray) Ranch, Hidalgo County, New Mexico. Report to New Mexico Department of Game and Fish, Santa Fe, NM. 3 p.

THREATENED

Neotropic Cormorant, *Phalacrocorax brasilianus*

Distribution: This widespread waterbird of Central and South America reaches its northernmost geographic limits in New Mexico (AOU 1998), where it is known only to nest in the middle Rio Grande Valley. Non-breeders wander north to Bernalillo County, west to Hidalgo County and the Gila Valley in Grant County, and east to the Tularosa Basin and middle and lower Pecos Valley, northwest to San Juan County, and northeast to Colfax and Union counties. Nesting cormorants require stands of trees or shrubs in or near water that are free from human disturbance.

Current Status: The species was listed by New Mexico as threatened in 1975. The species occurs in varying but typically small numbers primarily at Elephant Butte and Caballo reservoirs and at the Bosque del Apache National Wildlife Refuge (NWR), where it is outnumbered by (and often confused with) the larger Double-crested Cormorant (*P. auritus*). Although the species has been reported in New Mexico annually by bird watchers, documentation of nesting has been less consistent. The species was first documented nesting in New Mexico at Elephant Butte Reservoir in 1972 (Hundertmark 1974) and since then, no more than 50 nests have been found in any season and nesting was not documented anywhere in New Mexico from 1998 to 2006. In 2007, a NMDGF-contracted waterbird study in the middle and lower Rio Grande of New Mexico resulted in the discovery of 4 Neotropic Cormorant nests in Quates Marsh (near San Marcial, Socorro County) and 1 at Elephant Butte Reservoir (Stahlecker 2007). This number is comparable to reports from 1975. However, the lack of consistent, long-term data for this species has impeded attempts to assess population trends. An Atlas of breeding colonial waterbirds in the interior United States, including New Mexico, was conducted by the U.S. Fish and Wildlife Service from 2009 to 2011. Unfortunately, most cormorant sightings in New Mexico were not identified to species, so the Atlas did not adequately census the Neotropic Cormorant population (Cavitt et al. 2014).

Threats: Loss and degradation of limited breeding sites, disturbance of breeding colonies, fluctuations in food supply, contamination, and persecution are among the main threats to this fish-eating species (Telfair and Morrison 1995).

Recommendations: No change in status is recommended.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.

- Cavitt, J.F., S.L. Jones, N.M. Wilson, T.S. Zimmerman, R.H. Doster, and W.H. Howe. 2014. atlas of breeding waterbirds in the interior western United States. Research Report, U.S. Department of Interior, Fish and Wildlife Service, Denver, Colorado.
- Hundertmark, C. A. 1974. First record of Olivaceous Cormorant nesting in New Mexico. *Wilson Bull.* 86:65.
- Hundertmark, C. A. 1975. Breeding birds of Elephant Butte Marsh, 1975 survey report. Santa Fe, NM: New Mexico Department of Game and Fish.
- Stahlecker, D. W. 2008. Growth and decline in nesting waterbird populations in New Mexico's Rio Grande Valley: 1975-2007. Report to New Mexico Department of Game and Fish, Santa Fe, New Mexico.
- Telfair, R. C., II, and M. L. Morrison. 1995. Neotropic Cormorant. *In* The birds of North America, No. 137 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Bald Eagle, *Haliaeetus leucocephalus*

Distribution: The species is widespread in North America, occurring from Alaska and Newfoundland south to northern Mexico and the Gulf Coast. It migrates and winters in suitable habitat throughout New Mexico (Hubbard 1978). Beginning in the late 1980s, Bald Eagles were found nesting at four sites in two counties: three sites in Colfax and one in Sierra (Williams 2000). A pair nested in a new site in Rio Arriba County in 2006 and 2007, and a second breeding site in that county was confirmed in 2008. A new nesting site was discovered in Union County in 2012, bringing the total number of known breeding sites to 9. Although only two territories were occupied in 2007, one in Colfax County and one in Rio Arriba County, 5 territories were occupied in both 2009 and 2010, and a record 7 territories were occupied in April 2012. In New Mexico, nests are placed in large cottonwoods or ponderosa pines, typically in the vicinity of water and often also in close proximity to concentrations of small mammals such as prairie dogs (Williams 2000).

Current Status: An ongoing conservation success story, breeding pairs throughout the lower 48 states have been steadily increasing (417 in 1963, 5,750 in 1998, and an estimated 72,434 in 2009, USFWS 2016) since the species was listed on the precursor of the Endangered Species Act in 1967. Recovery of the species first led to the federal reclassification of the Bald Eagle from endangered to threatened in 1995 (USFWS 1995) and then to the removal of the species from the List of Endangered and Threatened Wildlife in 2007 (USFWS 2007). NMDGF supported the federal delisting of the species (Maracchini 1999), but the species was listed as threatened by New Mexico in 1975 and remains in need of conservation action in the state, primarily due to small breeding populations. The nesting population consisted of 2 active territories in 2007, 4 active in 2008, 5 active in both 2009 and 2010, and 7 active in 2012. Territories have not been monitored since 2012. Bald Eagles are federally protected under the Migratory Bird Treaty Act (MBTA) of 1918 (16 U.S.C. 703-712; Ch. 128; July 3, 1918; 40 Stat. 755) and the Bald and Golden Eagle Protection Act (16 USC 668-668c), both as amended.

Threats: The principal threats to Bald Eagles in New Mexico are human disturbance (especially to nesting pairs, but also to wintering birds), loss and degradation of breeding and wintering habitats (including declines in prey and in nest and roost site availability), environmental contamination, electrocution, and illegal killing (including both shooting and poisoning).

Recommendations: No change in status is recommended.

Literature Cited:

- Hubbard, J. P. 1978. Revised check-list of the birds of New Mexico. New Mexico Ornithological Society Publ. No. 6. 110 p.
- Maracchini, J. A. 1999. September 30, 1999 letter to United States Fish and Wildlife Service regarding proposal to delist the Bald Eagle in the lower 48 states. 2 p.
- United States Fish and Wildlife Service (USFWS). 1995. Final rule to reclassify the Bald Eagle from endangered to threatened in all of the lower 48 states. *Federal Register* 60:36000-36010.
- United States Fish and Wildlife Service (USFWS). 2007. Endangered and threatened wildlife and plants; removing the Bald Eagle in the lower 48 states from the list of endangered and threatened wildlife: final rule. *Federal Register* 72:37345-37372.

- United States Fish and Wildlife Service (USFWS). 2010. Endangered and threatened wildlife and plants; 12-month finding on a petition to list the Sonoran Desert Population of the Bald Eagle as a threatened or endangered distinct population segment. Federal Register 75(37):8601-8621.
- United States Fish and Wildlife Service. 2016. Bald and Golden Eagles: Population demographics and estimation of sustainable take in the United States, 2016 update. Division of Migratory Bird Management, Washington D.C., USA.
- Williams, S. O., III. 2000. History and current status of Bald Eagles nesting in New Mexico. New Mexico Ornithological Society Bull. 28:43-44.

Common Black-Hawk, *Buteogallus anthracinus*

Distribution: This Neotropical raptor reaches its northern geographic limits in the southwestern United States, where it is an uncommon but regular summer resident in New Mexico. Historically, this species was largely restricted to the San Francisco, Gila, and Mimbres drainages; however, there are rare but increasing observations east to the middle Rio Grande Valley, the Hondo Valley, and the middle and lower Pecos Valley, and in 2003, nesting was reported farther north along the Canadian River for the first time. Breeding birds require mature, well-developed riparian forest stands (e.g., cottonwood bosques) located near permanent streams where principal prey species (fish, amphibians, and reptiles) are available (Schnell 1994).

Current Status: The species declined in abundance as its riparian habitat was reduced, and was listed by New Mexico as threatened in 1975. It is also state listed by Texas and Arizona. In 1994 and 1995, R. W. Skaggs (1996) intensively surveyed the San Francisco, Gila, and Mimbres basins, and estimated a population of up to 80 pairs. Twenty-seven active territories were located in the Gila Watershed (primarily the Gila and San Francisco rivers) in 2011 during HawkWatch International surveys contracted by NMDGF. A pair successfully nested on the border of Los Lunas and Bosque farms in the years 2011 through 2013, which was an expansion of the historical range. With recent gains in eastern New Mexico, the statewide population may speculatively include more than 100 pairs (Sadoti 2010).

Threats: Loss of southwestern riparian habitat, particularly cottonwood bosques and free-flowing streams, is the principal threat to this riparian-obligate species (Hubbard 1965, Oberholser 1974, Schnell 1994). Other threats include disturbance to nesting birds and illegal shooting.

Recommendations: No change in status is recommended. NMDGF should continue to encourage the preservation and enhancement of riparian habitats, including beneficial water management practices.

Literature Cited:

- Hubbard, J. P. 1965. Bad days for the Black Hawk. Audubon Field Notes 19:474.
- Neal, Mike. 2012. Riparian raptor survey and Common Black-Hawk monitoring – Gila Watershed, NM [2011]. Glenwood, NM: HawkWatch International. Submitted to New Mexico Department of Game and Fish, Santa Fe, NM. 37 p.
- Oberholser, H. C. 1974. The bird life of Texas. Austin, TX: Univ. Texas Press. 1069 p.
- Schnell, J. H. 1994. Common Black-Hawk. In The birds of North America, No. 122 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Sadoti, G. 2010. Common Black Hawk (*Buteogallus anthracinus*). Pp. 213-225 In J.E. Cartron (ed). Raptors of New Mexico. University of New Mexico Press, Albuquerque. 728 p.
- Skaggs, R. W. 1996. The Common Black-Hawk in southwestern New Mexico, 1994-95 inventories. Report to New Mexico Department of Game and Fish, Santa Fe, NM. 14 p.

Peregrine Falcon, *Falco peregrinus*

Distribution: The species occurs almost worldwide (Brown and Amadon 1968). New Mexico supports both breeding and migratory populations of Peregrines. Breeding Peregrines in New Mexico are of the American

subspecies *F. p. anatum* and utilize mountains and river canyons (Skaggs et al. 1988). *En route* migrants are either the American subspecies, which can be found essentially statewide, or the more rare tundra subspecies *F. p. tundrius*.

Current Status: The *anatum* subspecies was federally delisted in 1999 (USFWS 1999); based on available data, NMDGF argued that federal downlisting from endangered to threatened was warranted, but that delisting was not (Maracchini 1998). The subspecies was first listed by New Mexico in 1975 and then, in response to encouraging observations of gradually increasing occupancy of breeding sites after 1980, it was downlisted from endangered to threatened in 1996. An investigation is currently under way to determine if delisting in New Mexico is warranted.

Threats: Chemical contamination of the environment remains a threat as old compounds continue to be used in parts of the species' range, and especially as new compounds are developed and applied to the land (Ratcliffe 1993, Williams and Johnson 2005). In New Mexico, disturbance to nesting pairs and, possibly, illegal taking are also threats (Johnson 1984, Johnson and Williams 2005).

Recommendations: An investigation is currently under way to determine if delisting is warranted.

Literature Cited:

- Brown, L., and D. Amadon. 1968. Eagles, hawks, and falcons of the world. New York, NY: McGraw-Hill Co. 945 p.
- Johnson, T. H. 1994. Peregrine Falcon habitat management in National Forests of New Mexico. Report to Southwest Region, United States Forest Service, Albuquerque, NM. 22 p.
- Johnson, T. H., and S. O. Williams, III. 2006. The Peregrine Falcon in New Mexico – 2006. Report to New Mexico Department of Game and Fish, Santa Fe, NM. 18 p.
- Johnson, T. H. 2011. The Peregrine Falcon in New Mexico – 2010. La Jara: NM. Report to New Mexico Department of Game and Fish, Santa Fe, NM. 39 p.
- Maracchini, J. A. 1998. November 23, 1998 letter to United States Fish and Wildlife Service regarding federal delisting of the American Peregrine Falcon. 3 p.
- Maracchini, J. A. 1999. November 12, 1999 letter to United States Fish and Wildlife Service regarding take of wild Peregrine Falcons. 2 p.
- Ratcliffe, D. 1993. The Peregrine Falcon, 2nd ed. San Diego, CA: Academic Press. 454 p.
- Skaggs, R. W., D. H. Ellis, W. G. Hunt, and T. H. Johnson. 1988. Peregrine Falcon. Pages 127-136. *In* Proceedings Southwest Raptor Management Symposium. Washington, D.C.: National Wildlife Federation.
- United States Fish and Wildlife Service (USFWS). 1984. Recovery plan for American Peregrine Falcon Rocky Mountain/Southwest population. Denver, CO: United States Fish and Wildlife Service. 105 p.
- United States Fish and Wildlife Service (USFWS). 1999. Final rule to remove the American Peregrine Falcon from the federal list of endangered and threatened wildlife, and to remove the similarity of appearance provision for free-flying peregrines in the conterminous United States. Federal Register 64:46542-46558.
- United States Fish and Wildlife Service (USFWS). 2003. Monitoring plan for the American Peregrine Falcon. Portland, OR: United States Fish and Wildlife Service, Divisions of Endangered Species and Migratory Birds and State Programs, Pacific Region. 53 p.

(Gould's) Wild Turkey, *Meleagris gallopavo mexicana*

Distribution: *Meleagris gallopavo* occurs widely in North America. However, the subspecies *mexicana*, of Mexico's Sierra Madre, occurs naturally from the sky islands of southwestern New Mexico and southeastern Arizona in the United States, to northern Jalisco and Hidalgo in Mexico. In New Mexico, the primary range is the Animas and Peloncillo ranges and the intervening Animas Valley in southern Hidalgo County, New Mexico (Ligon 1946, Ridgway and Friedmann 1946). It occurs in all major canyons and adjacent foothills in that area, but primarily occurs: 1) in the Peloncillo Mountains, from Guadalupe Canyon north to the Skeleton Canyon area; 2) in the Animas Mountains from Deer Creek north to Indian and Double Adobe creeks; and 3) along the Animas Creek in the middle Animas Valley. Where found, this subspecies concentrates in pine-oak forested canyons and adjacent slopes, and in riparian areas dominated by cottonwood and sycamore trees. Brown (1982) characterized habitat in the Peloncillo and Animas Mountains as Madrean Evergreen Woodland, dominated by evergreen oaks (*Quercus* spp.) and containing juniper (*Juniperus* spp.) and pine trees (*Pinus* spp.). Primary species in Gould's wild turkey habitat

include Arizona white oak (*Q. arizonica*) emory oak (*Q. emoryi*), silver leaf oak (*Q. hypoleucoides*), Chihuahuah pine (*P. leiophylla*), border piñon (*P. discolor*), piñon-ricegrass (*Piptochaetium fimbriatum*), beargrass (*Nolina microcarpa*), and grama grasses (*Boutelous* spp.) (Willging 1987, Figert 1989, York 1991). Important habitat components include water, tall trees for roosting, mast producing shrubs and trees, and beargrass.

Current Status: This unique subspecies was listed as threatened by New Mexico in 1975. The subspecies has experienced reductions in its range in Mexico (Leopold 1959). Gould's Wild Turkeys were studied intensively in New Mexico under NMDGF contracts from 1982 to 1996, and estimates for the Peloncillo Mountains population during that period fluctuated from fewer than 20 up to approximately 75 birds, with no consistent trend (Schemnitz and Potter 1984, Willging 1987, Figert 1989, York 1991). Recent (2018) field observations on public and private land in the Peloncillo Mountains (considered the 'core area' for Gould's wild turkey distribution in New Mexico) detected 130 birds. The subspecies occupies two other mountain ranges in New Mexico, the Animas and San Luis. The Animas lies entirely within private land while the Sierra San Luis barely enters the United States from Mexico. Both ranges support populations of Gould's wild turkey. The Animas has not been adequately surveyed in 20 years with the last estimate in 1997 ranging from 25 – 35 birds. The Sierra San Luis just enters the United States with the majority of this range lying within Mexico or private land. This range supports a healthy population of Gould's wild turkey that is likely a result of larger, contiguous tracts of available habitat. It is likely that immigration and emigration occurs between the three mountain ranges during years of favorable conditions. Based on historical and recent evidence, it seems likely that the subspecies has always been local and relatively rare in New Mexico, but that its populations in both the Peloncillo and Animas mountains are maintaining themselves. To increase the population, NMDGF completed a trade agreement with AZ Department of Game and Fish, where 60 Gould's wild turkeys were transplanted from Arizona to New Mexico between 2014 and 2016. New Mexico Game and Fish completed a Gould's Wild Turkey Recovery plan in 2017 (Cardinal and Bulger 2017), which focuses on populations in the Peloncillo Mountains. Department personnel have commenced implementing recovery objectives.

Threats: Potential threats to this subspecies in Hidalgo County include habitat loss from fire, localized overgrazing by livestock, lack of water sources, hybridization with non-native turkeys, habitat disturbance, and poaching.

Recommendations: No change in status is recommended. The NMDGF should continue and/or expand standardized surveys for this subspecies throughout its New Mexico range and should develop a monitoring program to identify population trends. Although the population has been and continues to be small, it seems to be well-adapted to local conditions. The NMDGF also should continue to coordinate with the Coronado National Forest to protect roost trees and provide additional water structures in critical areas.

Literature Cited:

- Brown, D. E. 1982. Madrean evergreen woodland. *In* Biotic communities of the American Southwest – United States and Mexico (Brown, D. E., Ed). Desert Plants. 4:59-65.
- Cardinal, C., and J. Bulger. 2017. Gould's Wild Turkey (*Meleagris gallopavo mexicana*) recovery plan. 5 April 2017. New Mexico Department of Game and Fish. 30 p.
- Figert, D. E. 1989. Status, reproduction, and habitat use of Gould's Turkey in the Peloncillo Mountains of New Mexico. M.S. Thesis, New Mexico State Univ., Las Cruces, NM.
- Leopold, A. S. 1959. Wildlife of Mexico. Berkeley, CA: Univ. California Press. 568 p.
- Ligon, J. S. 1946. History and management of Merriam's wild turkey. New Mexico Game and Fish Commission. University of New Mexico Press, Albuquerque, NM.
- Ridgway, R., and H. Friedmann. 1946. Birds of North and Middle America, vol. 10. United States National Museum Bull. 50:455-457.
- Schemnitz, S. D., and T. D. Potter. 1984. Status and ecology of Gould's Turkey (*Meleagris gallopavo mexicana*) in the Peloncillo Mountains, Coronado National Forest, New Mexico. New Mexico Department Game and Fish, contract 516-71-27, final report. 104 p.
- Schemnitz, S. D., and R. C. Willging. 1986. Gould's Turkey status report. West. Wild Turkey Workshop Proc. 3:38-39.
- Willging, R. C. 1987. Status, distribution, and habitat use of Gould's Turkey in the Peloncillo Mountains, New Mexico. M.S. Thesis, New Mexico State Univ., Las Cruces, NM.
- York, D. L. 1991. Habitat use, diet, movements, and home range of Gould's Turkey in the Peloncillo Mountains, New Mexico. M.S. Thesis, New Mexico State Univ., Las Cruces, NM.

Piping Plover, *Charadrius melodus*

Distribution: This small, migratory shorebird breeds in the northern Great Plains, Great Lakes region, and Atlantic coastal areas (Haig 1992). It occurs as a very rare migrant in New Mexico, where it has been reported at wetlands in Colfax, Guadalupe, Socorro, Chaves, and Eddy counties.

Current Status: The Great Lakes watershed population of Piping Plover is listed as endangered, and the Atlantic coast and northern Great Plains populations are listed as threatened (USFWS 1985). In New Mexico, Piping Plover was first listed as threatened in 1988, reclassified as endangered in 1990, and then downlisted back to threatened in 2006. It is also listed as threatened by Colorado. Although Piping Plovers nest in southeastern Colorado (Kingery 1998), the species has been only been reported in New Mexico on 9 occasions. No known breeding pairs were documented in Colorado from 1949 – 2002, but in 2003, 24 breeding pairs were located during surveys of southeastern Colorado reservoirs completed by the United States Army Corps of Engineers. Because the occurrence of Piping Plovers within the state is dependent upon status and conditions of breeding populations elsewhere, the number of Piping Plovers migrating through New Mexico should increase if Piping Plover numbers increase in Colorado (see USFWS 2016).

Threats: The major threats to this species are loss and degradation of nesting and wintering habitats from urbanization, vehicular traffic, human disturbance, and water impoundments and regulation (USFWS 1985, Ryan et al. 1993).

Recommendations: No change in status is recommended. Protection of mudflat and sandbar habitats at New Mexico wetlands will benefit this species as well as other migrating shorebirds. The species will also benefit from recommended recovery actions put forth in the Piping Plover Atlantic Coast Population Revised Recovery Plan (ACPPRT 1996) and the 2016 Revised Recovery Plans.

Literature Cited:

- Atlantic Coast Piping Plover Recovery Team (ACPPRT). 1996. Piping Plover (*Charadrius melodus*) Atlantic Coast population revised recovery plan. Prepared for the United States Fish and Wildlife Service, Region Five, Hadley, Massachusetts.
- Haig, S. M. 1992. Piping Plover. In *The birds of North America*, No. 2 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Kingery, H. E., Ed. 1998. Colorado breeding bird atlas. Denver, CO: Colorado Bird Atlas Partnership. 636 p.
- Ryan, M. R., B. G. Root, and P. M. Mayer. 1993. Status of Piping Plovers in the Great Plains of North America: a demographic simulation model. *Conservation Biology* 7:581-585.
- United States Fish and Wildlife Service (USFWS). 1985. Determination of endangered and threatened status for the Piping Plover; final rule. *Federal Register* 50:50726-50734.
- United States Fish and Wildlife Service (USFWS). 2016. Recovery Plan for the Northern Great Plains piping plover (*Charadrius melodus*) in two volumes. Volume I: Draft breeding recovery plan for the Northern Great Plains piping plover (*Charadrius melodus*) 132 pp. and Volume II: Draft revised recovery plan for the wintering range of the Northern Great Plains piping plover (*Charadrius melodus*) and Comprehensive conservation strategy for the piping plover (*Charadrius melodus*) in its coastal migration and wintering range in the continental United States. Denver, Colorado. 166 pp.
- Williams, S. O., III. 2001. New Mexico, spring season 2001. *N. Am. Birds* 55:336-338.

Whiskered Screech-Owl, *Megascops trichopsis*

Distribution: This primarily Mexican and Central American species occurs from the southwestern United States south to Nicaragua. In New Mexico, it occurs only in Hidalgo County, where it is found regularly in several canyons (e.g., Skeleton, Whitmire, Cottonwood, and Clanton) in the Peloncillo Mountains and, occasionally, in the Animas Mountains (e.g., in the vicinity of Indian Creek Canyon). As in Arizona, the species requires dense pine-oak woodlands and oak woodlands just below the pine-oak zone in New Mexico, especially favoring oak riparian areas in mountain canyons and dense woodlands on adjacent north-facing slopes (Marshall 1957).

Current Status: The species was listed as threatened by New Mexico in 1990, as the status of the small resident population in the Peloncillo Mountains became better understood. First detected in the state in 1974 (Ligon and Brenowitz 1976), it was found to be resident in small numbers in early 1990 (Williams and Hubbard 1990). Subsequent NMDGF surveys through the 1990s documented the extent of the Peloncillo Mountains population and 15 occupied territories were located in four canyons in that range in 2000 (Williams 2000). Individuals have been also reported from three sites in the Animas Mountains, most recently in May 2006 (Williams 2006). Owls abandoned one Peloncillo Mountain canyon in 2 years subsequent to a prescribed fire in 1997, as none were located there in 1998 or 1999, but they reoccupied the canyon in 2000. Nine territories were located in Skeleton Canyon in the Peloncillo Mountains in 2006 (Williams 2006) and 7 territories were located there in 2008 (Walker 2009), but recent fire in the canyon might have significantly reduced habitat availability. Approximately 5 individuals responded to an informal playback survey of Clanton Canyon in July 2009 and several were reported in that canyon by birdwatchers in 2010 and 2011. Birdwatchers reported 9 birds in 2012, 5 in 2013, 8 in 2014, and 11 in 2015; some of these sightings could be of the same individuals.

Threats: Loss of pine-oak and oak woodlands in the Peloncillo and Animas mountains, especially in canyon bottoms, through vegetation removal or fire (natural or prescribed) is the principal threat to this species. Cavity trees (snags, etc.) are especially vulnerable to fire and woodcutting. Human disturbance, particularly excessive playback of its vocalizations by bird watchers, could negatively impact New Mexico's small populations.

Recommendations: No change in status is recommended. NMDGF should encourage public and private land managers to protect pine-oak and oak woodlands in Hidalgo County, especially riparian canyons.

Literature Cited:

- Ligon, J. D., and G. L. Brenowitz. 1976. First record of the Whiskered Owl in New Mexico. *Condor* 78:112.
- Marshall, J. T., Jr. 1957. Birds of pine-oak woodland in southern Arizona and adjacent Mexico. *Pacific Coast Avifauna* 32:1-125.
- Walker, H. A. April 2009. 2008 field notes on bird species of the Peloncillo Mountains. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Coronado National Forest, Douglas, AZ.
- Williams, S. O., III, and J. P. Hubbard. 1990. New Mexico, winter season 1989-90. *Am. Birds* 44:305-308.
- Williams, S. O., III. 2000. New Mexico, spring season 2000. *North Am. Birds* 54:312-315.
- Williams, S. O., III. 2006. New Mexico, spring season 2006. *North American Birds* 60:412-416.

Boreal Owl, *Aegolius funereus*

Distribution: This northern species occurs in boreal forests of the Old and New Worlds. In North America, it reaches its southernmost geographic limits in the mountains of northern New Mexico, where it was first detected in 1987 (Stahlecker and Rawinski 1990). In New Mexico, NMDGF-assisted surveys found the species to be resident in undisturbed spruce-fir and similar forests in the San Juan, Sangre de Cristo, and Jemez mountains (Stahlecker and Duncan 1996).

Current Status: The species was listed as threatened in New Mexico in 1990. Intensive surveys in the state found that the species occurred in very small numbers at 10 specific sites in eight general areas in the Carson and Santa Fe national forests (Stahlecker and Duncan 1996). The most recent Boreal Owl records are of four birds heard at two sites in the Carson National Forest and 1 bird heard at a single site in the Santa Fe National Forest from September-October 2010 during NMDGF surveys (NMDGF unpubl. data). Bird watchers reported 3 sightings in 2012, 2 sightings in 2013, zero sightings in 2014, and 4 sightings in 2015. It should be noted, however, that some of these sightings could be of the same individuals.

Threats: New Mexico's small and highly fragmented Boreal Owl populations are vulnerable and would be negatively impacted by losses of their specialized and limited subalpine habitats. In particular, timber harvest in such habitats could eliminate nesting cavities, reduce prey populations, and remove forest structure necessary for nesting, foraging, and roosting; the slowness of forest succession in high elevation stands implies disturbed habitats would remain unsuitable for one-two centuries (Hayward and Hayward 1993, Hayward and Verner 1994, Hayward 1997).

Recommendations: No change in status is recommended. Conservation of the Boreal Owl in New Mexico depends on protection of its specialized habitat – high elevation stands of mature and older spruce-fir forests in the San Juan, Sangre de Cristo, and Jemez mountains. Protective measures should include the identification and conservation of areas of occupancy. Forest management should focus on maintaining the distribution and abundance of spruce-fir forests, whether occupied by Boreal Owls or not, with emphasis on retaining these vegetation types in their natural states. Even-aged timber management on a broad scale should be eliminated in high elevation areas, while management based on simple snag retention in clearcut areas should be recognized as having little ecological value.

Literature Cited:

- Hayward, G. D. 1997. Forest management and conservation of Boreal Owls in North America. *J. Raptor Res.* 31:114-124.
- Hayward, G. D., and P. H. Hayward. 1993. Boreal Owl. *In* The birds of North America, No. 63 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Hayward, G. D., and J. Verner, eds. 1994. Flammulated, Boreal, and Great Grey Owls in the United States: a technical conservation assessment, Gen. Tech. Report RM-253. Fort Collins, CO: United States Department of Agriculture Forest Service.
- Stahlecker, D. W., and R. B. Duncan. 1996. The Boreal Owl at the southern terminus of the Rocky Mountains: undocumented longtime resident or recent arrival. *Condor* 98:153-161.
- Stahlecker, D. W., and J. J. Rawinski. 1990. First records of the Boreal Owl in New Mexico. *Condor* 92:517-519.

Broad-billed Hummingbird, *Cyananthus latirostris*

Distribution: This widespread Mexican species reaches its northern geographic limits in the borderlands region of the southwestern United States (AOU 1998), where it inhabits low to mid-elevation riparian woodlands. In New Mexico, the species is a regular summer resident in Guadalupe Canyon, Hidalgo County, where it tends to nest in hackberry thickets and similar vegetation (Baltosser 1986, 1989). In 1998, breeding was confirmed in Skeleton Canyon in the central Peloncillo Mountains, the first recorded breeding away from Guadalupe Canyon (Williams 1998). In addition, there have been reports from several additional New Mexico counties, including confirmed records for Bernalillo, Doña Ana, Eddy, Grant, Otero, San Miguel, and Valencia counties, but there has been no documented breeding in any county other than Hidalgo. An interesting far afield breeding record is of a nesting female found in April 2012 in Baldwin County, Alabama, that was possibly mated with a Ruby-throated Hummingbird (*Archilochus colubris*).

Current Status: The species was listed as threatened in New Mexico in 1975. The small population in Guadalupe Canyon and immediately adjacent side canyons was estimated at about 18-25 individuals in 2009 and appears to have been relatively stable (Walker 2009). NMDGF surveys and cooperator reports indicate another 10-15 individuals might summer regularly in three additional canyons farther north in the Peloncillo Mountains. In addition, recent records from Eddy County (Carlsbad), Grant County (Silver City), and Doña Ana County (Radium Springs and Las Cruces) indicate that a few birds occasionally overwinter in the state (Williams 2006; 2009a,b).

Threats: The principal threat is loss of riparian woodlands in Guadalupe Canyon and similar canyons in the Peloncillo Mountains from clearing (brush removal, tree cutting), burning, excessive grazing, and lowering of water tables.

Recommendations: No change in status is recommended. The protection and enhancement of riparian woodlands and adjacent xeric habitats in Guadalupe Canyon and similar canyons in southwestern New Mexico should be encouraged.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.

- Baltosser, W. H. 1986. Nesting success and productivity of hummingbirds in southwestern New Mexico and southeastern Arizona. *Wilson Bull.* 98:353-367.
- Baltosser, W. H. 1989. Nectar availability and habitat selection by hummingbirds in Guadalupe Canyon. *Wilson Bull.* 101:559-578.
- Walker, H. A. October 2009. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.
- Williams, S. O., III. 1998. New Mexico, summer season 1998. *Field Notes* 52:487-490.
- Williams, S. O., III. 2006. New Mexico, winter season 2005-06. *North American Birds* 60:265-268.
- Williams, S. O., III. 2009a. August through November 2008: New Mexico. *North American Birds* 63(1):127-131.
- Williams, S. O., III. 2009b. December 2008 through February 2009: New Mexico. *North American Birds* 63(2):299-303.

White-eared Hummingbird, *Hylocharis leucotis*

Distribution: This species of Mexican and Central American highlands reaches its northernmost geographic limits in the mountains of southeastern Arizona and southwestern New Mexico (AOU 1998). This hummingbird prefers relatively moist montane forests and forested canyons, and is found most commonly in the pine and pine-oak zones (Howell and Webb 1995). White-eared Hummingbirds were first found summering in New Mexico in the Animas Mountains in the mid-1970s (Hubbard 1978) and have continued to be documented there, most recently in 2001 and 2003. There are additional reports from elsewhere in southwestern New Mexico: the species has been reported in the Peloncillo Mountains (most recently in 1992), the Pinos Altos mountains (in 1993, 1994, and 2009), and the Mogollon Mountains (in 2000 and 2005). Vagrants also have strayed farther north and east to the Manzanita Mountains in 1994 and 1995, to two sites in the Sangre de Cristo Mountains in 1993, and to the Sacramento Mountains in 2005.

Current Status: The species was listed as threatened in New Mexico in 1978. Only small numbers were detected in Hidalgo, Grant, and Catron counties from 2000 to 2013.

Threats: This species is restricted to moist mountain canyons and adjacent forested slopes, and is vulnerable to loss of its required habitats from fire, mining, lumbering, road-building, and excessive grazing. Acid rain from regional smelters likewise might impact these high mountain forests.

Recommendations: No change in status is recommended.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' union. 829 p.
- Howell, S. N. G., and S. Webb. 1995. A guide to the birds of Mexico and northern Central America. Oxford, U.K.: Oxford Univ. Press. 849 p.
- Hubbard, J. P. 1978. Revised check-list of the birds of New Mexico. New Mexico Ornithological Society Publ. No. 6. 110 p.

Violet-crowned Hummingbird, *Amazilia violiceps*

Distribution: This hummingbird of the Mexican highlands reaches its northernmost geographic limits in southeastern Arizona and southwestern New Mexico. In New Mexico, it summers regularly only in broadleaf riparian woodlands of sycamore, cottonwood, hackberry, and oak in Guadalupe Canyon, Hidalgo County, where it nests exclusively in sycamores (Zimmerman and Levy 1960; Baltosser 1986, 1989; Williams 2002). The species also has been found in the summer months in Clanton, Skeleton, and Post Office canyons in the Peloncillo Mountains and along the Double Adobe Creek in the Animas Mountains. Single individuals documented in Anthony from November 2001 to February 2002 and in Las Cruces in February 2002 (both in Doña Ana County) were the first known to winter in New Mexico. Presumed overwintering individuals were again detected in Las Cruces in

October 2009 and November 2010. Single vagrants have strayed east to Luna County in 2002 and north to Socorro County in 1981, Santa Fe County in 1999, and Los Alamos County in 2005.

Current Status: The species was listed as threatened in New Mexico in 1975. New Mexico's population is small, but does not show a detectable trend: it has rarely numbered more than about 12 individuals since the mid-1980s, distributed among 2 to 5, rarely 7, locations within the New Mexico portion of Guadalupe Canyon (Williams 2002, Walker 2009). Occurrences since the late 1990s of individuals in two additional canyons of the Peloncillo Mountains and one canyon in the Animas Mountains might signal pioneering of new range, but to date no breeding or even consistent summering has been documented away from Guadalupe Canyon.

Threats: This hummingbird is threatened by loss of low elevation broadleaf riparian and adjacent xeric habitats in Guadalupe Canyon and similar canyons in southwestern New Mexico, resulting from fire, clearing, excessive grazing, and lowering of water tables. Fire poses a significant threat if riparian areas supporting mature trees are burned or if nectar source plants such as agaves are destroyed by fire. Grazing in canyon bottoms might remove necessary dense understory vegetation and impede regeneration of riparian trees.

Recommendations: No change in status is recommended. NMDGF should encourage public and private land managers to preserve low-elevation broadleaf riparian woodlands in Guadalupe Canyon and elsewhere in southwestern New Mexico.

Literature Cited:

- Baltosser, W. H. 1986. Nesting success and productivity of hummingbirds in southwestern New Mexico and southeastern Arizona. *Wilson Bull.* 98:353-367.
- Baltosser, W. H. 1989. Nectar availability and habitat selection by hummingbirds in Guadalupe Canyon. *Wilson Bull.* 101:559-578.
- Walker, H. A. October 2009. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.
- Williams, S. O., III. 2002. Status of the Violet-crowned Hummingbird in New Mexico. *New Mexico Ornithological Society Bull.* 30:91-95.
- Zimmerman, D. A. and S. H. Levy. 1960. Violet-crowned Hummingbird nesting in Arizona and New Mexico. *Auk* 77:470-471.

Lucifer Hummingbird, *Calothorax lucifer*

Distribution: This primarily Mexican highland species reaches the United States only in southeastern Arizona, southwestern New Mexico, and Trans-Pecos Texas (Scott 1994). New Mexico's breeding population of this migratory species is found primarily in the Peloncillo Mountains in Hidalgo County, where it occurs regularly in several mid-elevation canyons (most regularly in Post Office, Skeleton, Cottonwood, and Clanton canyons) and occasionally in Guadalupe Canyon. Away from the Peloncillo Mountains, single vagrants have strayed north and east to Grant, Sierra, Luna, and Eddy counties. Where found, this species concentrates in rugged canyons, along slopes in dry mountain ranges (especially rocky hillsides and talus slopes), and in dry washes vegetated with desert scrub, such as shrubby trees (juniper, piñon, oak), cactus, yucca, ocotillo, and agave.

Current Status: This hummingbird was listed as threatened in New Mexico in 1985. The Peloncillo Mountains population is small; surveys from 1990 through 2006 detected about 20 breeding females annually. Fire has deterred breeding in areas in the central Peloncillo Mountains where birds were confirmed nesting in 1995 and 1996.

Threats: Loss of native dry canyon/hillside habitats, including loss of native food plants from burning or excessive grazing, is the principal threat to the small New Mexico breeding population.

Recommendations: No change in status is recommended. NMDGF should support protection of dry canyon/hillside habitat.

Literature Cited:

Scott, P. E. 1994. Lucifer Hummingbird. *In* The birds of North America, No. 134 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

Costa's Hummingbird, *Calypte costae*

Distribution: The distribution of this arid-land species is centered on the Sonoran Desert region of the southwestern United States and northwestern Mexico. Within New Mexico, it occurs primarily in the southwest, where it is a warm season migrant and occasional breeder (Baltosser 1989, Baltosser and Scott 1996). All documented or suspected breeding has been in Hidalgo, Grant, and Doña Ana counties; the species is most regular in Guadalupe Canyon in Hidalgo County where breeding has been documented, less regular along the lower Gila River in Grant and Hidalgo counties, and occasional east to the San Andres and Organ mountains in Doña Ana County. Migrants have been recorded at several sites in Hidalgo, Grant, and Doña Ana counties, and at single sites in McKinley, Sandoval, and Sierra counties.

Current Status: The species was listed by New Mexico as threatened in 1983; occurrence has been irregular. In 1993, up to 7 individuals occupied Guadalupe Canyon from late-March to mid-June, and breeding was suspected (Williams 1993). The species staged an impressive invasion in 1995, with reports from 4 sites in 3 counties (Williams 1995), including reports of 2 males in the San Andres Mountains (Weisenberger and Howe 1996). Displaying males were observed at 2 sites near Redrock in 1997, an individual bird was observed near Virden in 1998, and individual birds were observed in Silver City and in the Peloncillo Mountains in 1999. One to five birds were reported annually in southwestern New Mexico from 2000-2010, but there was no evidence of breeding (Williams 2006; 2007a, b; 2008; 2009; 2010). Birdwatchers reported one individual in 2010, and zero individuals in 2011-2014. In 2015, birdwatchers reported three sightings, but it is unclear if they are three separate individuals or repeated sightings of the same individual. The first individual to be found wintering in New Mexico was documented in Placitas, Sandoval County from January to February 2002 (Williams 2002). More recently, an overwintering adult male was seen in Las Cruces, Dona Ana County from 29 November 2005 - 2 January 2006 (Williams 2006).

Threats: The long-term persistence of the species in the state is threatened by loss (from fire, excessive grazing, or clearing) of native xeric hillside vegetation and adjacent riparian vegetation in the Peloncillo Mountains, the lower Gila Valley, and elsewhere in southwestern New Mexico.

Recommendations: No change in status is recommended. NMDGF should continue to work with public and private land managers to identify, preserve, and restore riparian areas and associated xeric hillside vegetation in southwestern New Mexico, including in Guadalupe Canyon and other canyons in the Peloncillo Mountains, and in the lower Gila Valley, particularly in the Middle Box and Lower Box.

Literature Cited:

- Baltosser, W. H. 1989. Costa's Hummingbird: its distribution and status. *Western Birds* 20:41-62.
- Baltosser, W. H., and P. E. Scott. 1996. Costa's Hummingbird. *In* The birds of North America, No. 251 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Weisenberger, M. E., and W. H. Howe. 1996. Costa's Hummingbird on the San Andres National Wildlife Refuge. *New Mexico Ornithological Society bull.* 24:32.
- Williams, S. O., III. 1993. New Mexico, spring season 1993. *Am. Birds* 47:440-443.
- Williams, S. O., III. 1995. New Mexico, spring season 1995. *Field notes* 49:288-290.
- Williams, S. O., III. 2002. New Mexico, winter season, 2001-02. *N. Am. Birds* 56:207-209.
- Williams, S. O., III. 2006. New Mexico, spring season 2006. *North American Birds* 60:412-416.
- Williams, S. O., III. 2007a New Mexico, summer season 2006. *North American Birds* 60:558-561.
- Williams, S. O., III. 2007b. New Mexico, fall season 2006. *North American Birds* 61:115-118.
- Williams, S. O., III. 2008. New Mexico, summer season 2007. *North American Bird*.
- Williams, S. O., III. 2009. March through May 2009: New Mexico. *North American Birds* 63(3):473-477.
- Williams, S. O., III. 2010. June through July 2009: New Mexico. *North American Birds* 63(4):

Gila Woodpecker, *Melanerpes uropygialis*

Distribution: This species of the southwestern United States and western Mexico is found only in southwestern New Mexico, where it is a permanent resident in southern Hidalgo County and in the lower Gila Valley in Hidalgo and Grant counties. Within the state, Gila Woodpeckers require well-developed broadleaf riparian woodlands characterized by extensive groves of mature cottonwoods and/or sycamores.

Current Status: The species was listed as threatened by New Mexico in 1975. The species is listed as endangered by California, where loss of native riparian habitats in the lower Colorado River Valley has reduced populations (Rosenberg et al. 1991). NMDGF surveys conducted annually from 1987-2004 and 2008-2009 documented 5-8 pairs in Guadalupe Canyon in Hidalgo County (Walker 2009), and reports from additional southern Hidalgo County sites (including nesting in the Animas Valley) have been encouraging. Observations (1996-2005) on the east side of the Animas Mountains represent the species' first documentation east of the Continental Divide. Based on available information, however, numbers have declined in the Gila Valley since the 1970s and have remained depressed.

Threats: The principal threats to the species in the state are habitat destruction, especially tree cutting or other destructive clearing (burning, inundation) of cottonwood and sycamore stands, and lowering of water tables. Habitat fragmentation also threatens the species, as mature but isolated cottonwood groves smaller than 20 ha (50 acres) tend to be avoided by Gila Woodpeckers (Rosenberg et al. 1991).

Recommendations: No change in status is recommended. NMDGF should continue to encourage land managers, including public and private water managers, to preserve and restore extensive riparian woodlands, particularly mature groves of cottonwoods and sycamores. Prescribed fires that can kill large trees should be avoided in riparian areas.

Literature Cited:

- Edwards, H. H., and G. D. Schnell. 2000. Gila Woodpecker. *In* The birds of North America, No. 532 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Rosenberg, K. V., R. D. Ohmart, W. C. Hunter, and B. W. Anderson. 1991. Birds of the lower Colorado River Valley. Tucson, AZ: Univ. Arizona Press. 416 p.
- Walker, H. A. October 2009. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.

Bell's Vireo, *Vireo bellii*

Distribution: This small, insectivorous Neotropical migrant breeds in the central and southwestern United States and northern Mexico (Kus et al. 2010, Klicka et al. 2016). Within New Mexico, Bell's Vireo is locally distributed across the southern third of the state (Hubbard 1978). It breeds in riparian areas, typically nesting in low, shrubby vegetation such as willow, mesquite, and tamarisk (Parody and Parker 2002, Kus et al. 2010).

Current Status: Bell's Vireo experienced significant declines in portions of its range in the mid- to late 1900s (Kus et al. 2010), most notably in the lower Colorado River Valley (Rosenberg et al. 1991) and in central and coastal California (Goldwasser 1980, Franzreb 1987), where the California subspecies is federally-listed as endangered (USFWS 1986). Population declines or loss of local populations were also noted in Arizona (Phillips et al. 1964) and New Mexico (Hubbard 1978), and the species was listed by New Mexico as threatened in 1975. New Mexico surveys and reports through 2011 indicate overall numbers remained very low and reproductive failure, often caused by Brown-headed Cowbird (*Molothrus ater*) brood parasitism, was high at some locations. The state's largest documented population is in the Lower Gila Box in Grant and Hidalgo counties, where up to 44 territories were located in 1998 (Parody 2001). Upstream from Lower Gila Box, significant numbers of singing males have also been documented at the nearby Red Rock Wildlife Management Area, Gila Middle Box, and the Cliff-Gila Valley (Shook 2015, 2017). Along the middle Rio Grande River, at least 30 Bell's Vireo territories were documented from

Belen to Elephant Butte Reservoir during surveys for Southwestern Willow Flycatcher in 2005 (Moore and Ahlers 2006). A population in the vicinity of Rattlesnake Springs, Eddy County numbered about 20 pairs in the late 1990s, but cowbird brood parasitism there typically exceeded 60% of vireo nests (Parody 2001) and 2010 and 2011 estimates suggested that the population might be less than 10 pairs (NMDGF unpubl. data). An average of 11.5 territories were detected in Guadalupe Canyon from 2008-2009 on a subset (7 of 10) of transect points (Walker 2009).

Threats: The species is primarily threatened by loss and fragmentation of dense shrubby/woody riparian habitats from urbanization, land conversion to agriculture, excessive grazing, burning, brush removal, flood control, and water management activities. Brood parasitism by cowbirds may negatively affect some New Mexico's breeding populations (Parody 2001, Kus et al. 2010).

Recommendations: No change in status is recommended. NMDGF should resume monitoring efforts to detect population distribution and trends. NMDGF should continue to encourage land managers to preserve and restore riparian and adjacent shrubby habitats along lowland streams. Restoration projects elsewhere that have employed local information have proved successful in increasing Bell's Vireo populations (Kus 1998). Cowbird control can be useful in very localized areas, but it is only successful when completed in conjunction with other habitat-related conservation measures (Franzreb 1989, Kus et al. 2010).

Literature Cited:

- Franzreb, K. E. 1987. Endangered status and strategies for conservation of the Least Bell's Vireo (*Vireo bellii pusillus*) in California. *Western Birds* 18:43-49.
- Franzreb, K. E. 1989. Ecology and conservation of the endangered Least Bell's Vireo. *United States Fish and Wildlife Service Biol. Rept.* 89:1-17.
- Goldwasser, S., D. Gaines, and S. R. Wilber. 1980. The Least Bell's Vireo in California: a defacto endangered race. *Am. Birds* 34:742-745.
- Hubbard, J. P. 1978. Revised check-list of the birds of New Mexico. *New Mexico Ornithological Society Publ. No.* 6. 110 p.
- Klicka, L. B., B. E. Kus, P. O. Title, and K. J. Burns. 2016. Conservation genomics reveals multiple evolutionary units within Bell's Vireo (*Vireo bellii*). *Conservation Genetics* 17:455-471.
- Kus, B. E. 1998. Use of restored riparian habitat by the endangered Least Bell's Vireo (*Vireo bellii pusillus*). *Restoration Ecology* 6:75-82.
- Kus, B., S. L. Hopp, R. R. Johnson, and B. T. Brown. 2010. Bell's Vireo (*Vireo bellii*), *The Birds of North America* (P. G. Rodewald, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America: <https://birdsna.org/Species-Account/bna/species/belvir> DOI: 10.2173/bna.35.
- Moore, D., and D. Ahlers. 2006. 2005 Southwestern Willow Flycatcher study results: selected sites along the Rio Grande from Velarde to Elephant Butte Reservoir, New Mexico. Prepared for Bureau of Reclamation, Albuquerque Area Office, March 2006. 47 p. plus attachment.
- Parody, J. M. 2001. Bird-habitat relationships and the utility of multiscale methods. Ph.D. Diss., Univ. New Mexico, Albuquerque, NM.
- Parody, J. M., and T. H. Parker. 2002. Biogeographic variation in nest placement: a case study with conservation implications. *Diversity and Distribution* 8:11-20.
- Phillips, A. R., J. Marshall, and G. Monson. 1964. *The birds of Arizona*. Tucson, AZ: Univ. Arizona press. 212 p.
- Rosenberg, K. W., R. D. Ohmart, W. C. Hunter, and B. W. Anderson. 1991. *Birds of the lower Colorado River Valley*. Tucson, AZ: Univ. Arizona Press. 416 p.
- Schweitzer, S. H., D.M. Finch, and D.M. Leslie, Jr. The brown-headed cowbird and its riparian-dependent hosts in New Mexico. RMRS-GTE-1. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, CO. 23 p.
- Shook, R. 2015. The Gila River Bird Habitat Management Unit: an analysis of avian populations mid-May 1996 through August 2014. Unpublished Report, USDA Forest Service, Gila National Forest, Silver City, NM. 16 p. plus appendix.
- Shook, R. 2017. Southwestern Willow Flycatcher (*Empidonax traillii extimus*) survey results. U Bar Ranch The Nature Conservancy U.S. Forest Service Cliff-Gila Valley, New Mexico – 2017. Unpublished report to Freeport-McMoRan Tyrone Inc., The Nature Conservancy, and the Gila National Forest, 133 pp.
- United States Fish and Wildlife Service (USFWS). 1986. Determination of endangered status for the Least Bell's Vireo: final rule. *Federal Register* 51:16474-16482.

Walker, H. A. October 2009. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.

Gray Vireo, *Vireo vicinior*

Distribution: This little-studied but widespread Neotropical migrant breeds in the Four Corners states, southern California, and western Texas, and winters in northwestern Mexico (AOU 1998). In New Mexico, it is most often found in arid juniper woodlands on foothills and mesas, sometimes associated with oaks or piñons, and often in areas with a well-developed grass component. Within the state, the species has been found summering/breeding in most counties west of the Great Plains.

Current Status: Gray Vireo was listed by New Mexico as threatened in 1983. Based on its restricted range, and small overall population size, this species is listed by Partners in Flight as a North American priority species, and by the United States Fish and Wildlife Service as a national species of conservation concern (USFWS 2002). In the state, breeding populations have disappeared from some historical habitats, but persisted at others. Some new areas with unexpected numbers of Gray Vireos have been discovered. Since the mid-1990s, surveys by NMDGF and other agencies and organizations (e.g., Bureau of Land Management, National Park Service, United States Fish and Wildlife Service, Hawks Aloft, New Mexico Natural Heritage Program, Kirtland Air Force Base) have documented territories at a number of sites, including: Bernalillo County (the Manzanito Mountains); Doña Ana County (San Andres and Organ mountains); Eddy County (Guadalupe Mountains); Luna County (Cooke's Peak Range); Otero County (McGregor Range and Sacramento mountains); Rio Arriba County; San Juan County; Santa Fe County (the Caja del Rio area); and Socorro County (at multiple sites, including in the Los Pinos and Oscura mountains). In addition, several substantial populations have been reported from tribal lands along the middle Rio Grande. A summary of this species' distribution, abundance, habitat associations, and breeding success throughout New Mexico was completed by NMDGF in 2006 (DeLong and Williams 2006), and a proceedings was published in 2009 (Walker and Doster 2009); this included expanded abstracts of oral papers presented at the New Mexico Department of Game and Fish and the New Mexico Ornithological Society co-sponsored Gray Vireo Symposium, on the topics: 1) population status and trends; 2) habitats utilized at multiple scales; and 3) research and management needs

Threats: Threats include loss and degradation of quality juniper-grassland habitat from burning, clearing, excessive grazing, and oil and gas development. High brood parasitism by Brown-headed Cowbirds (*Molothrus ater*) also reduces New Mexico's breeding populations.

Recovery Plan Status. This species has a state Recovery Plan, accepted by the New Mexico Game Commission in 2007. Major recovery efforts since 2010 Review were to begin monitoring response of species to habitat restoration in central New Mexico and surveys on U.S. Department of Defense properties to determine tree and landscape structures favored by the species (e.g., Johnson et al. 2014). Future recovery efforts will be to replicate the work conducted on the US Department of Defense properties in other parts of the state. This data will assist with development of statewide guidelines for preferred habitat and to better refine Recovery Plan management unit boundaries.

Recommendations: No change in status is recommended. A state recovery plan has been developed for the Gray Vireo (Pierce 2007), and NMDGF should work with other agencies and organizations to accomplish management strategies outlined in the plan. In particular, implementation of a standardized survey protocol (Walker and Doster 2009) and development of recommended guidelines for habitat management practices is required to effectively quantify population trends and to coordinate management of the Gray Vireo with juniper thinning projects. Identifying and maintaining quality juniper savannah and other occupied habitats are also priorities, and land managers should consider the needs of this species when undertaking activities in quality Gray Vireo habitats, such as clearing or burning of juniper woodland for fuel reduction, grazing enhancement, bighorn sheep habitat improvement, and oil and gas exploration and drilling.

Literature Cited:

American Ornithologist's Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists Union. 829 p.

- DeLong, J. P., and S. O. Williams, III. 2006. Status report and biological review of the Gray Vireo in New Mexico. Report to New Mexico Department of Game and Fish, Santa Fe, NM.
- Johnson, K., L. Wickersham, J. Smith, G. Sadoti, T. Neville, J. Wickersham, and C. Finley. 2014. Habitat use at multiple scales by pinyon-juniper birds on Department of Defense lands III: Landscape, territory/colony, and nest scale. Final Project Report, March, 2014. Project Number 12-425, DOD Legacy Resource Management Program. Natural Heritage New Mexico Publication 14-GTR-381.
- Pierce, L. J. S. 2007. Gray Vireo (*Vireo vicinior*) recovery plan. Santa Fe, NM: New Mexico Department of Game and Fish. 30 p.
- United States Fish and Wildlife Service (USFWS). 2002. Birds of conservation concern 2002. Arlington, VA: United States Fish and Wildlife Service, of Migratory Birds. 99 p.
- Walker, H. A., and R. H. Doster, Eds. 2009. Proceedings of the Gray Vireo Symposium Co-Sponsored by the New Mexico Department of Game and Fish and the New Mexico Ornithological Society, 12-13 April 2008; Albuquerque, New Mexico. Santa Fe, NM: New Mexico Department of Game and Fish.

Abert's Towhee, *Melospiza aberti*

Distribution: This is primarily a species of the lowlands of central and southwest Arizona and adjacent areas, where it is a permanent resident along desert rivers and streams (Tweit and Finch 1994). It is found in New Mexico only in Grant and Hidalgo counties primarily in the Gila Valley and at San Simon Cienega, where it inhabits riparian thickets and similar native habitats.

Current Status: The species was listed by New Mexico in 1983. Small numbers (up to 12) inhabit San Simon Cienega (Williams 1993). In the Gila Valley, incidental observations suggest that numbers are reduced from 25 years ago. At Redrock, 50 birds were counted in 1969, and 55 were counted in 1981, but only 14 were found in 1994 (Williams 1994); numbers continued to decline through 2005. A small population persisted upstream in the Cliff-Gila Valley, where 11 nests were documented in 2000, but only 5 pairs were reported in 2003.

Threats: The species is threatened by loss and degradation of native riparian habitats, particularly due to excessive grazing, within its restricted New Mexico range. Rea (1983) observed that extensive loss of cottonwood-willow and brushy mesquite habitat along the Gila River in Arizona reduced this species' density. Alternatively, after removal of livestock from the San Pedro Riparian National Conservation Area in Arizona, Abert's Towhee densities in cottonwood-willow habitat more than doubled over five years (Krueper et al. 2003).

Recommendations: No change in status is recommended. NMDGF should continue to work with land and water managers to protect and restore native riparian habitats in the Gila Valley and at San Simon Cienega.

Literature Cited:

- Krueper, D., J. Bart, and T. D. Rich. 2003. Response of vegetation and breeding birds to the removal of cattle on the San Pedro River, Arizona, USA. *Conservation Biology* 17:607-615.
- Rea, A. 1983. Once a river: bird life and habitat changes on the middle Gila. Tucson, AZ: Univ. Arizona Press. 285 p.
- Tweit, R. C., and D. M. Finch. 1994. Abert's Towhee. *In* The birds of North America, No. 111 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Williams, S. O., III. 1993. New Mexico, spring season 1993. *Am. Birds* 47:440-443.
- Williams, S. O., III. 1994. New Mexico, spring season 1994. *Field Notes* 48:327-329.

Baird's Sparrow, *Ammodramus bairdii*

Distribution: This grassland sparrow breeds in the northern Great Plains from the Canadian prairie provinces south to Montana, the Dakotas, and western Minnesota (AOU 1998, Green et al. 2002). It winters in southeastern Arizona and southwestern Texas south into north-central Mexico (AOU 1998, Green et al. 2002). Birds in New Mexico are

primarily migrants moving through the eastern plains and southern lowlands, but wintering birds occur locally in southern grasslands, particularly in Otero, Luna, and Hidalgo counties.

Current Status: The status of this migratory species is of international concern, including Canada (Gossen et al. 1993) and the United States where it is listed by Partners in Flight as a North American priority species and by the United States Fish and Wildlife Service as a species of conservation concern (USFWS 2008). In 2017, Baird's Sparrow was listed as a species of "Special Concern" in Canada under the Species at Risk Act (SARA; Somershoe 2018). It was listed by New Mexico as threatened in 1975. The species was previously relatively numerous and widespread in New Mexico (Hubbard 1978), but is very rarely reported in recent years. Surveys by NMDGF cooperators from 2000 to 2005 identified Otero Mesa grasslands as especially important to migrating Baird's Sparrows.

Threats: The decline throughout the species' range is attributed to loss of native grassland habitat owing to unsustainable range management practices, conversion to cropland, exotic plant invasion, and shrub encroachment (Phillips et al. 1964, Oberholser 1974, Gossen et al. 1993, Green et al. 2002). In New Mexico, loss, degradation, and fragmentation of grasslands from excessive grazing, as well as oil and gas development, are of particular concern.

Recommendations: No change in status is recommended. Little is known about migration and winter demographics and habitat preferences of this species; NMDGF should work with public and private land managers to identify, describe, and protect migration and overwintering habitats.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Gossen, J. P., S. Brechtel, D. DeSmet, D. Hijertaas, and C. Werschler. 1993. Canadian Baird's Sparrow recovery plan. Recovery of nationally endangered wildlife, Rept. No. 3. Ottawa, Canada: Canadian Wildlife Federation. 28 p.
- Green, M. T., P. E. Lowther, S. L. Jones, S. K. Davis, and B. C. Dale. 2002. Baird's Sparrow. *In* The birds of North America, No. 638 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Hubbard, J. P. 1978. Revised check-list of the birds of New Mexico. New Mexico Ornithological Society Publ. No. 6. 110 p.
- Oberholser, H. C. 1974. The bird life of Texas. Austin, TX: Univ. Texas Press. 1069 p.
- Phillips, A. R., J. Marshall, and G. Monson. 1964. The birds of Arizona. Tucson, AZ: Univ. Arizona Press. 212 p
- Somershoe, S. G. (ed). 2018. A Full Annual-Cycle Conservation Plan for Sprague's Pipit, Chestnut-collared and McCown's Longspurs and Baird's Sparrow (DRAFT). U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C.
- United States Fish and Wildlife Service (USFWS). 2008. Birds of conservation concern 2008. Arlington, VA: United States Fish and Wildlife Service, Division of Migratory Birds.

Yellow-eyed Junco, *Junco phaeonotus*

Distribution: This sparrow of the higher mountains of Mexico and Guatemala reaches its northern geographic limits in the sky island mountain ranges of southeastern Arizona and southwestern New Mexico (AOU 1998, Sullivan 1999). In New Mexico, it was historically only known to occur in the Animas Mountains, Hidalgo County, where it was largely confined, at least in the nesting season, to coniferous forest. A second population was discovered in the Big Burro Mountains, Grant County in 2003 (Williams 2004) and nesting was documented there in 2004 and 2005 (DeLong 2004, 2005a), and again in 2008-2010 (Griffin 2009, 2010a, 2011a). The resident species undertakes altitudinal migration in Arizona (Moore 1972, Horvath and Sullivan 1988) and presumably does so in New Mexico as well, which might explain post-breeding and winter sightings in the Big Hatchet, Burro, Mogollon, Peloncillo, and Pinos Altos mountains and on Mount Withington (Griffin 2010b; 2011a, b).

Current Status: The species was listed by New Mexico as threatened in 1975. It was reported as "common" in the Animas Mountains in early years (Bailey 1928), but precise data are lacking. Surveys of suitable habitat in the Animas Mountains in 1992 and 1995-1997 found fewer than 30 adults each year. However, informal surveys found

only 2 birds there in 2000, none in 2001, 5 singing males in 2002, and none in 2003. In 2005, NMDGF surveys of available habitat in the Animas Mountains documented only 9 territories, with successful reproduction in at least 2 territories (DeLong 2005b). Due to limited access, little information exists regarding the impacts of the Adobe Fire (a lightning-ignited fire that burned an estimated 23,500 to 26,460 acres in the Animas Mountains over a two-week period in late May 2006) on the Animas Yellow-eyed Junco population. No birds were reported in the Animas Mountains in May 2006 (Williams 2007c) and 2008 (Williams 2008), but a nest was found in 2007. In the Big Burro Mountains population, 4-6 territories were detected in 2004 (DeLong 2004), 7 territories were documented in 2005 (DeLong 2005a), at least 5 territories were documented in 2006 (Williams 2007a, b), and at least 4 territories were documented in 2007 (Williams 2007c) with nesting confirmed in most years. A total of 16 pairs and 2 unpaired individuals were detected in 2008 in the Burro Mountains (Griffin 2009), and a total of 11 pairs and 4 unpaired males were detected in 2009, which suggests that the population may have been increasing (Griffin 2010). However, apparent hybrids between Yellow-eyed Juncos and its closely-related congener, the Gray-headed “Red-backed” (*J. hyemalis dorsalis*) subspecies of Dark-eyed Juncos, in Burro Mountains (Griffin 2009, 2010; SORA 2009) might be complicating the population and conservation status of the Yellow-eyed Junco. It is also unknown whether Dark-eyed Juncos (*J. hyemalis*) are now nesting in the Animas Mountains and possibly hybridizing with the Yellow-eyed Juncos; prior to the discovery of nesting Gray-headed Juncos in the Burro Mountains, it was thought that they did not breed sympatrically with the Yellow-eyed junco (Sullivan 1999).

Threats: The very small and restricted New Mexico populations are vulnerable to loss and degradation of their limited coniferous forest habitat from burning, cutting, and excessive grazing. Grazing pressure has been shown to be especially detrimental to the Yellow-eyed Junco’s closely-related congener, the Dark-eyed Junco, in Arizona, where cattle grazing was responsible for a dramatic 75% reduction in nest success (Walsberg 2005). In addition, productivity can suffer in years when dry conditions suppress breeding. Hybridization with the Dark-eyed Junco might also be diluting the genetic integrity of New Mexico’s small Yellow-eyed Junco population in the Burro Mountains.

Recommendations: No change in status is recommended. Private and public land managers are encouraged to protect this junco’s limited New Mexico habitat.

Literature Cited:

- American Ornithologists’ Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists’ Union. 829 p.
- Bailey, F. M. 1928. Birds of New Mexico. Santa Fe, NM: New Mexico Department of Game and Fish. 807 p.
- DeLong, J. P. 2004. Yellow-eyed Junco surveys in the Big Burro Mountains in southwestern New Mexico [2004]. Report to New Mexico Department of Game and Fish, Santa Fe, NM. 13 p.
- DeLong, J. P. 2005a. Yellow-eyed Junco surveys in the Big Burro Mountains of southwestern New Mexico [2005]. Report to New Mexico Department of Game and Fish, Santa Fe, NM 13 p.
- DeLong, J. P. 2005b. Yellow-eyed Junco surveys in the Animas Mountains in southwestern New Mexico [2005]. Report to New Mexico Department of Game and Fish, Santa Fe, NM. 11 p.
- Griffin, D. J. 2009. Surveys for Yellow-Eyed Juncos in the Big Burro Mountains, Grant County, New Mexico, 2008: Final annual report 2008. Las Cruces, NM: Griffin Biological Services. Submitted to New Mexico Department of Game and Fish, Santa Fe, NM. 62 p.
- Griffin, D. J. 2010a. Surveys for Yellow-Eyed Juncos in the Big Burro Mountains, Grant County, New Mexico, 2009: Final annual report 2009. Las Cruces, NM: Griffin Biological Services. Submitted to New Mexico Department of Game and Fish, Santa Fe, NM. 61 p.
- Griffin, D. 2010b. Winter Surveys for Yellow-eyed Juncos in the Big Burro Mountains, Grant Co., New Mexico, 2010. Las Cruces, NM: Griffin Biological Services. Submitted to the New Mexico Department of Game and Fish, Santa Fe, NM. 25 p.
- Griffin, D. 2011a. Surveys for post-breeding Yellow-eyed Juncos in Grant, Catron, and Socorro counties, New Mexico, 2010. Las Cruces, NM: Griffin Biological Services. Submitted to the New Mexico Department of Game and Fish, Santa Fe, NM. 27 p.
- Griffin, D. 2011b. Winter Season Report of Surveys for Yellow-eyed Juncos in the Big Burro Mountains, Grant County, New Mexico, 2011. Las Cruces, NM: Griffin Biological Services. Submitted to the New Mexico Department of Game and Fish, Santa Fe, NM. 21 p.

- Griffin, D. 2011c. Status Review for the Yellow-eyed Junco (*Junco phaeonotus*) in New Mexico. Las Cruces, NM: Griffin Biological Services. Submitted to the New Mexico Department of Game and Fish, Santa Fe, NM. 52 p.
- Horvath, E. G., and K. A. Sullivan. 1988. Facultative migration in Yellow-eyed Juncos. *Condor* 90:482-484.
- Moore, N. J. 1972. Ethology of the Mexican Junco (*Junco phaeonotus palliatus*). Ph.D. diss., Univ. Arizona, Tucson, AZ.
- SORA. 2009. Yellow-Eyed Junco (*Junco phaeonotus*) netting and banding to support site fidelity studies in the Big Burro Mountains: survey report – 2009. Albuquerque, NM: SORA. Submitted to New Mexico Department of Game and Fish, Santa Fe, NM.
- Sullivan, K. A. 1988. Ontogeny of time budgets in Yellow-eyed Juncos: adaptation to ecological constraints. *Ecology* 69:118-124.
- Sullivan, K. A. 1999. Yellow-eyed Junco. *In* The birds of North America, No. 464 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.
- Walsberg, G. E. 2005. Cattle grazing in a National Forest greatly reduces nesting success in a ground-nesting sparrow. *Condor* 107:714-716.
- Williams, S. O., III. 2007a. New Mexico, summer season 2006. *North American Birds* 60:558-561.
- Williams, S. O., III. 2007b. New Mexico, fall season 2006. *North American Birds* 61:115-118.
- Williams, S. O., III. 2007c. New Mexico, spring season 2007. *North American Birds* 61:487-491.
- Williams, S. O., III. 2008. March through May 2008: New Mexico. *North American Birds* 62(3):452-456.

Varied Bunting, *Passerina versicolor*

Distribution: This is primarily a Mexican species that enters the United States only along the Mexican border in Arizona, New Mexico, and Texas during the breeding season (AOU 1998, Groschupf and Thompson 1998). In New Mexico, this Neotropical migrant summers regularly in small numbers in Hidalgo, Doña Ana, and Eddy counties (Walker 2009a), where it prefers dense, shrubby vegetation associated with relatively arid canyons.

Current Status: The species was listed as threatened in New Mexico in 1975. Surveys and reports by NMDGF personnel and cooperators from 1987 to 2011 indicate that this species persists as a summer resident in local areas of Hidalgo, Doña Ana, and Eddy counties. In addition, there are also reports of vagrants in Grant, Luna, Socorro, Sierra, and Otero counties. New Mexico's populations remain small, however, and are estimated at about 45 breeding pairs total. In Guadalupe Canyon, Hidalgo County, 0 - 4 territories were found from 1987 – 2004, and 7 territories were documented in 2008; no surveys were conducted in 1999 or from 2005-2007 (Walker 2009b). Surveys in the vicinity of Carlsbad Caverns National Park in 2003, 2009, and 2010 detected this species in six canyons and estimated the Park's population to be around 30 territories (Williams 2004, West 2010, NMDGF unpubl. data), suggesting larger numbers in Eddy County than previously known and that the area might support the state's largest 'concentration' of the species. In addition, 2011 surveys on the San Andres National Wildlife Refuge indicate that it supports at least 3 breeding pairs (NMDGF unpubl. data).

Threats: This species is threatened primarily by habitat loss, particularly the loss of dense, shrubby, riparian habitat, resulting from burning, clearing, excessive grazing, and lowering of water tables. Brown-headed cowbird (*Molothrus ater*) parasitism, documented in Guadalupe Canyon in 1993 (Williams 1994), might also threaten New Mexico's small breeding populations.

Recommendations: No change in status is recommended. NMDGF should encourage land managers to preserve and restore dense shrubby (e.g., mesquite) habitat in areas where this species occurs.

Literature Cited:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds, 7th ed. Washington, D.C.: American Ornithologists' Union. 829 p.
- Groschupf, K. D., and C. W. Thompson. 1998. Varied Bunting. *In* The birds of North America, No. 351 (A. Poole and F. Gill, Eds.). Philadelphia, PA: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists' Union.

- Walker, H. A. 2009a. Second documented nest of Varied Bunting (*Passerina versicolor*) in New Mexico. New Mexico Ornithological Society Bulletin 37(3):74-86.
- Walker, H. A. 2009b. Threatened and endangered bird species population status and trends in the Guadalupe Canyon, New Mexico: Final 2008 report. Santa Fe, NM: New Mexico Department of Game and Fish. Submitted to the Guadalupe Canyon Ranch, Animas, NM.
- West, S. 2010. Final report: Varied Bunting study, Carlsbad Caverns National Park, Eddy County, New Mexico. Carlsbad, NM. Submitted to New Mexico Department of Game and Fish, Santa Fe, NM.
- Williams, S. O., III. 1994. New Mexico, fall season 1994. Am. Birds 48:137-139.
- Williams, S. O., III. 2004. New Mexico, spring season 2003 & summer season 2003. North Am. Birds 57:383-385; 525-527.

AMPHIBIANS

ENDANGERED

Jemez Mountains Salamander, *Plethodon neomexicanus*

Distribution and Biology: *Plethodon neomexicanus* is endemic to north-central New Mexico where it is found only in the Jemez Mountains in Sandoval, Rio Arriba, and Los Alamos counties. It occurs from 7,200-11,256 ft elevation in mixed conifer habitat with abundant rotted logs and surface rocks. This habitat is dominated by Douglas fir, blue spruce, Engelmann spruce, ponderosa pine, and white fir with occasional aspen, Rocky Mountain maple, New Mexico locust, oceanspray, and various shrubby oaks (Degenhardt et al. 1996; Hathcock 2008; Whitford 1976; Williams 1973). *Plethodon neomexicanus* is rarely observed on the surface or encountered under surface litter or aspen logs. It is most often encountered under and inside well-rotted Douglas-fir logs or under rocks. Researchers from the University of Rhode Island, USFWS, USFS, the US National Park Service, and the Department are working to develop a system for monitoring the species without disturbing rotted logs or other critical elements of the salamander's habitat.

Current Status: *Plethodon neomexicanus* is listed as endangered by the USFWS, with critical habitat (USFWS 2013 a & b). The New Mexico Endemic Salamander Team has completed the Jemez Mountains Salamander Management Plan. This plan was approved and signed by NMDGF, USFWS, and USFS during January 2000, and was designed to provide guidance for management of the Jemez Mountains salamander on USFS lands.

Threats: Current threats to the already fragmented populations of *P. neomexicanus* are numerous, including: 1) the findings of significantly elevated microhabitat temperatures on the habitat severely burned during the Cerro Grande and Dome fires, 2) the widening of NM Hwy 126 into occupied habitat, 3) the low recapture rates at historic sites, and 4) the detection of a fungal infection from specimens on the Valles Caldera (Cummer et al. 2005).

Wildfire: There is a continued threat of additional negative impacts to populations of *P. neomexicanus* from natural wildfire and management-ignited fire (Cummer and Painter 2007). Salamander populations are known to be susceptible to fire-related effects, including decreased forest humidity, desiccation of habitat, loss of microhabitat (such as downed logs and litter), erosion, and filling of subterranean habitat utilized by salamanders via siltation during post-fire runoff. Post-fire management actions that have negatively impacted Jemez Mountains Salamanders and their habitat include the mulching and reseeding of occupied habitat with soil-binding, non-native grasses. The cumulative effects of the Dome (1996), Cerro Grande (2000), and Los Conchas (2011) fires within the habitat of the *P. neomexicanus* has had devastating impacts on populations of this species (USFWS 2013a).

Logging: A large percentage of the range of *P. neomexicanus* occurs on National Forest lands and the close association of *P. neomexicanus* with mixed coniferous forests makes them vulnerable to many forest management practices (Ramotnik and Scott 1988). Wiltenmuth (1996) suggested that *P. neomexicanus* might not be able to withstand the additional stress of drying environmental conditions associated with activities such as logging. Historically, the effects of logging were considered to be a major threat to *P. neomexicanus*, however, the recent reduction of timber harvesting in the Jemez Mountains has somewhat diminished that concern. Silvicultural activity

today in the habitat of *P. neomexicanus* is generally restricted to post-fire salvage logging and tree thinning in the urban-forest interface zones.

Road Construction: Roads and other development (residential, recreational, or commercial) would have negative effects on *P. neomexicanus* if constructed in their habitat, via direct take, habitat loss, population fragmentation and soil compaction. The widening and realignment of NM Hwy 126 just north of the town of Seven Springs likely caused population fragmentation and resulted in the direct take of salamanders.

Disease: Disease has been implicated in the decline of many amphibians, and it is an unknown, but credible threat to *P. neomexicanus*. Cummer et al. (2005) reported the chytridiomycete fungus (*Batrachochytrium dendrobatidis*) from an individual *P. neomexicanus* from Sierra Toledo on the Valles Caldera in Sandoval County. Since then other individuals have tested positive for *B. dendrobatidis* (NMDGF files). Another chytridiomycete fungus (*B. salamandrivorans*) is also of concern. The fungus was identified in 2013 and is known to harm salamander populations throughout Europe. A national task force has been organized in the United States to prepare for the arrival of this fungus (www.salamanderfungus.org). In addition, to prevent unintended transmission of the fungus the USFWS proposed a rule under the Lacey Act to prohibit the importation, transportation, or acquisition of any live or dead specimen, including parts, but not eggs or gametes of various salamander species, including *P. neomexicanus* (USFWS 2016). However, a recent court ruling indicated the Lacey Act only applies to importation of animals into the United States and not across state lines (US Association of Reptile Keepers v. [Ryan Zinke as] Secretary of Interior). The impact of the ruling on the USFWS rule is unknown at the time of this review.

Because there is so much inherent variability in monitoring secretive species where only an unknown percentage is surface active at any given time, as in *P. neomexicanus*, hard data is lacking to definitively conclude whether the species is declining throughout its known range. However, antidotal evidence strongly suggests this is the case. For example *P. neomexicanus* were found at only 6 (44%) of 14 historically occupied sites surveyed during 2007. Based on numerous recent surveys, *P. neomexicanus* appear to be extinct at the type locality where numerous early investigators found the species to be very abundant. Additionally, Cummer et al. (2003, 2004) reported the absence of *P. neomexicanus* at a site on the Valles Caldera National Preserve where the species was once abundant (Whitford 1976).

Recommendations: *Plethodon neomexicanus* should maintain its listing as endangered. NMDGF should continue to provide support for the New Mexico Endemic Salamander Team and the implementation of the Jemez Mountains Salamander Management Plan. This Team should continue to review the effectiveness of this Plan and should consider revision as necessary. NMDGF should continue monitoring *P. neomexicanus* within areas burned by the Dome Fire, the Cerro Grande Fire and the Los Conchas Fire. Cummer and Painter (2007) recommended that surveys are valuable for determining presence-absence, but alone are ineffective and not appropriate for monitoring or measuring populations after a disturbance. Given the challenge of monitoring this animal without negatively impacting its habitat, the Department should continue to explore less invasive survey methods as well as occupancy modeling. Investigations of the population on the Valles Caldera and elsewhere for the presence of the *Batrachochytrium dendrobatidis* should be continued. A monitoring program for *B. salamandrivorans* should be developed following the recent release of monitoring guidelines (Grant et al. 2015).

Literature Cited:

- Cummer, M.R., B.L. Christman, and M.A. Wright. 2003. Investigations of the status and distribution of amphibians and reptiles on the Valles Caldera National Preserve, Sandoval County, New Mexico 2002. Unpubl. Rept. submitted to Valles Caldera Trust, Los Alamos, NM 13 p. + 3 appendices.
- Cummer, M.R., B.L. Christman, and M.A. Wright. 2004. Investigations of the status and distribution of amphibians and reptiles on the Valles Caldera National Preserve, Sandoval County, New Mexico 2003. Unpubl. Rept. submitted to Valles Caldera Trust, Los Alamos.
- Cummer, M.R., D. E. Green, and E.M. O'Neill. 2005. Aquatic chytrid pathogen detected in terrestrial plethodontid salamander. *Herpetol. Rev.* 36(3):248 - 249.
- Cummer, M.R. and C.W. Painter. 2007. Three case studies of the effect of wildfire on the Jemez Mountains salamander (*Plethodon neomexicanus*): microhabitat temperatures, size distributions, and a historical locality perspective. *Southwest. Nat.* 52(1):26-37.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. *Amphibians and Reptiles of New Mexico*. Univ. New Mexico Press, ABQ. xix + 431 p.

- Grant, E.H.C., Muths, E., Katz, R.A., Canessa, S., Adam, M.J., Ballard, J.R., Berger, L., Briggs, C.J., Coleman, J., Gray, M.J., Harris, M.C., Harris, R.N., Hossack, B., Huyvaert, K.P., Kolby, J.E., Lips, K.R., Lovich, R.E., McCallum, H.I., Mendelson, J.R., III, Nanjappa, P., Olson, D.H., Powers, J.G., Richgels, K.L.D., Russell, R.E., Schmidt, B.R., Spitzen-van der Sluijs, A., Watry, M.K., Woodhams, D.C., and White, C.L. 2015. Salamander chytrid fungus (*Batrachochytrium salamandrivorans*) in the United States—Developing research, monitoring, and management strategies: U.S. Geological Survey Open-File Report 2015–1233, 16 p., <http://dx.doi.org/10.3133/ofr20151233>.
- Hathcock, C.D. 2008. The status of the Jemez Mountains Salamander (*Plethodon neomexicanus*) at Los Alamos National Laboratory, 2008. Los Alamos Nat'l. Lab Unpubl Rept. LA-UR-08-0826. 6 pp.
- Painter, C.W. 2005. *Plethodon neomexicanus*. Pp 828-829 in Lannoo, M.L. (ed.). Amphibian declines. The conservation status of United States species. Univ. California Press, xxi + 1094 pp.
- Ramotnik, C.A. and N.J. Scott. 1988. Habitat requirements of New Mexico's endemic salamanders. Pp. 54-63 in R. C. Szaro, K. E. Severson, and D. R. Patton (eds.). Management of Amphibians, Reptiles, and Small Mammals in North America. USDA Forest Serv., Rocky Mt. Forest Range Exp. Stat. Gen. Tech. Rept. RM-166, Ft. Collins, CO. 458 p.
- U.S. Association of Reptile Keepers versus Ryan Zinke, Secretary of the Interior. 2017. Appeal from the U.S. District Court for the District of Columbia (No. 1:13-cv-02007).
- U.S. Fish and Wildlife Service. 2013a. Determination of endangered status for Jemez Mountains Salamander (*Plethodon neomexicanus*) throughout its range, final rule. Federal Register 78 (175): 55600-55627.
- U.S. Fish and Wildlife Service. 2013b. Designation of critical habitat for the Jemez Mountains Salamander. Federal Register 78 (224): 69569-69591.
- U.S. Fish and Wildlife Service. 2016. Injurious wildlife species; Listing salamanders due to risk of salamander chytrid fungus. Federal Register 81(8): 1534-1556.
- Whitford, W.G. 1976. The biota of the Baca Geothermal site. Unpubl. Rept.
- Williams, S.R. 1973. *Plethodon neomexicanus*. Cat. Amer. Amphib. Rept.:131.1-131.2.
- Wiltenmuth, E. 1996. Effects of hydration on a plethodontid salamander endemic to the Southwestern U.S. Unpubl. Rept. NM Dept. Game and Fish, Santa Fe. 4 p.

Lowland Leopard Frog, *Lithobates yavapaiensis*

Distribution and Biology: In New Mexico, *L. yavapaiensis* is known from 3700-5575 ft in western Catron, Hidalgo, and Grant counties (Degenhardt et al. 1996, Sredl 2005). This is a frog of permanent to semi-permanent streams and ponds; most populations occupy small streams and rivers, springs, and associated pools at low elevations in desert scrub localities. *Lithobates yavapaiensis* reaches the extreme eastern edge of its range in southwest New Mexico (Platz 1988; Sredl 2005). The species is abundant in select tributaries of Canon Bonito in Sonora, Mexico. Yuan et al. (2016) have proposed reclassifying the species within the genus *Rana*, but the suggested revision has not yet been widely adopted.

Current Status: *Lithobates yavapaiensis* is listed as a Species of Concern by USFWS (USFWS 2008), and is listed as a species of wildlife of special concern in Arizona (AGFD 1996). The species is subject to protection in Mexico (SEMARNAT 2010). Herpetologists in Arizona have documented the extinction of several populations in recent years and viable populations at all known historic localities in New Mexico no longer exist (Jennings 1987, 1995). During August 2000, a single individual was observed in the New Mexico portion of Guadalupe Canyon in extreme southwest Hidalgo County approximately 1.1 air miles upstream of the NM/AZ border. This remains the first and only specimen reported from New Mexico since April 1985 (Degenhardt et al. 1996). No reproduction of this species, i.e., egg masses or tadpoles, have been reported from New Mexico. *Lithobates yavapaiensis* is considered very rare and perhaps extirpated in New Mexico.

Threats: The likely causative agent for the decline in this species is a chytridiomycete fungus, *Batrachochytrium dendrobatidis*, which has been implicated in dieoffs of Lowland Leopard Frogs in southeast Arizona (Bradley et al. 2002, Sredl 2005, Savage et al. 2011) and is known to be present in New Mexico populations of leopard frogs (C.W. Painter and R.D. Jennings *unpubl data*). Rosen et al. (1995) reported a strong negative co-occurrence between the Lowland Leopard Frog and American Bullfrog (*Lithobates catesbeianus*) as well. Jennings and Hayes (1994) reviewed the decline of *L. yavapaiensis* in the desert southwest.

Recommendations: *Lithobates yavapaiensis* should maintain its current listing as endangered. Museum specimens of this species from New Mexico should be examined for the presence of *Batrachochytrium dendrobatidis*. Landowner permission should be requested to routinely monitor the suitability of habitat at the single site where the species was last known to occur in New Mexico. Translocation of the species from Arizona to proper habitat within New Mexico should be considered.

Literature Cited:

- Arizona Game and Fish Dept. 1996. Wildlife of Special Concern in Arizona. (Public Review Draft). Arizona Game and Fish Dept. Phoenix, AZ. 40 p.
- Bradley, G.A., P.C. Rosen, M.J. Sredl, T.R. Jones, and J.E. Longcore. 2002. Chytridiomycosis in native Arizona frogs. *J. Wildlife Diseases* 38(1):206-2.2
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, ABQ. xix + 431 p.
- Jennings, M.R. and M.P. Hayes. 1994. Decline of native ranid frogs in the desert southwest. Pp. 183-211 in Brown, P. R. and J. W. Wright (eds.). Herpetology of the North American Deserts. Proceedings of a Symposium. Southwest. Herpetol. Soc. Spec. Publ. (5):iv + 311 p.
- Jennings, R.D. 1987. The status of *Rana berlandieri*, the Rio Grande leopard frog, and *Rana yavapaiensis*, the lowland leopard frog in New Mexico. Unpubl. Rept. NM Dept. Game & Fish, Santa Fe. iv + 44 p.
- Jennings, R.D. 1995. Investigations of recently viable leopard frog populations in New Mexico, *Rana chiricahuensis* and *Rana yavapaiensis*. Unpubl. Rept. NM Dept. Game & Fish, Santa Fe. 36 p.
- Platz, J.E. 1988. *Rana yavapaiensis*. *Cat. Amer. Amphib. Rept.*:418.1-418.2.
- Rosen, P.C., C.R. Schwalbe, D.A. Parizek, Jr., P.A. Holm, and C.H. Lowe. 1995. Introduced aquatic vertebrates in the Chiricahua region: effects on declining native ranid frogs. Pp. 251-261 in Biodiversity and Management of the Madrean Archipelago: The Sky Islands of Southwestern United States and Mexico. USDI. Rocky Mt. Forest & Range Exp. Stat., Ft. Collins, Co. GTM RM-GTR-264.
- Savage, A. E., M. J. Sredl, and K. R. Zamudio. 2011. Disease dynamics vary spatially and temporally in a North American amphibian. *Biological Conservation* 144: 1910-1915.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.
- Sredl, M.J. 2005. *Rana yavapaiensis*. Pp 596-599 in Lannoo, M.L. (ed.). Amphibian declines. The conservation status of United States species. Univ. California Press, xxi + 1094 pp.
- U.S. Fish and Wildlife Service. 2008. List of Candidate and Species of Concern; Southwest Region Ecological Service. http://www.fws.gov/southwest/es/New_Mexico/SBC.cfm.
- Yuan, Z-Y., W.-W. Zhou, X. Chen, N.A. Poyarkov, Jr, H.-M. Chen, N.-H. Jang-Liaw, W.-H. Chou, N.J. Matzke, K. Iizuka, M.-S. Min, et al. 2016. Spatiotemporal diversification of the True Frogs (genus *Rana*): a historical framework for a widely studied group of model organisms. *Systematic Biology* 65:824–842.

Boreal Toad, *Anaxyrus boreas*

Distribution and Biology: In New Mexico, *A. boreas* is known only from north-central Rio Arriba County between 9100-10,500 ft in the San Juan Mountains at Canjilon Lakes, Trout Lakes, and Lagunitas Lakes (Stuart and Painter 1994). It lives in high mountain ponds, slow-moving streams, or low wet meadows. Dominant vegetation where *A. boreas* occurs in New Mexico includes corkbark fir, Engelmann spruce, aspen, willows, and various grasses and sedges. The species reaches its southern edge of its range in northcentral New Mexico (Degenhardt et al. 1996; Muths and Nanjappa 2005; NMDGF 2006).

Severe declines and extirpations of many populations have occurred in most areas where the Boreal Toad was once abundant (Muths and Nanjappa 2005). NMDGF (2006; 2008; 2010a; 2010b; 2012a, b; 2013, 2014) provides a summary of the status of this species in New Mexico.

Current Status: The Southern Rocky Mountain form of *Anaxyrus boreas* was classified as a “warranted but precluded” candidate species for federal listing (USFWS 2001). USFWS (2005) reversed this decision and found the species “not warranted” for federal listing based on the lack of sufficient genetic evidence to designate this form as a

distinct population segment. However, USFWS initiated a review of the status of the Eastern Population of *A. boreas* (which included the former Southern Rocky Mountain form) to determine if listing it as a Distinct Population Segment was warranted (USFWS 2012), and recently determined that listing was not warranted given that the species was well distributed across its range and continued to retain adaptive capacity (USFWS 2017). The USFS lists the species as Sensitive (USFS 2007). *Anaxyrus boreas* is listed as endangered in Colorado (Goettl 1997; Hammerson 1999), and as a species of special concern in Utah (UDWR 1997). The distribution and abundance of *A. boreas* have declined approximately 80% (Colorado) and 94% (Wyoming) in the last 20 years (Nesler and Goettl 1994). Although not reported from New Mexico until June 1966 (Campbell and Degenhardt 1971), the native population of *A. boreas* is currently thought to be extinct in New Mexico (Carey 1993). Jones (1978) estimated a population of 327 toads occurred at Upper Lagunitas Lake during 1978 whereas Woodward and Mitchell (1985) surveyed 139 ponds in known or expected *A. boreas* habitat in Rio Arriba County and located adults or tadpoles in only two ponds. During July-August, 1993, J.P. Hubbard and J.N. Stuart (*pers. comm.*) visited known localities and were unable to confirm the continued existence of *A. boreas* in New Mexico. During September 1996 retired USFWS personnel reported an unconfirmed sighting of *A. boreas* from Bobo Lake, a site ca 7 mi. ESE of Chama. Visits to this site in 1997 and 1998 failed to locate *A. boreas*. Surveys conducted during 2002 and 2006 at historic sites in New Mexico were also negative (Christman 2006), as were surveys of potential habitat in the Cruces Basin Wilderness.

From June 2008 through July 2017 NMDGF released approximately 20,044 *A. boreas* tadpoles and metamorphs provided by Colorado Division of Wildlife into Trout Lakes (NMDGF 2008; 2010a; 2010b; 2012a,b; 2013, 2014). Due to a shortage of tadpoles in Colorado, no animals were repatriated in 2015 or 2016. The success of these tadpoles has been regularly monitored since their release and various age classes, including adults, have been observed and photographed. This is in spite of several specimens having been found to be infected with the chytrid fungus, *Batrachochytrium dendrobatidis*, each year since 2009 (NMDGF files; Voyles 2015). Therefore the long-term results of this repatriation are somewhat problematic.

From 2014 to 2015 representatives from various agencies worked to develop a Structured Decision Model for how to best conserve the Southern Rocky Mountain population of *A. boreas*, with the model completed in 2016 (Converse et al. 2016, Gerber et al. 2016). The model is central to the revision of the conservation plan for the Southern Rocky Mountain population (Goettl et al. 1997); as of this Review, the new draft of the conservation plan is being finalized.

Threats: Several factors have potentially contributed to the decline of *A. boreas* and other montane amphibians in western North America, including the damaging effects of increased ultraviolet (UV-B) light on embryos; acidification and heavy-metal contamination of water, habitat destruction and degradation, such as may result from water, minerals, and livestock management, road construction, timber and fire management, and recreation; impact of introduced trout; infectious fungal disease; pathogen-induced mortality resulting from suppressed immune systems caused by some undetermined environmental stressors; climate change; predation, and life history characteristics (Hammerson 1999; Carey 2005). A combination of these factors is likely involved in dieoffs of the Boreal Toad. However the chytridiomycete fungus (*Batrachochytrium dendrobatidis*) has been implicated in mass dieoffs and significant population declines of the species in Colorado (Muths et al. 2003). Christman (2006) reported the presence of *B. dendrobatidis* in the Chorus Frog, (*Pseudacris maculata*) at Canjilon Lakes, a site historically occupied by *A. boreas*. A subsequent study found *P. maculata* subject to infection by the fungus within the region (Voyles 2015). Finally, any resource management activities that degrade alpine wetlands will negatively affect breeding habitat for Boreal Toads.

Recovery Plan Status: This species has a state Recovery Plan, accepted by the New Mexico Game Commission in 2006. Major recovery efforts were to repatriate tadpoles each year to a northern New Mexico locality in 2014 as well as in 2017, constituting 8 years of doing so. The site was also monitored for the status of toad that metamorphosed from those and previous tadpole cohorts and samples were collected for the chytrid fungus. Future recovery efforts will monitoring for breeding by repatriated toads, starting in 2012, geospatial modeling to determine ponds least likely to have the chytrid fungus, and determining a second site for repatriation. No new methods or strategies have been developed and no revision to plan is called for at this time. Revision of the Southern Rocky Mountain Boreal Toad Recovery Team Conservation Plan is now underway and in the future the state Recovery Plan should reflect this.

Recommendations: *Anaxyrus boreas* should maintain its current listing as endangered. NMDGF should continue work with the Boreal Toad Recovery Team, Colorado Division of Wildlife, USFS, and private landowners to continue to translocate Boreal Toads into historic habitat. NMDGF should continue to work with the Recovery Team to revise the outdated conservation plan. All efforts should be made to control the spread of the chytrid fungus, *B. dendrobatidis*, and monitoring of all species of amphibians occurring at historic sites of the Boreal Toad for the presence of *B. dendrobatidis* should be continued. Additional surveys that concentrate on locating eggs, tadpoles, and new metamorphs should be carried out by people experienced with the ongoing repatriation efforts of the Trout Lakes population of Boreal Toads. An experienced Project Leader should be assigned the responsibility of monitoring this population and those efforts should become a part of the overall responsibilities of the Leader.

Literature Cited:

- Campbell, J.B. and W.G. Degenhardt. 1971. *Bufo boreas boreas* in New Mexico. Southwest. Nat. 16(1):219
- Carey, C. 1993. Hypothesis concerning the causes of the disappearance of boreal toads from the mountains of Colorado. *Conser. Biol.* 7(2):355-362.
- Carey, C. 2005. Factors limiting the recovery of Boreal Toads (*Bufo b. boreas*). Pp 222-236 in Lannoo, M.L. (ed.). Amphibian declines. The conservation status of United States species. Univ. California Press, xxi + 1094 pp.
- Christman, B.L. 2006. Chytrid fungus and *Bufo boreas* distribution investigation, Rio Arriba County, New Mexico, 2006. Unpubl. Rept. to NM Dept. Game and Fish, Santa Fe. 27 pp.
- Converse, S. J., L. L. Bailey, B. A. Mosher, W. C. Funk, B. D. Gerber, and E. Muths. 2016. A model to inform management actions to chytridiomycosis-associated decline. *Ecohealth*: DOI: 10.1007/s10393-016-1117-9.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, ABQ. xix + 431 p.
- Gerber, B.D., S.J. Converse, E. Muths, H.J. Crockett, B.A. Mosher, and L.L. Bailey. 2016. Identifying species conservation strategies to reduce disease-associated declines. *Conservation Letters* July 2017:1-10.
- Goettl, J.P. [ed.] and the Boreal Toad Recovery Team. 1997. Boreal Toad Recovery Plan. Colorado Division of Wildlife. 56 p. + Appendix.
- Hammerson, G.A. 1999. Amphibians and Reptiles in Colorado: A Colorado Field Guide. 2nd Ed. University Press of Colorado, Niwot, Colorado xxvi + 484 p.
- Jones, K.L. 1978. Status of *Bufo boreas* in New Mexico project. Unpubl. Rept. NM Dept. Game and Fish, Santa Fe. 9 p.
- Muths, E. and P. Nanjappa. 2005. *Bufo boreas*. Pp 392-396 in Lannoo, M.L. (ed.). Amphibian declines. The conservation status of United States species. Univ. California Press, xxi + 1094 pp.
- Muths, E., P.S. Corn, A.P. Pessier, and D.E. Green. 2003. Evidence for disease-related amphibian decline in Colorado. *Biological Conservation* 110(2003):357-365.
- Nesler, T.P. and J.P. Goettl. 1994. State of Colorado, Boreal Toad, *Bufo boreas boreas* Recovery Plan. Colorado Div. of Wildlife, Denver. v + 34 p.
- New Mexico Dept. Game and Fish (NMDGF) 2008. New Mexico Boreal Toad Repatriation 2008 (Year One). . Unpubl. Rept. NM Dept. Game and Fish (NMDGF) 2010. New Mexico Boreal Toad Repatriation 2009 (Year Two). Unpubl. Rept. NM Dept. 22 pp.
- New Mexico Dept. Game and Fish (NMDGF). 2014. New Mexico Boreal Toad Repatriation 2014 (Year Seven). Unpubl. Rept. NM Dept. Game and Fish, Santa Fe, NM. 15p.
- New Mexico Dept. Game and Fish (NMDGF). 2006. Boreal Toad (*Bufo boreas boreas*) Recovery Plan. NM Dept. Game and Fish, Santa Fe, NM. 25 pp.
- New Mexico Dept. Game and Fish (NMDGF). 2010b. New Mexico Boreal Toad Repatriation 2010 (Year Three). NM Dept. Game and Fish, Santa Fe, NM. 22 pp.
- New Mexico Dept. Game and Fish (NMDGF). 2012a. New Mexico Boreal Toad Repatriation 2011 (Year Four). Unpubl. Rept. NM Dept. Game and Fish, Santa Fe, NM. 20 pp.
- New Mexico Dept. Game and Fish (NMDGF). 2012b. New Mexico Boreal Toad Repatriation 2012 (Year Five). Unpubl. Rept. NM Dept. Game and Fish, Santa Fe, NM. 18p.
- New Mexico Dept. Game and Fish (NMDGF). 2013. New Mexico Boreal Toad Repatriation 2013 (Year Six). Unpubl. Rept. NM Dept. Game and Fish, Santa Fe, NM. 15p.
- Stuart, J.N. and C.W. Painter. 1994. A review of the distribution and status of the boreal toad, *Bufo boreas boreas*, in New Mexico. *Bull. Chicago Herpetol. Soc.* 29(6):113-116.

- U. S. Fish and Wildlife Service. 2012. Endangered and Threatened Wildlife and Plants; 90-Day Finding on a Petition To List the Eastern or Southern Rocky Mountain Population of the Boreal Toad as an Endangered or Threatened Distinct Population Segment. Federal Register 77(71):21920-21936.
- U.S. Fish and Wildlife Service. 2001. Endangered and Threatened wildlife and plants; Review of plant and animal species that are candidates or proposed for listing as Endangered or Threatened, Annual notice of findings on recycled petitions, and Annual description of progress on listing actions; Proposed rule. Federal Register 66(210):54808-54832.
- U.S. Fish and Wildlife Service. 2005. Endangered and Threatened wildlife and plants; Revised 12-month finding of the southern Rocky Mountains distinct population segment of the Boreal Toad (*Bufo boreas boreas*). Federal Register 70(188):56880-56884.
- U.S. Fish and Wildlife Service. 2017. Endangered and threatened wildlife and plants; 12 month findings on petitions to list 25 species as endangered or threatened species. Federal Register 82(192):46618-46645.
- U.S. Forest Service. 2007. USDA Forest Service Southwest Region Sensitive Animals – September 21, 2007 version.
- Utah Division of Wildlife Resources (UDWR). 1997. Utah sensitive species list. From Internet <http://www.nr.state.ut.us/dwr/sensspl.htm>
- Voyles, J. 2015. Effects of *Batrachochytrium dendrobatidis* on amphibian communities in New Mexico. Unpubl. Rept. to NM Dept. Game and Fish, Santa Fe, NM. 16 p.
- Woodward, B.W. and S. Mitchell. 1985. The distribution of *Bufo boreas* in New Mexico. Unpubl. Rept. NM Dept. Game & Fish, Santa Fe. 26 p.

Western Narrow-mouthed Toad, *Gastrophryne olivacea*

Distribution and Biology: In New Mexico, populations of this small, toad-like frog are known from two highly disjunct localities: 1) southwestern New Mexico along NM Hwy 9 near Hermanas in southern Luna County near the U.S.-Mexican border (Degenhardt 1986, Stuart and Painter 1996), and 2) northeastern New Mexico in the Kiowa National Grasslands just north of Clayton, Union County (Moriarty et al. 2000). The distribution of this animal is poorly understood for the state. All specimens known from New Mexico have been collected in low-lying, flooded roadside ditches in desert scrub habitat dominated by mesquite, creosotebush, and various arid-land grasses or in flooded grasslands. Other reports have placed the animal in Union County in the Black Mesa area and down near Carlsbad and Carlsbad Caverns in Eddy County (NMDGF files). The Western Narrow-mouthed Toad is active above ground only after torrential rains when it is easily detected by its distinctive call. Ants are the primary prey (Fitch 1956). During the first week of August 2006, numerous breeding adults were observed in flooded roadside ditches at the NM Hwy 9 locality near Hermanas.

Current Status: *Gastrophryne olivacea* is a wildlife species of special concern in Arizona (AGFD 1996). The Republic of Mexico lists this species as rare (SEMARNAT 2010). Populations in Colorado are small and geographically limited, although they appear secure (Hammerson 1999). The species was not discovered in New Mexico until June 1986 (Degenhardt 1986). During 2011-2012 researchers studied habitat suitability in Union County for the species but was unable to find any individuals, in all likelihood due to the two years being the 8th and 2nd driest years on record (Griffis-Kyle 2011, 2012).

Threats: Overgrazing and other habitat modifications (i.e., draining or filling low-lying areas) are the primary threats to this species. Pesticide application in the adjacent agricultural regions is a potential threat, due to toxicity to eggs and larvae and impacts on adult food sources. Roadway mortality as a result of increased borderland security traffic may be a significant threat in southwest New Mexico as the only population known is in a flooded roadside ditch. Drought conditions, as has been the case in recent years, only exacerbates the aforementioned threats (Griffis-Kyle 2011, 2012). The chytridiomycete fungus (*Batrachochytrium dendrobatidis*), which has been implicated in mass dieoffs and significant population declines of other state-listed amphibians, has been detected on this species in southern Oklahoma (Marhanka et al. 2017), and therefore is of concern in New Mexico.

Recommendations: *Gastrophryne olivacea* should maintain its current listing as endangered. Habitat of the few known populations in New Mexico should be routinely monitored for any changes due to overgrazing or other anthropogenic modifications. Additional suitable habitat in Lea and Union counties should be surveyed for the

presence of this species during summer monsoon rains. The distribution and status of this animal in the state of New Mexico warrants further work; all individual specimens should be sampled for the presence of the chytrid fungus.

Literature Cited:

- Arizona Game and Fish Dept. 1996. Wildlife of Special Concern in Arizona. (Public Review Draft). Arizona Game and Fish Dept. Phoenix, AZ. 40 p.
- Degenhardt, W.G. 1986. Geographic Distribution: *Gastrophryne olivacea* (Great Plains narrowmouth toad). Herpetol. Rev. 17(4):91.
- Fitch, H.S. 1956. A field study of the Kansas ant-eating frog, *Gastrophryne olivacea*. Univ. Kansas Publ. Mus. Nat. Hist. 8(4):275-306.
- Griffis-Kyle, K. 2011. Evaluation of Great Plains narrowmouth toad habitat in northeastern New Mexico. Rept. to Share With Wildlife, NM Dept. Game and Fish, Santa Fe, NM. 11p.
- Griffis-Kyle, K. 2012. Evaluation of Great Plains narrowmouth toad habitat in northeastern New Mexico. Final rept. to Share With Wildlife, NM Dept. Game and Fish, Santa Fe, NM. 64p.
- Hammerson, G.A. 1982. Amphibians and Reptiles in Colorado. Colorado Div. Wild. Publ. DOW-M-I-27-82. vii + 131 p.
- Hammerson, G.A. 1999. Amphibians and reptiles in Colorado: A Colorado field guide. 2nd Ed. University Press of Colorado, Niwot, Colorado xxvi + 484 p.
- Marhanka, E.C., J. L. Watters, S.L. McMillin, C. C. Winfrey, D.J. Curtis, D.R. Davis, K. Farkas, J. L. Kerby, and C. D. Siler. 2017. Detection of high prevalence of *Batrachochytrium dendrobatidis* in amphibians from southern Oklahoma, USA. Herpetological Review 48(1):70-74.
- Moriarty, E.C., S.L. Collins, and J.T. Collins. 2000. Geographic Distribution: *Gastrophryne olivacea* (Great Plains narrowmouth toad). Herpetol. Rev. 31(1):50.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.
- Stuart, J.N. and C.W. Painter. 1996. Natural history notes on the Great Plains narrowmouth toad, *Gastrophryne olivacea* in New Mexico. Bull. Chicago Herpetol. Soc. 31(3):44-47.

THREATENED

Sacramento Mountain Salamander, *Aneides hardii*

Distribution and Biology: *Aneides hardii* is endemic to south-central New Mexico where it is found only in the White, Capitan, and Sacramento mountains in Otero and Lincoln counties. Osborne et al. (2017) collected mitochondrial and nuclear DNA samples from the three populations. The Capitan Mountain population had high genetic diversity with deeper divergence between haplotypes; the White Mountain population had very low genetic diversity; and the Sacramento Mountain population had high genetic diversity with low divergence between haplotypes.

A. hardii is generally associated with Douglas fir and spruce at elevations from 7850-11,700 ft where it is found under large woody debris or rocks (Degenhardt et al. 1996; Ramotnik 1997). Dominant overstory includes Douglas fir and white fir with lesser amounts of Engelmann spruce and southwestern white pine. Rocky Mountain maple, gooseberry, and oceanspray share the understory with seedling conifers and downed logs in various stages of decay. There are usually limestone rocks and boulders exposed on the surface (Scott and Ramotnik 1992). *Aneides hardii* may be locally abundant where essential microhabitat characteristics are available.

Current Status: The Sacramento Mountain Salamander is listed as Sensitive by the USFS (USFS 2007) and as a Species of Concern by USFWS (USFWS 2008).

Threats: Ramotnik and Scott (1988) suggested that intensive logging, slash removal, and burning may reduce or eliminate populations of *A. hardii*. Ramotnik (1996) reported that smaller, presumably juvenile, salamanders comprise 47% of the total salamanders collected on unlogged plots while only 30% of the total on logged plots.

Reasons for this difference may include lower reproductive rates or lower survival rates of eggs, hatchlings, or juveniles on logged plots and may indicate that logged plots represent less than optimal habitat. Borg (2001) found that Sacramento Mountain salamanders were more limited by the availability of cool microhabitats in logged sites than in forested sites and that juvenile salamanders on logged sites had significantly poorer body condition than those on unlogged sites.

Logging and other disturbances that cause desiccation of the habitat remain the primary threat to *A. hardii*. These salamanders survived the historic, low-intensity fires in the Sacramento Mountains but recent fire suppression has created the inevitable possibility of “stand-replacing” fires. The intensity of these fires compared to the more frequent, historic fires makes it difficult to predict how *A. hardii* will respond (Ramotnik 2005). In a five-year study of such a fire in the Sacramento Mountains, Ramotnik (2007) found that counts of *A. hardii* declined sharply during the first year post fire and remained low for 5 years. She suggested that salamanders either moved off of the site or retreated below ground to avoid desiccation, and that recolonization of the site will be possible only after canopy cover develops, depth of litter increases, and large natural cover objects become suitable habitat. Soil pH increased sharply on the burned sites immediately after the fire but after 3 years pH has begun to decrease due to the dilution effect caused by precipitation. Organic matter content and water-holding capacity are significantly lower on burned sites than on unburned sites. These soil characteristics are important because they are associated with soil moisture and can influence the ability of salamanders to repopulate burned sites. The relative proportion of prey items (primarily ants, springtails, harvestman spiders, and dipteran flies) to non-prey items is highest on the low-burn and unburned sites. The response of arthropods to fire, however, can be expected to change seasonally and annually as a function of climatic variation, recovery rate of the vegetation and forest floor, and differences in life history patterns of individual arthropods.

The possible effects of pesticide application (Ramotnik 1997) and ORV use on populations of Sacramento Mountain Salamanders need investigation.

Another chytridiomycete fungus (*B. salamandrivorans*) is also of concern. The fungus was identified in 2013 and is known to harm salamander populations throughout Europe. A national task force has been organized in the United States to prepare for the arrival of this fungus (www.salamanderfungus.org). In addition, to prevent unintended transmission of the fungus the USFWS proposed a rule under the Lacey Act to prohibit the importation, transportation, or acquisition of any live or dead specimen, including parts, but not eggs or gametes of various salamander species, including *P. neomexicanus* (USFWS 2016). However, a recent court ruling indicated the Lacey Act only applies to importation of animals into the United States and not across state lines (US Association of Reptile Keepers v. [Ryan Zinke as] Secretary of Interior) and the impact of the ruling on the USFWS rule is unknown at the time of this review.

Recommendations: This species should maintain its current listing as threatened. All logging and other ground disturbing silvicultural activities within occupied or potential sites where *A. hardii* occur should be coordinated with and approved by the New Mexico Endemic Salamander Team. A Management Plan should be drafted and implemented to guide the management of this species. NMDGF should continue to provide support for the New Mexico Endemic Salamander Team. A monitoring program for *B. salamandrivorans* should be developed following the recent release of monitoring guidelines (Grant et al. 2015). The genus *Aneides* has not been tested for its vulnerability to the salamander chytrid fungus and should be investigated for *A. hardii*. A more thorough monitoring program is being developed by the Department and the US Forest Service, particularly of the White Mountains population, where genetic diversity is low.

Literature Cited:

- Borg, C.K. 2001. Impacts of timber harvest on the endemic Sacramento Mountain salamander, *Aneides hardii* (Caudata: Plethodontidae), in the southern Rocky Mountains of New Mexico, USA. Unpubl. MS thesis. New Mexico State University, Las Cruces. 46 p.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, ABQ. xix + 431 p.
- Osborne, M. J.Cordova, and T. Turner. 2017. Population genetics of a plethodontid salamander endemic to New Mexico (Sacramento Mountains Salamander, *Aneides hardii*). Unpublished New Mexico Department of Game and Fish Share With Wildlife Program, Santa Fe, NM. 33 pp.

- Ramotnik, C.A. 1996. Studies of the effects of forest management practices on the Sacramento mountain salamander, *Aneides hardii*. Unpubl. Rept. U.S. Forest Service. Alamogordo, NM. 8 p.
- Ramotnik, C.A. 1997. Conservation assessment of the Sacramento Mountain Salamander. Gen. Tech. Rept. RM-GTR-293. Ft. Collins, CO: USDA, USFS Rocky Mt. Forest and Range Exp. Station. 19 p.
- Ramotnik, C.A. 2005. *Aneides hardii*. Pp 661-662 in Lannoo, M.L. (ed.). Amphibian declines. The conservation status of United States species. Univ. California Press, xxi + 1094 pp.
- Ramotnik, C.A. 2007. Effects of the Scott Able Fire on Sacramento Mountain Salamander abundance and arthropod prey base. Administrative Report to the U.S. Forest Service, Alamogordo, NM. 81 pp.
- Ramotnik, C.A., I. Murray, and D. Alba. 2004. Impact of the Scott Able Fire on salamander abundance and arthropod prey base: Year Three. Annual report to the U.S. Forest Service, Alamogordo, NM.
- Ramotnik, C. A. and N. J. Scott. 1988. Habitat requirements of New Mexico's endemic salamanders. Pp. 54-63 in R. C. Szaro, K. E. Severson, and D. R. Patton (eds.). Management of Amphibians, Reptiles, and Small Mammals in North America. USDA Forest Serv., Rocky Mt. Forest Range Exp. Station. Gen. Tech. Rept. RM-166, Ft. Collins, Colorado. 458 p.
- Scott, N. J. and C. A. Ramotnik. 1992. Does the Sacramento mountain salamander require old-growth forests? Pp. 170-178 in M. R. Kaufmann, W. H. Moir, and R. L. Bassett (eds.). Old-growth forests in the Southwest and Rocky Mountain regions. Proceedings of a Workshop. USDA Forest Service., Rocky Mt. Forest Range Exp. Station. Gen. Tech. Rept. RM-213, Ft. Collins, CO. 201 p.
- U.S. Fish and Wildlife Service. 2008. List of Candidate and Species of Concern; Southwest Region Ecological Service. [http://www.fws.gov/southwest/es/New Mexico/SBC.cfm](http://www.fws.gov/southwest/es/New%20Mexico/SBC.cfm).
- U.S. Forest Service. 2007. USDA Forest Service Southwest Region Sensitive Animals – September 21, 2007 version.
- U.S. Fish and Wildlife Service. 2016. Injurious wildlife species; Listing salamanders due to risk of salamander chytrid fungus. Federal Register 81(8): 1534-1556.

Sonoran Desert Toad, *Incilius alvarius*

Distribution and Biology: In New Mexico, *I. alvarius* is an uncommon species that occurs only in southwest Hidalgo County in the vicinity of Rodeo and in scattered localities in the adjacent Peloncillo Mountains at elevations of 4100-4950 ft (Degenhardt et al. 1996). It reaches the extreme eastern limit of its range in southwest New Mexico. *Incilius alvarius* was not collected in New Mexico until the summer of 1961 (Cole 1962). Habitat includes mesquite-creosotebush lowlands, arid grasslands, rocky riparian zones with sycamore and cottonwood, and oak-walnut woodlands in mountain canyons (Fouquette et al. 2005, and citations therein). This large toad spends most of the summer months in rodent holes and generally emerges only during the summer rains to breed. Breeding usually occurs during 1 night, 2-3 days following a major rainfall event of more than 25 mm (Sullivan and Malmos 1994). Average clutch size is 7,500 – 8,000 eggs that are deposited in shallow waters of seasonal and permanent pools (Fouquette et al. 2005).

Current Status: *Incilius alvarius* does not receive formal protection elsewhere. Fouquette (1970) characterized this species as one of the least known of all American toads.

Threats: Habitat modification and overcollecting are possible threats to this species in southwest New Mexico. Draining or filling in of cattle watering tanks poses a threat to the species, as does the diversion of roadside silt and runoff into known breeding ponds. The conversion of mesquite-creosotebush lowlands and arid grasslands to agriculture or subdivisions near Rodeo, NM, eliminates habitat. Roadway mortality as a result of increased borderland security traffic has been observed in southwest New Mexico. Take by collectors that want to use the animal for drug use via the bufotoxins found in the parotoid glands of *I. alvarius* have also been reported (NMDGF files).

Recommendations: *Incilius alvarius* should maintain its current listing as threatened. Regular monitoring of the habitat known to be occupied by this toad should occur. Additionally, surveys in suitable habitat should be conducted during the summer breeding season to locate new occupied sites.

Literature Cited:

- Cole, C. J. 1962. Notes on the distribution and food habits of *Bufo alvarius* at the eastern edge of its range. *Herpetologica* 18(3):172-175.
- Crother, B. I. (ed.). 2012. Scientific and English common names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. SSAR Herpetological Circular 39: 1-32.
- Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. *Amphibians and Reptiles of New Mexico*. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Fouquette, M. J. 1970. *Bufo alvarius*. *Cat. Amer. Amphib. Rept.*:93.1-93.4.
- Fouquette, M.J., Jr., C.W. Painter, and P. Nanjappa. 2005. *Bufo alvarius*. Pp 384-386 in Lannoo, M.L. (ed.). *Amphibian declines. The conservation status of United States species*. Univ. California Press, xxi + 1094 pp.
- Frost, D.R., T. Grant, J. Faivovich, R.H. Bain, A. Haas, C.F.B. Haddad, R.O. De Sa, A. Channing, M. Wilkinson, S.C. Donnellan, C.J. Raxworthy, J.A. Campbell, B.L. Blotto, P. Moler, R.C. Drewes, R.A. Nussbaum, J.D. Lynch, D.M. Green, and W.C. Wheeler. 2006. The amphibian tree of life. *Bull. Amer. Mus. Nat. Hist.* 297:1-370.
- Frost, D.R., R.W. McDiarmid, and J.R. Mendelson, III. 2008. Anura: Frogs. *In* B.I. Crother (ed.). *Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico*, pp. 1-84. SSAR Herpetological Circular 37.
- Sullivan, B.K. and K.B. Malmos. 1994. Call variation in the Colorado River toad (*Bufo alvarius*): behavioral and phylogenetic implications. *Herpetologica* 50:146-156.

REPTILES

ENDANGERED

Gila Monster, *Heloderma suspectum*

Distribution and Biology: *Heloderma suspectum* reaches the eastern edge of its range in southwest New Mexico where there are only a few isolated records from Hidalgo, Grant, Luna, and perhaps Doña Ana counties at elevations of 6100-6400 ft (Degenhardt et al. 1996). It was first reported from New Mexico in 1950 (Shaw 1950) and is known to be common only at Redrock Wildlife Area in Grant County (Beck 1994, 2005) and at Granite Gap in Hidalgo County. Surveys funded by the Department's Share with Wildlife program in 2017 detected the species in the Lower Box of the Gila River, Antelope Pass, Granite Gap, and in the BLM's Peloncillo Mountains Wilderness Study Area (Giermakowski et al. 2018). Records of historical occurrence in Luna and Doña Ana counties may represent displaced, released, or escaped captive individuals (Degenhardt et al. 1996). However, individual Gila Monsters were observed near the Mimbres River south of Faywood in 2016, and on the west and south sides of the Little Hatchet Mountains in 2017 (NMDGF files), suggesting that our understanding of the species' distribution in New Mexico is incomplete.

Heloderma suspectum is the largest lizard native to the United States and the only venomous one. The Reticulated Gila monster, *H. s. suspectum*, occurs in New Mexico. The seasonal activity period extends from March-November although *H. suspectum* spends as much as 96% of its time in sub-surface refugia (Beck and Lowe 1994). Davis and DeNardo (2010) determined that Gila monsters are capable of enduring drought conditions through behavioral and physiological adjustments, allowing them to persist under intense environmental conditions. Beck and Jennings (2003) investigated shelter use in Gila monsters in southwest New Mexico for six years. Their results suggest that the availability of suitable refugia played an important role in habitat selection by Gila monsters and thus influenced the pattern of local dispersal. Age at sexual maturity is 2-3 years with ca. 85% adult survivorship, which is considerably higher than expected. Longevity may exceed 20 years and adult females may lay a mean clutch of 6 eggs every 2nd to 3rd year. Beck (2005) provided a thorough review of the species' natural history throughout its range.

Current Status: *Heloderma s. suspectum* is listed endangered in New Mexico and as threatened by the Republic of Mexico (SEMARNAT 2010). The USFS (2007) lists the Gila monster as Sensitive. The population in New Mexico appears stable, although the species is commercially valuable and therefore susceptible to illegal collecting. The

Department completed a recovery plan for this species in 2017 (Bulger 2017), and will undertake additional efforts at determining its distribution in the state in the near future.

Threats: Threats to *H. suspectum* are largely from habitat loss and fragmentation, including alteration of refugia (see above), and illegal collection. Individuals are often killed by lay public who believe they are dangerous and represent a hazard. Roadway mortality likely as a result of increased borderland security traffic has been observed in southwest New Mexico. Although Gila monsters are adapted for living under harsh conditions (Beck 2005, Davis and DeNardo 2010), climatic projections suggest an additional threat may be climate change through increased, chronic thermal stress and deteriorating habitat suitability (Giermakowski and Snell 2011, Giermakowski et al. 2018).

Recommendations: *Heloderma suspectum* should maintain its current listing as endangered. Habitat known to be occupied by Gila monsters should be regularly monitored and any loss or fragmentation should be investigated to determine impacts to local populations. Given the importance of the Red Rock Wildlife Area to the species in New Mexico a management plan for *H. suspectum* should be developed for the property as part of the overall state recovery plan. Information on identification and legal status should be distributed to the public within the range of the Gila monster in New Mexico. Protection from illegal collecting should be strictly enforced.

Literature Cited:

- Beck, D.D. 1994. A field study of the Gila monster in southwestern New Mexico. Unpubl. Progress Rept. NM Dept. Game & Fish, Santa Fe, NM. 8 p.
- Beck, D.D. 2005. Biology of Gila Monsters and Beaded Lizards. Univ. California Press, Berkeley and Los Angeles. xii + 211 pp.
- Beck, D.D. and R.D. Jennings. 2003. Habitat use by Gila monsters: the importance of shelters. Herpetol. Monographs 17:111-129.
- Beck, D.D. and C.H. Lowe. 1994. Resting metabolism of helodermatid lizards: allometric and ecological considerations. J. Comp. Physiol. B 164(2):124-129.
- Bulger, J. 2017. Gila monster (*Heloderma suspectum*) recovery plan. 5 April 2017. New Mexico Department of Game and Fish. 23 p.
- Davis, J. R. and D. F. DeNardo. 2010. Seasonal patterns of body condition, hydration state, and activity of Gila Monsters (*Heloderma suspectum*) at a Sonoran Desert site. J. Herpetology 44(1): 83-93.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, ABQ. xix + 431 p.
- Giermakowski, J. T. and H. L. Snell. 2011. Final report: evaluating the potential extinction of selected New Mexican lizards due to climate change. Unpubl. Final Report to Share With Wildlife Program, NM Dept. Game & Fish, Santa Fe, NM. 54p.
- Giermakowski, J.T., M.J. Ryan, and I.M. Latella. 2018. Evaluation of the distribution and conservation status of the Gila monster (*Heloderma suspectum*) in southwestern New Mexico. Final Report, 31 May 2018. Share with Wildlife Program, New Mexico Department of Game and Fish. 15 p.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.
- Shaw, C.E. 1950. The Gila monster in New Mexico. Herpetologica 6(2):37-39.
- U.S. Forest Service. 2007. USDA Forest Service Southwest Region Sensitive Animals – September 21, 2007 version.

Dunes Sagebrush Lizard, *Sceloporus arenicolus*

Distribution and Biology: *Sceloporus arenicolus* is endemic to southeast New Mexico and a small area of adjacent Texas. In New Mexico, it occurs only in portions of Chaves, Eddy, Lea, and southern Roosevelt counties (Degenhardt et al. 1996). The species inhabits the second smallest range of any North American endemic lizard (Conant and Collins 1991). *Sceloporus arenicolus* is a habitat specialist and is confined to areas of shinnery oak - sand dunes and their peripheries, where the uneven sandy terrain and wind-created blowouts are essential habitat requirements. Individuals show a strong preference for large, deep blowouts with intermediate sand grain coarseness and little vegetation (Fitzgerald et al. 1995, 1997).

Current Status: *Sceloporus arenicolus* was proposed for federal listing as Endangered by the USFWS but subsequently that proposal was withdrawn (USFWS 2012), the Service citing that threats were no longer as significant as believed at the time of the original proposal. This was in part because of a Candidate Conservation Agreement/Candidate Conservation Agreement with Assurances in New Mexico (CCA/CCAA) and a Conservation Plan in Texas, both seeking to provide protection through voluntary cooperative agreements between land owners and the USFWS. The CCA/CCAA is applicable to this species and lesser prairie-chicken, *Tympanachus pallidicinctus*, and requires the permit holder of the CCA/CCAA to develop, coordinate, and implement conservation actions that reduce and/or eliminate known threats to both species in New Mexico on federal, state and private properties; to support ongoing efforts to re-establish and maintain viable populations of both species in currently occupied and suitable habitats; and to encourage development and protection of suitable habitat by giving participating cooperators incentives to implement specific conservation measures. To date, 69 ranches have been enrolled in the program, and this, along with other agreements, have brought in 3,797,215 acres under the CCA/CCAA, including state, private, and federal allotments while 43 companies are also enrolled (CEHMM 2018). While monitoring of various individual sites occurs annually (CEHMM 2018) at present a monitoring program has not been implemented to determine the effectiveness of the overall conservation agreements in New Mexico. Under the agreement, the USFWS would restart the listing decision-making process if it is determined that the measures in the agreements are not benefiting the species (USFWS, pers. comm.). Evidence that such agreements will provide sufficient protection in the long run is presently lacking. *Sceloporus arenicolus* receives no formal protection in Texas, where the distribution and abundance of populations are declining. Fitzgerald (2007) reported finding *S. arenicolus* at only 3 of 27 (11%) sites in potential habitat surveyed in Texas, and other research (Leavitt et al. 2011) in the New Mexico ranges suggests the species is declining there also.

Threats: *Sceloporus arenicolus* continues to be found in its specialized habitat, shinnery-oak blowouts, when the habitat is undisturbed (M Hill, CEHMM, pers.comm.). However, when the blowouts have been disturbed, the future of lizard populations is less certain with the primary threat to this narrowly endemic lizard being community disassembly through fragmentation, specifically through habitat loss (Leavitt and Fitzgerald 2013). Elimination and modification of shinnery oak-dune habitat resulting from chemical brush control programs on BLM, state, and private lands is a significant threat to the persistence of populations of *S. arenicolus* (Gorum 1995; Snell et al. 1993, 1994). An additional significant threat, again through fragmentation of the lizard communities through habitat loss, includes oil and gas exploration and extraction, as well as mining of sand for frac-sand operations. Data collected in the oil field near Maljamar and Loco Hills, Lea/Eddy counties, NM unquestionably demonstrate that statistically significant differences exist in lizard communities among fragmented and non-fragmented sites (i.e., fragmented by oil and gas development activities). Non-fragmented sites had significantly greater lizard diversity and a higher average number of captures for *S. arenicolus*. These data indicate that differences in lizard diversity exist where land management practices differ. Study areas in fragmented treatments contained fewer species, including fewer *S. arenicolus*. As a result of this, fragmented study areas have lower lizard diversity than those that are non-fragmented (Leavitt et al. 2011, Walkup et al. 2012). Sand grain size is particularly important for this species and restoration of such a self-organizing habitat as the shinnery-oak blowouts present a significant challenger (Ryberg and Fitzgerald 2014, Ryberg et al. 2014).

Recommendations: *Sceloporus arenicolus* should maintain its listing in New Mexico as Endangered. Chan et al. (2009) recognized three distinct groups of *S. arenicolus* corresponding to northern, central, and southern portions of the species' range. The authors recommended conservation efforts should focus not only on preservation of the sand dune complex but also preservation of these complexes within each of these geographic areas and the Department should support such conservation efforts. Given the primary concerns toward this species involve habitat loss and the significant challenge of restoring the habitat in such a way as to support the lizard, the CCA/CCAA shows promise toward the conservation of *S. arenicolus*, in particular working with private companies and individuals to prevent disturbance of the remaining habitat and NMDGF should continue to support the program. NMDGF should closely monitor activities in the range of *S. arenicolus* and recommend to all land management agencies and private consumptive industry (oil/gas development and ranchers) that the newly developed collaborative conservation strategies for *S. arenicolus* in New Mexico are strictly adhered to. A monitoring program under the CCA/CCAA should be established, not only to monitor the effectiveness of the program but also toward the status of this highly localized species. The State of Texas is currently exploring reintroduction of the species and this should be monitored for its applicability toward the populations in New Mexico. Finally, the recent increase in mining of sand for use in subsequent frac-sand mining in established dunes sagebrush lizard habitat in the state of Texas, an issue

not covered under the current Texas Conservation Plan for the species (TX Comptroller 2017), is of concern from the standpoint of the overall success of the conservation agreements. The Department should advise land managers for the potential impact of such mining and, where possible, prevent mining directly in known habitat for the species.

Sceloporus arenicolus can easily be mistaken for another, more common species of the same genus, the prairie lizard, *S. consobrinus*; therefore personnel in land management agencies who conduct surveys for dunes sagebrush lizard must be thoroughly trained in field identification of the species. The state of Texas has undertaken extensive work toward standardization of monitoring for the species and have been in discussion with the permit holders of the New Mexico conservation agreements about coordinating monitoring across the range of *S. arenicolus*. The Department should support this effort to have a rangewide monitoring program in place in addition to current conservation efforts.

Literature Cited:

- Center of Excellence for Hazardous Materials Management (CEHMM). 2018. CEHMM candidate conservation agreements for lesser prairie-chicken and dunes sagebrush lizard 2017 annual report. Center of Excellence for Hazardous Materials Management, Carlsbad, NM. 58 p.
- Chan, L.M., L.A. Fitzgerald, and K.R. Zamudio. (2009). The scale of genetic differentiation in the Dunes Sagebrush Lizard (*Sceloporus arenicolus*), an endemic habitat specialist. Conservation Genetics 10:131-142.
- Conant, R and J.T. Collins. 1991. A Field Guide to Reptiles and Amphibians of Eastern and Central North America. 3rd Ed. Houghton Mifflin Co., Boston. 450 pp.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Fitzgerald, L.A. 2007. Geographic distribution and habitat suitability of the Sand Dune Lizard, (*Sceloporus arenicolus*) in Texas. Unpubl. Final Rept. Submitted Texas Parks and Wildlife, Lubbock and Alpine, TX 17 pp.
- Fitzgerald, L.A., C.W. Painter, D.S. Sias, and H.L. Snell. 1997. The range, distribution, and habitat of *Sceloporus arenicolus* in New Mexico. Final Rept. Submitted to New Mexico Dept. Game and Fish. 31 p + Appendix 1-4.
- Fitzgerald, L.A., D.S. Sias, H.L. Snell, and C.W. Painter. 1995. Distribution survey of the dunes sagebrush lizard, *Sceloporus arenicolus* in New Mexico. Unpubl. Progress Rept. New Mexico Dept. Game and Fish, Santa Fe. 8 p.
- Fitzgerald L.A., Allen T., Chan L.M., Chopp J., Dixon J.R., Ferguson G., Gluesenkamp A., Hibbitts T.J., Hill D., Hill M.T., Howard R., Leavitt D.J., Miles D.B., Painter C.W., Pifer E., Ryberg W.A., Sears M., Snell H.L. 2012. The Research Program on *Sceloporus arenicolus*: Integration of findings, gaps in knowledge, and priorities for conservation oriented research. Report to Center of Excellence for Hazardous Materials Management (CEHMM), Carlsbad, NM. 20 p.
- Gorum, L.W., H.L. Snell, L.J.S. Pierce, and T.J. McBride. 1995. Results from the fourth year (1994) research on the effect of shinnery oak removal on the Dunes sagebrush lizard, *Sceloporus graciosus arenicolous*, in New Mexico. Unpubl. Progress Rept. New Mexico Dept. Game and Fish, Santa Fe. 12 p.
- Leavitt, D. J. and L. A. Fitzgerald. 2013. Disassembly of a dune-dwelling lizard community due to habitat fragmentation. Ecosphere 4(8): 1-15.
- Leavitt, D.J., D.K. Walkup, K.E. Narum, and L.A. Fitzgerald 2011. Results from the third year of research: effects of management practices for oil and gas development on the Mescalero dune landscape and populations of the endemic Dunes Sagebrush Lizard, *Sceloporus arenicolus*. Unpubl. Rept. submitted to the Bureau of Land Management, Carlsbad, NM. Submitted by Texas Cooperative Wildlife Collection, Dept. Wildlife Fisheries Sciences, Texas A&M University, College Station, Texas 77843.
- Ryberg, W. A. and L. A. Fitzgerald. 2014. Sand grain size composition influences subsurface oxygen diffusion and distribution of an endemic, psammophilic lizard. Journal of Zoology 295:116-121.
- Ryberg, W. A., M. T. Hill, C. W. Painter, and L. A. Fitzgerald. 2014. Linking irreplaceable landforms in a self-organizing landscape to sensitivity of population vital rates for an ecological specialist. Conservation Biology 29(3):888-898.
- Snell, H.L., L.W. Gorum, and A. Landwer. 1993. Results of second years research on the effect of shinnery oak removal on the Dunes sagebrush lizard, *Sceloporus graciosus arenicolous*, in New Mexico. Unpubl. Progress Rept. New Mexico Dept. Game and Fish, Santa Fe. 16 p.

- Snell, H.L., L.W. Gorum, M.W. Doles, and C.K. Anderson. 1994. Results of third years (1993) research on the effect of shinnery oak removal on the Dunes sagebrush lizard, *Sceloporus arenicolus*, in New Mexico. Unpubl. Progress Rept. New Mexico Dept. Game and Fish, Santa Fe. 13 p.
- Texas Comptroller's Office. 2017. Supplement to July 2017 monthly report for the Texas conservation plan for the dunes sagebrush lizard (TCP) submitted to the US Fish and Wildlife Service: non-TCP participant surface disturbance activities affect dune sagebrush lizard habitat and buffer in Texas. Unpublished report to US Fish and Wildlife Service. 8 pp.
- U.S. Fish and Wildlife Service. 2012. Withdrawal of the proposed rule to list dunes sagebrush lizard, proposed rule. Federal Register 77 (118): 36872-36899.
- Walkup, D. K., D. J. Levitt, W. Ryberg, and L. A. Fitzgerald. 2012. Research report 2012: effects of landscape fragmentation on the Mescalero dune landscape and populations of the Dunes Sagebrush Lizard, *Sceloporus arenicolus*. Report to U.S. Bureau of Land Management, Carlsbad Office, Carlsbad, NM. 47p.

Gray Checkered Whiptail, *Aspidoscelis dixonii*

Distribution and Biology: *Aspidoscelis dixonii* is a diploid unisexual species that normally reproduces by parthenogenetic cloning. This asexually reproducing lizard is known from only two areas; a small area in Trans-Pecos Texas and in the vicinity of Antelope Pass in Hidalgo County, New Mexico (Painter 2009; Scudday 1973). The total range of *Aspidoscelis dixonii* in New Mexico is only 3 x 5 miles, where populations are fragmented by patches of unsuitable habitat. In New Mexico, *A. dixonii* is found on creosotebush flats with little or no shrubby undergrowth on sandy to gravelly soils. It has not been found in the sandy arroyo bottoms of Antelope Pass or in the surrounding desert grasslands. These grasslands likely serve as barriers to dispersal and result in a range of only a few square miles. Overall, *A. dixonii* is a rare lizard in New Mexico, although it may be locally common at elevations of 4265-4760 ft where suitable habitat occurs (Painter 1991, 1992). From 1987-1993, NMDGF biologists conducted mark-recapture trapping for this species throughout its range at Antelope Pass. During 417,366 trap days and 8,288 lizard captures, only 409 (ca. 5%) were *A. dixonii* (Sias and Painter 2001).

Current Status: *Aspidoscelis dixonii* is listed as a Species of Concern by USFWS (USFWS 2008). The species receives no formal protection in Texas. Based on reproductive traits and morphometrics, Walker et al. (1994) suggested that the New Mexico population of *A. dixonii* is distinct from those in Trans-Pecos, Texas. Additionally, current studies of this species by the American Museum of Natural History also suggest the form at Antelope Pass may be genetically distinct from that in Trans-Pecos, Texas (C.J. Cole, Adjunct Curator of Herpetology, American Museum of Natural History, *pers. comm.* 2000).

The taxonomic status of this animal is problematic. Crother et al. (2012) determined that *Aspidoscelis dixonii* is synonymous with the common checkered whiptail, *A. tessellata*. However, other evidence suggests that while the population in Trans-Pecos, Texas is *A. tessellata*, the population in New Mexico is distinct and is likely a different species (Cordes and Walker 2006, Cole et al. 2007, M. Ryan, UNM, *pers. comm.*). As of this Review, the current nomenclature of gray-checkered whiptail, *Aspidoscelis dixonii* is retained.

Threats: Potential threats to this species include overgrazing, habitat alteration, chemical brush control, mining, and unregulated overcollecting. Cole et al. (2007) suggested that destabilizing hybridization and interspecific competition with the Western Whiptail, *Aspidoscelis tigris*, is causing significant population declines of *A. dixonii* at Antelope Pass.

Recommendations: This species should maintain its current listing as endangered. Habitat of the species in Hidalgo County should be regularly monitored for fragmentation and degradation through anthropogenic causes. Population monitoring should be conducted in the range of *A. dixonii* in New Mexico. Recent data and unverified observations suggest the species has declined since an extensive status review was conducted during 1987-1993 (Cole et al. 2007; Tomberlin *pers. comm.*). Collecting of any type should be strictly controlled. A review of the current status of the species should be undertaken, particularly the taxonomic status.

Literature Cited:

- Cole, C.J., C.W. Painter, H.C Dessauer, and H.L. Taylor. 2007. Hybridization between the endangered unisexual Gray-Checkered Whiptail Lizard (*Aspidoscelis dixonii*) and the bisexual Western Whiptail Lizard (*Aspidoscelis tigris*) southwestern New Mexico. American Museum Novitates 3555, 31 pp.
- Cordes, J.E., and J.M. Walker. 2006. Evolutionary and systematic implications of skin histocompatibility among parthenogenetic teiid lizards: three color pattern classes of *Aspidoscelis dixonii* and one of *Aspidoscelis tessellata*. Copeia 1:14-26.
- Painter, C. W. 1991. Interim Report: Results of the 1990 survey for the gray-checked whiptail (*Cnemidophorus dixonii*) on Bureau of Land Management lands in southwestern New Mexico. Unpubl. Rept. NM Dept. Game and Fish, Santa Fe. 20 p.
- Painter, C. W. 1992. Interim Report: Results of the 1991 survey for the gray-checked whiptail (*Cnemidophorus dixonii*) on Bureau of Land Management lands in southwestern New Mexico. Unpubl. Rept. NM Dept. Game & Fish, Santa Fe. 32 p.
- Painter, C.W. 2009. Gray Checkered Whiptail. *Aspidoscelis dixonii*, Pp. 354-337 in: Lizards of the American Southwest (L. L. C. Jones and R. E. Lovich, eds.). Rio Nuevo, Tucson, AZ.
- Scudday, J. F. 1973. A new species of lizard of the *Cnemidophorus tessellatus* group from Texas. J. Herpetol. 7(4):363-371.
- Sias, D.S. and C.W. Painter 2001. Natural history data from reptile and amphibians trapping at Antelope Pass in southwestern New Mexico. Unpubl. Report submitted to NMDGF Share with Wildlife Program. 12 p + 18 tables.
- U.S. Fish and Wildlife Service. 2008. List of Candidate and Species of Concern; Southwest Region Ecological Service. [http://www.fws.gov/southwest/es/New Mexico/SBC.cfm](http://www.fws.gov/southwest/es/New%20Mexico/SBC.cfm).
- Walker, J.M., J.E. Cordes, C.C. Cohn, H.L. Taylor, R.V. Kilambi, and R.L. Meyer. 1994. Life history characteristics of three morphotypes in the parthenogenetic *Cnemidophorus dixonii* complex (Sauria: Teiidae) in Texas and New Mexico. Texas J. Sci. 46(1):27-33.

Gray-banded Kingsnake, *Lampropeltis alterna*

Distribution and Biology: *Lampropeltis alterna* is a medium-sized colubrid snake found in the United States from the Balcones Escarpment of the Edward's Plateau in central Texas westward through the Trans-Pecos to the Hueco Mountains in El Paso County, Texas (Miller 1979; Merker and Merker 2005). In New Mexico, *L. alterna* is known only from Eddy County where it occurs in the southern end of the Guadalupe Mountains (Degenhardt et al. 1996; Hakkila 1994). Painter et al. (1992) first reported the species from New Mexico.

Lampropeltis alterna is a secretive and nocturnal inhabitant of the Chihuahuan Desert. It occurs on desert hills and dry mountain slopes in rocky limestone areas associated with various xeric-adapted plants including sotol, lechugulla, acacia, mesquite, ocotillo, creosotebush, and various cacti. Elevation in these areas range from 1460 – 5850 feet (Merker and Merker 2005). Small rodents and lizards are the primary prey, although small treefrogs (*Hyla arenicolor*) have also been reported in the diet. Very little is known regarding reproduction in the wild; clutch size of captive females averages eight and varies from 3-13 eggs; neonates average ca. 10 inches total length. The species is very commonly seen in the pet trade (Fitzgerald et al. 2004).

Current Status: Depending upon the number of specimens taken and/or the ultimate disposition of the specimens, collection of *L. alterna* in Texas requires either a Nongame Dealer Permit or a Nongame Collection Permit (letter in NMDGF files from Wildlife Permits Coordinator, TPWD, 8 March 1999). The species is listed as threatened by the Republic of Mexico (SEMARNAT 2010). The subspecies *L. a. alterna*, the Gray-banded Kingsnake, occurs in New Mexico.

Threats: Due to the presumed very small population size, the primary threat to this species in New Mexico is overcollecting. It is believed that the removal of even a small number of females from a population could significantly affect the population size. However, Hansen and Salmon (2017) suggest otherwise, citing how scarce the species is above ground and how relatively few roads occur in within the range of *L. alterna*. At present no new information is available on any populations of the species not associated with roads within the state.

Recovery Plan Status: This species has a state Recovery Plan, accepted by New Mexico Game Commission in 2002 (Painter et al. 2002). Major recovery efforts in period since 2010 Review were surveys in Carlsbad Region

and development of geospatial models of habitat for the species. No specimens were found in surveys but this may be more indicative of the rarity of the animal than any possible decline or extirpation of the local population. Future recovery efforts will be to continue surveys for the species, particularly on Carlsbad Caverns National Park following fires in 2011. No new methods or strategies have been made available so therefore no revision is called for the recovery plan at this time.

Recommendations: *Lampropeltis alterna* should maintain its current listing as endangered. NMDGF should monitor the effectiveness of the conservation recovery actions in the NMDGF Recovery Plan. Areas known to be occupied by *L. alterna* should be regularly patrolled for illegal collecting activities.

Literature Cited:

- Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, ABQ. xix + 431 p.
- Fitzgerald, L.A., Painter, C.W., Reuter, A., and Hoover, C. 2004. Collection, trade, and regulation of reptiles and amphibians of the Chihuahuan Desert ecoregion. TRAFFIC North America, Washington, D.C.: World Wildlife Fund. 75 pp + appendices.
- Hakkila, M. 1994. An assessment of potential habitat and distribution of the gray-banded kingsnake (*Lampropeltis alterna*) in New Mexico. Unpubl. Rept. To NM Dept. Game and Fish. Santa Fe. 12 p + 3 maps.
- Hansen, R.W., and G. T. Salmon. 2017. Distribution analysis, taxonomic updates, and conservation status of the *Lampropeltis mexicana* group (Serpentes: Colubridae). *Mesoamerican Herpetology* 4: 700–758.
- Merker, G. and W. Merker. 2005. *Alterna* The Gray-Banded Kingsnake. LM Digital. 80 pp.
- Miller, D.J. 1979. A life history study of the gray-banded kingsnake, *Lampropeltis mexicana alterna* in Texas. Chihuahuan Desert Research Inst. Cont. No. 87. Alpine, Texas. 48 p.
- Painter, C.W., C.L. Hayes, and J.N. Stuart. 2002. Recovery and conservation of the Gray-banded Kingsnake: Final Plan. NM Dept. Game and Fish, Conservation Services Div., Santa Fe, NM.
- Painter, C.W., P.W. Hyder, and G. Swinford. 1992. Three species new to the herpetofauna of New Mexico. *Herp. Review* 23(2):62.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. *Diario Oficial de la Federación*. 30 Diciembre 2010. 2: 1-77.

Mexican Gartersnake, *Thamnophis eques*

Distribution and Biology: *Thamnophis eques* is a widespread and variable species with at least 10 subspecies recognized throughout its extensive range (Rossman et al. 1996; Conant 2003). The species ranges from the southwestern United States in southeast Arizona and southwest New Mexico, on south into southern Mexico (Tipton 2005). In New Mexico, *Thamnophis eques* likely occurred at scattered sites throughout the Gila and San Francisco watersheds from 3690-5420 ft in western Grant and Hidalgo counties. Documented localities include single localities at and near Mule Creek and along the Gila River near Virden (Fitzgerald 1986). There is a single, century-old record from Duck Creek in Grant County near Cliff and a single roadkill specimen was found near Gila in 2016 (Degenhardt et al. 1996, NMDGF files). The species is known from adjacent Arizona (Cochise County at San Bernardino NWR), although populations at that site have declined significantly with introduction of non-native bullfrogs implicated for the decline (Rosen and Schwalbe 1988, Schwalbe and Rosen 1988). During August 2002 a single individual was observed and photographed along the Gila River near Riverside, Grant County. In June 2013, 4 males and 2 females were found along the Gila River in Grant County (Albuquerque Biopark, *pers. comm.*) The subspecies, *T. e. megalops*, occurs in New Mexico.

Current Status: *Thamnophis eques* is a species of wildlife of special concern in Arizona (AGFD 1996) and is listed as threatened by the Republic of Mexico (SEMARNAT 2010). The subspecies *T. eques megalops* was petitioned for federal listing by the Center for Biological Diversity (2003), and the USFWS initiated a status review to determine if listing this species was warranted (USFWS 2006a). The basis of this petition was cited as documented population declines, decreased range, and local extinction. Despite that fact that USFWS biologists concluded that *T. eques megalops* has declined from 85-90% of its US range, USFWS (2006b) found this petition not warranted based on a lack of information throughout the species range in Mexico. However, this finding was questioned by the Center for

Biological Diversity who filed suit against USFWS to overturn the agency's decision. The species, along with Narrow-headed Gartersnake (*T. rufipunctatus*) has now been listed by USFWS for federal protection as threatened under the U.S. Endangered Species Act (USFWS 2014).

Threats: Threats throughout the range of this subspecies include loss of wetlands, urbanization, habitat alteration, pollution, livestock grazing, loss of native prey species, exotic species predation (including bullfrogs, non-native crayfish and non-native predatory fishes), and possibly overcollecting (USFWS 2014).

Recommendations: *Thamnophis eques* should maintain its current listing as endangered, and permits for collection should be limited to research that aids in conservation of the species or wetlands where they occur. Projects should continue to document the condition of the recently discovered population. Individuals should be kept for captive rearing for potential repatriation to previously known localities. Permission to conduct surveys on private lands should be applied for and further surveys should be conducted at historic localities. Research projects designed for conservation of the species and reestablishment of wetlands within the historic range of the species should be initiated. Projects directed at the removal of non-native predators, restoration of the natural stream flow, and restoration of native riparian vegetation should be designed and implemented. Holycross et al. (2006) suggested that until these recommendations are implemented on a broad scale the general pattern of decline in the US populations will continue. NMDGF should continue to support staff participation in the interagency Mexican and Narrow-headed Garter Snake Conservation Working Group.

Literature Cited:

- Arizona Game and Fish Dept. 1996. Wildlife of Special Concern in Arizona. (Public Review Draft). Arizona Game and Fish Dept. Phoenix, AZ. 40 p.
- Center for Biological Diversity. 2003. Petition to list the Mexican Garter Snake, *Thamnophis eques megalops*, as an endangered or threatened species under the Endangered Species Act. Unpubl. Rept. submitted to Gale Norton, Secretary of the Interior, Washington D.C. 42 p.
- Conant, R. 2003. Observations on garter snakes of the *Thamnophis eques* complex in the lakes of Mexico's Transvolcanic Belt, with descriptions of new taxa. American Museum Novitates 3406:1–64.
- Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Fitzgerald, L. A. 1986. A preliminary status survey of *Thamnophis rufipunctatus* and *Thamnophis eques* in New Mexico. Unpubl. Rept. New Mexico Dept. Game & Fish, Santa Fe. 12 p.
- Holycross, A.T., W.P. Burger, E.J. Nirgo, and T.C. Brennan. 2006. Surveys for *Thamnophis eques* and *Thamnophis rufipunctatus* in the Gila River watershed of Arizona and New Mexico. Unpubl Rept. submitted to Arizona Game and Fish Dept. 105 pp.
- Rosen, P. C. and C. R. Schwalbe. 1988. Status of the Mexican and narrow-headed garter snakes (*Thamnophis eques megalops* and *Thamnophis rufipunctatus*) in Arizona. Unpubl. Rept. U.S. Fish & Wildlife Service, Albuquerque, NM. 69 pp.
- Rossmann, D.A. N.B. Ford, and R.A. Seigel. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. xx + 332 pp.
- Schwalbe, C. R. and P. C. Rosen. 1988. Preliminary report on the effect of bullfrogs on wetland herpetofaunas in southeastern Arizona. Pp. 166-173 in R. C. Szaro, K. E. Severson, and D. R. Patton (eds.). Management of Amphibians, Reptiles, and Small Mammals in North America. USDA Forest Serv., Rocky Mt. Forest Range Exp. Station. Gen. Tech. Rept. RM-166, Ft. Collins, CO. 458 p.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.
- Tipton, B.L. 2005. Snakes of the Americas: Checklist and Lexicon. Krieger Publishing Co., Malabar, Florida. xiv + 477 pp.
- U.S. Fish and Wildlife Service. 2006a. Endangered and threatened wildlife and plants; 90-day finding on a petition to list the Northern Mexican Gartersnake as threatened or endangered with critical habitat. Federal Register 71(2):315-324.
- U.S. Fish and Wildlife Service. 2006b. Endangered and threatened wildlife and plants; 12 month finding on a petition to list the Northern Mexican Gartersnake (*Thamnophis eques megalops*) as threatened or endangered with critical habitat: Proposed Rule. Federal Register 71(186):56228-56256.

U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants; Threatened Status for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake; Final Rule. Federal Register 79: 38678-38746.

Plain-bellied Watersnake, *Nerodia erythrogaster*

Distribution and Biology: *Nerodia erythrogaster* is a wide ranging, variable species that occurs from the central and southern United States and then south to the central Mexican Plateau. In New Mexico, it is confined to the lower Pecos River drainage, including along the Black and Delaware rivers. However, there is a recent verified record of adults and juveniles of the species from a stock tank near Nara Visa, Quay County, NM (Brown 2009). This population likely is an extension of the species range from nearby known localities in northwest Texas (Dixon 2000). In New Mexico the species is a rare, nocturnal, and little observed species that seems to prefer permanent, shallow, flowing water with rocky retreats and foraging areas where it forages for fish and frogs. Christman and Kamees (2007) examined 41 wild caught individuals and 128 museum specimens and found only fish, tadpoles, and frogs in the diet. *Nerodia erythrogaster* reaches the extreme western extent of its range in southeast New Mexico (Degenhardt et al. 1996). Being at the western limits of its range in New Mexico, populations of *N. erythrogaster* are less dense and perhaps more likely to be fragmented through habitat loss (Christman and Kamees 2007). Despite numerous surveys along the lower Pecos River drainage since 1988, fewer than 10 individuals of this species were located (Painter 1991, 1993). However, Christman and Kamees (2007) reported finding 40 individuals (20 males, 20 females) on the Pecos and Delaware rivers in Eddy County during 1205 trap days and 45 hours of active searching. Fifteen of the 40 snake captures occurred along the Pecos River between the NM Hwy 31 crossing and 10-Mile Dam. The lack of recaptured snakes in this river reach suggests a robust population (Christman and Kamees 2007). A phylogeographic analysis of the species indicated low levels of genetic differentiation and therefore no subspecies is recognized for New Mexico (Makowsky et al. 2010, Crother et al. 2012).

Current Status: No protection is afforded this species in Texas. It is listed as threatened by the Republic of Mexico (SDS 1994). Populations in Mexico are rapidly declining due to alteration of aquatic habitat (Conant 1977, Scudday 1977).

Threats: Primary threats are from direct take and alteration of current water use practices. Populations that exist in areas of high human impact, e.g., 6-Mile Dam, 10-Mile Dam, and the acequia on the north edge of Carlsbad are particularly susceptible to take (NMDGF files). It is often killed by uninformed fishermen who believe it to be venomous and injurious to game fish populations (West 1992). *Nerodia erythrogaster* is not venomous. A potential concern is the establishment of other species of *Nerodia* through unintentional release of pets, as has happened in California and Arizona (Rose et al. 2013, AZDGF, pers. comm.).

Recommendations: *Nerodia erythrogaster* should retain its current status as endangered. An educational program designed to provide public information (especially to the anglers along the lower Pecos River) on the natural history, status, and distribution of this species around Carlsbad should be initiated. A research program using radio telemetry and designed to investigate population trends and habitat utilization should be initiated. Suitable habitat in the New Mexico eastern tier of counties should be searched for unknown populations of this species, and monitoring should be conducted within the range of the species for other, non-native species of *Nerodia*.

Literature Cited:

- Brown, T.L. 2009. A report on the New Mexico Herpetological Society field trip to Nara Visa, Quay Co., New Mexico. NM Herpetol. Soc. Unpubl. Rept. Albuquerque. 10 pp.
- Christman, B.L. and L.K. Kamees. 2007. Current distribution of the Blotched Watersnake (*Nerodia erythrogaster transversa*) and Rio Grande Cooter (*Pseudemys gorzugi*) in the Lower Pecos River system Eddy County, New Mexico 2006-2007. Unpubl. Rept. to NM Dept Game and Fish, Santa Fe. 36 pp.
- Conant, R. 1977. Semiaquatic reptiles and amphibians of the Chihuahuan Desert and their relationships to drainage patterns of the region. Pp. 455-491 in R. H. Wauer, and D. H. Riskind (eds.). Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico. U.S. Dept. Interior, Natl. Park Serv., Trans. Proc. Ser. (3):xxii + 658 p.

- Crother, B. I., J. Boundy, J. A. Campbell, K. DeQuieroz, D. Frost, D. M. Green, R. Highton, J. B. Iverson, R. W. Scientific and standard English names of amphibians and reptiles of North America north of Mexico: Update. *Herpetol. Rev.* 34(3):196-203.
- Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. *Amphibians and Reptiles of New Mexico*. Univ. New Mexico Press, ABQ. xix + 431 p.
- Dixon, J.R. 2000. *Amphibians and reptiles of Texas with keys, taxonomic synopses, bibliography, and distribution maps*. 2nd ed. Texas A & M Univ. College Station. 421 pp.
- Makowsky, R., J. C. Marshall, Jr., J. McVay, P. T. Chippendale, and L. J. Risser. 2010. Phylogeographic analysis and environmental niche modeling of the plain-bellied watersnake (*Nerodia erythrogaster*) reveals low levels of genetic and ecological differentiation. *Mol. Phylogenet. Evol.* 55(3): 985-995.
- Painter, C. W. 1991. Summary of Field Work - 1991. Blotched water snake (*Nerodia erythrogaster transversa*). New Mexico Dept. Game and Fish Unpubl. Rept. Submitted to BLM Carlsbad Resource Area, Carlsbad, NM. 7 p.
- Painter, C. W. 1993. Preliminary investigations of the distribution and natural history of the blotched water snake (*Nerodia erythrogaster transversa*) in New Mexico. New Mexico Dept. Game and Fish Unpubl. Rept. Submitted to BLM Carlsbad Resource Area, Carlsbad, NM. 16 p.
- Rose, J.P., O.J. Miano, and B. D. Todd. 2013. Trapping efficiency, demography, and density of an introduced population of northern watersnakes, *Nerodia sipedon*, in California. *Journal of Herpetology* 41(3):421-427.
- Scudday, 1977. Some recent changes in the herpetofauna of the northern Chihuahuan Desert. Pp. 513-522 in R. H. Wauer, and D. H. Riskind (eds.). *Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico*. U.S. Dept. Interior, Natl. Park Serv., Trans. Proc. Ser. (3):xxii + 658 p.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. *Diario Oficial de la Federación*. 30 Diciembre 2010. 2: 1-77.
- West, S. 1992. Eddy County water moccasins. *The Phainopepla* 1(3):3-4.

New Mexico Ridgenosed Rattlesnake, *Crotalus willardi obscurus*

Distribution and Biology: The total known range of this federally threatened subspecies of *C. willardi* includes the high elevations of the Animas Mountains (5970-8500') and Peloncillo Mountains (5600-6200') in southwest Hidalgo County, New Mexico, and the northern Sierra San Luis (extreme NE Sonora and NW Chihuahua, Mexico; Barker 1991). The species was not reported from the Peloncillo Mountains in Arizona until 1997 (Holycross and Smith 1997). Genetic data demonstrate that the three mountain ranges harbor isolated populations that should be regarded as Evolutionarily Significant Units (i.e., Distinct Population Segments) under the Endangered Species Act. Multiple lines of evidence suggest an exceptionally small population occurs in the Peloncillo Mountains, and the Peloncillo population tested positive for genetic bottlenecks (Holycross and Douglas 2007). Recent surveys have shown the population in the Animas Mountains to still exist, but efforts to find the species in the Peloncillo Mountains have been unsuccessful (L. Kamees, U. Arkansas, pers. comm.).

Crotalus willardi obscurus is a montane generalist, found in rocky hillsides, canyon bottoms, and talus slopes. Dominant vegetation in the habitat of *C. willardi obscurus* in New Mexico includes various oaks, Apache and Chihuahua pine, alligator bark juniper, manzanita, and various grasses (Degenhardt et al. 1996). A large wildfire in the Animas Mountains during 1996 destroyed at least 75% of the Critical Habitat (USFWS 1985) of the species, although recent investigation of the population status in the burned area suggest population trends in the short-term may be stable. The adult diet is composed mostly of rodents (brush mouse, *Peromyscus boylii*), although birds are occasionally taken. The juvenile diet is made up of mostly lizards (Yarrow's spiny lizard, *Sceloporus jarrovi*) and centipedes (*Scolopendra* sp.; Holycross et al. 2002)

Current Status: *Crotalus willardi obscurus* is listed as threatened by the USFWS (USDI 1991) and as a species of special concern in Arizona. A federal recovery plan was approved in 1985 (USFWS 1985). The overall species is subject to protection in Mexico (SEMARNAT 2010). The Animas Mountains population is protected by private land ownership and appears fairly secure (Holycross 1995), although there is the continued threat of catastrophic wildfire. In the Peloncillo Mountains a total of only 26 specimens are known to science. Eighteen of these were collected by

A.T. Holycross et al. (Arizona State Univ.) with funding provided by NMDGF, AGFD, and USFWS between 1995 and 2001 (Holycross 1999; Holycross, *pers. comm.*).

Threats: The most prominent threat to *Crotalus willardi obscurus* is habitat loss (i.e., type conversion of woodland habitat) and direct take resulting from wildfire or prescribed management-ignited fires. Additionally, changes in land ownership or land use practices that result in habitat modification could negatively affect populations. Prescribed fire may pose a threat to marginal and fragmented habitat for this species in the Peloncillo Mountains. Seasonal variation of the threat imposed by fire deserves additional research. This species, because of very small population numbers and low genetic diversity, appears to be at significant risk of extinction from habitat alteration due to climate change (Davis et al. 2015).

The species is commercially valuable and sought after by private herpetoculturists. While investigating the status of *C. willardi* in the Animas Mountains, Harris and Simmons (1975) reported encountering 15 collectors from 6 states during late August 1974, and they felt that the species could not withstand such overexploitation. However, all of the habitat in the Animas Mountains of New Mexico is on private land and access is strictly prohibited. Habitat in the Peloncillo Mountains is under authority of the USFS and state/federal permits are required for take for this species.

Recommendations: *Crotalus willardi obscurus* should maintain its current state-listing as state endangered. NMDGF should cooperate with USFWS and form an Advisory Team to redraft the Recovery Plan (USFWS 1985), which is over 20 years old and outdated. Staff biologists from NMDGF, USFWS, and USFS should work together to design a program of prescribed fire. The primary goal should be to develop a fire management program which emphasizes the need for cool-season, low-intensity fires to reduce the buildup of woody fuels and thus the chance for catastrophic wildfire within the montane habitat of *C. willardi obscurus*.

Literature Cited:

- Barker, D. G. 1991. An investigation of the natural history of the New Mexico ridgenose rattlesnake, *Crotalus willardi obscurus*. Unpubl. Rept. New Mexico Dept. Game and Fish, Santa Fe. 100 p.
- Davis, M. A., M. R. Douglas, C. T. Webb, M. L. Collyer, A. T. Holycross, C. W. Painter, L. K. Kamees, and M. E. Douglas. 2015. Nowhere to go but up: Impacts of climate change on demographics of a short-range endemic (*Crotalus willardi obscurus*) in the sky-islands of southwestern North America. PLoS ONE 10(6): e0131067.doi:10.1371/journal.pone.0131067
- Degenhardt, W. G., C. W. Painter, and A. H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Harris, H. S., Jr. and R. S. Simmons. 1975. An endangered species, the New Mexican ridge-nose rattlesnake. Bull Maryland Herpetol. Soc. 11(1):1-7.
- Holycross, A. H. 1995. Status of the Animas Mountains Population of *Crotalus willardi obscurus*. Unpubl. Preliminary Rept. New Mexico Dept. Game and Fish, Santa Fe. 14 p.
- Holycross, A.H. 1999. A map of potential core habitat for *Crotalus willardi obscurus* on Coronado National Forest lands in the Peloncillo Mountains. Unpubl. Rept. submitted to Malpai Borderlands Group, Douglas, Arizona. 144 p.
- Holycross, A.T. and M.E. Douglas. 2007. Geographic isolation, genetic divergence, and ecological non-exchangeability define ESUs in a threatened sky-island rattlesnake. Biological Conservation 134(2007):142-154.
- Holycross, A. T. and S. W. Smith. 1997. Geographic Distribution: *Crotalus willardi obscurus*. Herpetol. Rev. 28(2):97.
- Holycross, A.T., C.W. Painter, D.G. Barker, and M.E. Douglas. 2002. Foraging ecology of the threatened New Mexico Ridge Nosed Rattlesnake (*Crotalus willardi obscurus*). Pp. 244-251 In Schuett et al. (eds.) Biology of the Vipers. Eagle Mountain Publ. Co., Eagle Mountain, Utah. xii + 579 p.
- United States Department of the Interior (USDI). 1991. Title 50-Wildlife and Fisheries. Part 17: Endangered and threatened wildlife and plants, Subpart B: Lists, endangered and threatened wildlife (CFR 17.11 and 17.12). U.S. Govt. Printing Office, Washington, D.C. 37 p.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.

U.S. Fish and Wildlife Service (USFWS). 1985. New Mexico Ridgenose Rattlesnake Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM.

THREATENED

Western River Cooter, *Pseudemys gorzugi*

Distribution and Biology: In New Mexico, *P. gorzugi* is confined to the Pecos River drainage, including the Pecos, Black, and Delaware rivers below Brantley Dam and in Rocky Arroyo in Eddy County (Degenhardt et al. 1996; Christman and Kamees 2007). The historic record of *P. gorzugi* from Bitter Lake NWR in Chaves County (Bundy 1951) is questionable (Painter 1991), although the dried shell of a recently-predated large adult was discovered there during late summer 2008 (Giermakowski and Pierce 2016). Christman and Kamees (2007) trapped 56 individuals at 11 of 24 sites surveyed in southeastern New Mexico. During these surveys, *P. gorzugi* was most commonly encountered in the Black River. Researchers from Eastern New Mexico University, partially funded through the Department's Share with Wildlife program, have started a survey program to update the status of the species and to learn more about its biology. More than 200 captures of *P. gorzugi* were made in both 2016 and 2017, including captures of juveniles. Researchers from the University of New Mexico were unable to find the species in the Delaware River in 2016 and 2017 (NMDGF files). In addition, the Albuquerque BioPark is actively working on propagation techniques for the species (R. Reams, Alb. BioPark, *pers. comm*, Letter et al. 2017).

Pseudemys gorzugi is often an abundant turtle within its limited habitat, preferring river systems with deep pools and generally avoiding shallow riffles (Degenhardt et al. 1996). The species is primarily herbivorous, although it is easily trapped using sardines as bait.

Current Status: *Pseudemys gorzugi* is one of the ten least-known freshwater turtles in North America (Lovich and Ennen 2013, Ernst 1995, Ernst et al. 1994) and Ernst and Lovich (2009) suggest an ecological study of the species is much needed. Populations of *P. gorzugi* in Texas are declining, due primarily to take for the pet trade (M. Forstner 2001 *in litt.* NMDGF files), and habitat loss and degradation (Scudday 1974). It is listed as Rare by the Republic of Mexico (SEMARNAT 2010). In July 2012, the USFWS was petitioned by the Center of Biological Diversity to consider this species for protection under the U.S. Endangered Species Act (CBD 2012). As of this Review, the USFWS has not made a decision concerning this petition.

Threats: The primary threat to *P. gorzugi* is from weekend recreationists who use this turtle for target practice, as numerous dried shells with obvious bullet holes have been found along the Delaware River (Painter 1991; Christman and Kamees 2007, Bailey et al. 2008, Mali and Forstner 2017). Fishermen often take it on trotlines set for catfish or while fishing for other species with live or dead animal bait and a specimen was recently caught having a fishing hook in its throat (Waldon et al. 2017). Numerous shells, likely predated by raccoons have been observed along the Delaware River in Eddy County. Wildfire along the riparian habitat of the Delaware has also resulted in numerous take of the species (NMDGF files *unpubl. data*). Cooter turtles of the genus *Pseudemys*, including *P. gorzugi*, are popular turtles in the commercial pet trade, making overcollection a concern (Fitzgerald et al. 2004, Schlaepfer et al. 2005, Bailey et al. 2014). Runoff pollution from oil and gas wells are likely a factor in the decline of this species in select reaches of the Pecos River (Ward 1984). Flooding, such as seen in September 2014, and drawdown of water may also be of concern (Mali and Forstner 2017, Mali 2017).

Recommendations: *Pseudemys gorzugi* should maintain its current listing as threatened. The status of the enigmatic population at Bitter Lakes NWR in Chaves County should be investigated. Attempts to obtain permission to investigate sites on private land at Willow Lake and Blue Spring should be made. Research on the demography and biology of this poorly studied species should continue to be supported, including the research toward captive propagation. A program of public awareness should be initiated and informative signs should be posted around the commonly used fishing areas in the lower Pecos River drainage.

Literature Cited:

Bailey, L., J. R. Dixon, R. Hudson, and M. R. J. Forstner. 2008. Minimal genetic structure in the Rio Grande cooter (*Pseudemys gorzugi*). *Southwestern Naturalist* 53:406–411.

- Bailey, L., M. R. J. Forstner, J. R. Dixon, and R. Hudson. 2014. Contemporary status of the Rio Grande cooter (Testudines: Emydidae: *Pseudemys gorzugi*) in Texas: phylogenetic, ecological and conservation considerations. pp. 320-334 in C.A. Hoyt and J. Karges (eds.), Proceedings of the Sixth Symposium on the Natural Resources of the Chihuahuan Desert Region, October 14–17, 2004. Chihuahuan Desert Research Institute, Fort Davis, Texas.
- Bundy, R.E. 1951. New locality records of reptiles in New Mexico. *Copeia* 1951(4):314.
- Center for Biological Diversity. 2012. Before the secretary of the interior: petition to list 53 amphibians and reptiles in the United States as threatened or endangered species under the Endangered Species Act. 454p.
- Christman, B.L. and L.K. Kamees. 2007. Current distribution of the Blotched Watersnake (*Nerodia erythrogaster transversa*) and Rio Grande Cooter (*Pseudemys gorzugi*) in the Lower Pecos River system Eddy County, New Mexico 2006-2007. Unpubl. Rept. to NM Dept Game and Fish, Santa Fe. 36 pp.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Ernst, C.H. 1995. Freshwater and terrestrial turtles of the United States: Status and prognosis. *Bull. Chicago Herp. Soc.* 30(11):225-230.
- Ernst, C.H., J.E. Lovich, and R.W. Barbour. 1994. Turtles of the United States and Canada. Smithsonian Inst. Press. Washington, D.C. xxxviii + 578 p.
- Ernst, C.H. and J.E. Lovich. 2009. Turtles of the United States and Canada. 2nd Edition. John Hopkins University Press. Baltimore. xii + 827 p.
- Fitzgerald, L. A., C. W. Painter, A. Reuter, and C. Hoover. 2004. Collection, trade, and regulation of reptiles and amphibians of the Chihuahuan Desert ecoregion. TRAFFIC North America, Washington, D.C.: World Wildlife Fund. 75 pp + appendices.
- Giermakowski, J.T., and L.J.S. Pierce. 2016. *Pseudemys gorzugi*. Geographic distribution. *Herpetological Review* 47:626.
- Letter, A.W., K.J. Waldon, I. Mali, and R.D. Reams. 2017. *Pseudemys gorzugi*. Maximum clutch size. *Herpetological Review* 48(4):836-837.
- Lovich, J. E. and J. R. Ennen. 2013. A quantitative analysis of the state of knowledge of the turtles of the United States and Canada. Amphibia-Reptilia DOI:10.1163/15685381-00002860.
- Mali, I. 2017. Phase II: demography of western river cooter (*Pseudemys gorzugi*) within the Black River drainage. Interim Report to New Mexico Department of Game and Fish, Santa Fe, NM. 8pp.
- Mali, I., and M.R.J. Forstner. 2017. Survey of western river cooter (*Pseudemys gorzugi*) in New Mexico within the Black River drainage. Final Report to New Mexico Department of Game and Fish, Santa Fe, NM. 17 pp.
- Painter, C.W. 1991. Preliminary investigations of the distribution and natural history of the Rio Grande river cooter (*Pseudemys concinna gorzugi*) in New Mexico. New Mexico Dept. Game and Fish Unpubl. Rept. submitted to Bureau of Land Management, Carlsbad Resource District. Carlsbad, New Mexico. 27 p.
- Schlaepfer, M. A., C. Hoover, and Ck. K. Dodd Jr. 2005. Challenges in evaluating the impact of the trade in amphibians and reptiles on wild populations. *BioScience* 55:256-264.
- Scudday, J.F. 1974. Some recent changes in the herpetofauna of the northern Chihuahuan Desert. Pp. 513-522 in Wauer and Riskind (eds.). Transactions of the Symposium on the Biological Resources of the Chihuahuan Desert Region, United States and Mexico. USDI, Nat'l. Park Service Trans. Proc. Series (3). xxii + 658 pp.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.
- Waldon, K.J., A.W. Letter, and I. Mali. 2017. *Pseudemys gorzugi*. Ingested Fish Hook. *Herpetological Review* 48(4):837.
- Ward, J.P. 1984. Relationships of chrysemid turtles of North America (Testudines: Emydidae). *Spec. Publ. Mus. Texas Tech. Univ.* 231:1-50.

Slevin's Bunchgrass lizard, *Sceloporus slevini*

Distribution and Biology: *Sceloporus slevini* in New Mexico is known only from extreme southwest Hidalgo County, where it occurs in the grasslands and adjacent foothills in the southern end of the Animas Valley at elevations of 5100-5300 ft (Degenhardt et al. 1996; Painter 2009). Dixon and Medica (1965) first reported the species from New Mexico. As the common name suggests, *S. slevini* occurs in areas of dense bunch grass, usually

on hillsides within the ponderosa pine zone. The specimens from New Mexico are enigmatic because of their grassland origin, although research suggests this was once a widespread grassland species that has only recently retreated to the mountain slopes to escape the destruction of the grasslands brought about by overgrazing (Bock et al. 1990). In southeastern Arizona grasslands it was found to be common in ungrazed areas but was virtually absent from adjacent grazed habitat (Brennan 2008). The species is primarily diurnal although it may be active any time of the year on sunny days. Eggs are laid in mid-late summer, hatchlings appear in August or September. The diet of *S. slevini* consists of true bugs, ants, beetles, and grasshoppers.

Current Status: Other than in New Mexico, *S. slevini* receives no formal protection anywhere throughout its range. Within its limited habitat in southeast Arizona, many populations are suffering significant declines because of severe overgrazing (Congdon 1994). Prior to 1994, *S. slevini* had not been collected in New Mexico since 1967 when it was known from only 6 specimens. During 1994-97 however, trapping efforts in suitable habitat in the Animas Valley have shown *S. slevini* to be more abundant and widespread than previously known.

Threats: The primary threat to *S. slevini* is overgrazing which has been linked to severe declines in populations of the species. Maintenance of the bunchgrass microhabitat is important in the conservation of this species because of its importance for cover and thermoregulation during winter months (Painter 2009). Unregulated, excessive collecting may cause localized reductions in populations.

Recommendations: *Sceloporus slevini* should retain its status as threatened. The current status of the small New Mexico population in the Animas Valley should be investigated to ensure that grazing practices and wildfires, especially in times of severe drought, do not cause declines. In addition, strict regulations regarding collecting should continue to be enforced.

Literature Cited:

- Bock, C.E., H.M. Smith, and J.H. Bock. 1990. The effect of livestock grazing upon abundance of the lizard, *Sceloporus scalaris*, in southeastern Arizona. *J. Herpetol.* 24(4):445-446.
- Brennan, T.C. 2008. Online Field Guide to the Amphibians and Reptiles of Arizona. <http://www.reptilesfaz.org/index.html> accessed 28 April 2010.
- Congdon, J.D. 1994. Letter addressed to USFS, Douglas Ranger District. Data provided on 100% decline of some *S. scalaris* populations in SE Arizona. Letter on file with NMGF, Endangered Species Program. Santa Fe, New Mexico.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Dixon, J.R. and P.A. Medica. 1965. Noteworthy records of reptiles from New Mexico. *Herpetologica* 21(1):72-75.
- Painter, C.W. 2009. Slevin's Bunchgrass Lizard: *Sceloporus slevini*. Pp 250-253 In Jones and Lovich (eds.). *Lizards of the American Southwest*. Rio Nuevo Publishers, Tucson, AZ. 567 pp.

Giant Spotted Whiptail, *Aspidoscelis stictogramma*

Distribution and Biology: The range of this large whiptail lizard extends southward into Mexico to extreme northwestern Sinaloa (Rosen 2009). It reaches the extreme eastern and northern edge of its range in southwest New Mexico. In New Mexico, it occurs only in Guadalupe Canyon in southwest Hidalgo County where it is common in its limited habitat at 4330-4520 ft (Degenhardt et al. 1996). Records from the Peloncillo Mountains along Geronimo Trail and from the Alamo Hueco Mountains (Hayward et al. 1977) are questionable and have not been verified. In New Mexico, *A. stictogramma* is only known in riparian woodland habitat although elsewhere in its range in the United States it is known from in thorn scrub environments in mountain canyons in semi-desert grassland, the Arizona Upland portion of the Sonoran Desert, and the lower Madrean oak woodlands (Rosen 2009). This is the largest member of the genus *Aspidoscelis* in North America reaching 140 mm body length and 468 mm total length (Rosen 2009). It is an active diurnal species that depends upon a mosaic of open spaces and cover where it forages for insects, its primary prey. The species is quick to retreat into dense underbrush when threatened.

Current Status: *Aspidoscelis stictogramma* receives no formal protection in Arizona or Mexico.

Threats: Habitat alteration and overcollecting are the only major perceived threats to this species in New Mexico. Populations of *A. stictogramma* in Guadalupe Canyon are healthy and stable (Painter and Tomberlin 1996) although they could be negatively impacted by uncontrolled wildfire or by overgrazing of the riparian vegetation in their limited habitat. Rosen (2009) suggests that competition with unisexual parthenogenetic hybrid whiptails in the *Aspidocelis inornatus* complex may be responsible in part for the limited range of this species; *A. stictogramma* is one of the parental species for that complex.

Recommendations: *Aspidoscelis stictogramma* should be retained as threatened. NMDGF biologists should coordinate with private landowners and USFS within the habitat of *A. stictogramma* to help design a program of prescribed fire. The primary goal should be to develop a fire management program which emphasizes the need for cool-season, low-intensity fires to reduce the buildup of woody fuels and thus the chance for catastrophic wildfire within the habitat of *A. stictogramma*. The current status of the small New Mexico population in Guadalupe Canyon should be investigated to ensure that grazing practices and wildfires, especially in times of severe drought, do not cause declines. In addition, strict regulations regarding collecting should continue to be enforced.

Literature Cited:

- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Hayward, B. J., T. C. Heiner, and R. F. Miller. 1977. Resource inventory of the Alamo Hueco-Big Hatchet-Sierra Rica mountain complex. Unpubl. Rept. BLM, Las Cruces District, Contract No. YA-512-CT6-201. 155 p.
- Painter, C. W. and B. R. Tomberlin. 1996. Status of Guadalupe Canyon herpetofauna, Hidalgo County, New Mexico. Summary of 1995 studies. Unpubl. Rept. BLM, Las Cruces District, 12 p.
- Rosen, P.C. 2009. Canyon Spotted Whiptail: *Aspidoscelis burti*. Pp 330-333 In Jones and Lovich (eds.). Lizards of the American Southwest. Rio Nuevo Publishers, Tucson, AZ. 567 pp.

Mountain Skink, *Plestiodon callicephalus*

Distribution and Biology: In New Mexico, *Plestiodon callicephalus* occurs only in the southern Peloncillo Mountains of southwest Hidalgo County. It is known from 4300-6400 ft in Guadalupe Canyon and along Geronimo Trail, where it is uncommon in its limited habitat (Degenhardt et al. 1996). *Plestiodon callicephalus* requires abundant and well-rotted leaf litter for forage areas and sites for egg-laying. The species feeds on spiders, terrestrial beetles, and a variety of insects. It is secretive and rarely observed, although it is easily captured using pitfall traps. The species is found in Madrean Evergreen Woodland and the associated riparian habitats. It is most often found under rocks, logs, and other surface cover in moist areas such as riparian corridors, rocky canyon bottoms, and grassy hillsides.

Plestiodon callicephalus is a medium sized skink, reaching a maximum length of only 79 mm SVL. Little information is available on reproduction in this species. Females lay clutches of 3-6 eggs and the females are known to guard the eggs, and guarding of the hatchlings has also been reported. Reports of the young being born alive are available from Arizona. Hatchlings appear as early as 23 July in New Mexico and are 20-25 mm SVL (Swann et al. 2009).

Current Status: No protection is afforded *P. callicephalus* in Arizona or Mexico.

Threats: Habitat alteration and overcollecting are the only perceived threats to this species in New Mexico. Populations of *P. callicephalus* in Guadalupe Canyon are healthy and stable (Painter and Tomberlin 1996) although the species could be impacted by uncontrolled wildfire or by overgrazing of the riparian vegetation in its limited habitat.

Recommendations: This species should maintain its current listing as threatened. NMDGF should coordinate with private landowners and federal land management agencies within the habitat of *P. callicephalus* to help design a program of prescribed fire. The primary goal should be to develop a fire management program which emphasizes the need for cool-season, low-intensity fires to reduce the buildup of woody fuels and thus the chance for catastrophic wildfire within the riparian habitat of *P. callicephalus*. The current status of the small New Mexico population, especially those in Guadalupe Canyon, should be investigated to ensure that grazing practices and

wildfires, especially in times of severe drought, do not cause declines. In addition, strict regulations regarding collecting should continue to be enforced. The status of this species in New Mexico needs to be updated.

Literature Cited:

- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Painter, C. W. and B. R. Tomberlin. 1996. Status of Guadalupe Canyon herpetofauna, Hidalgo Co., New Mexico. Summary of 1995 studies. Unpubl. Rept. BLM, Las Cruces District, 12 p.
- Swann, D.E., M.D. Caron, and T. Edwards. 2009. Mountain Skink: *Plestiodon callicephalus*. Pp 446-448. In Jones and Lovich (eds.). Lizards of the American Southwest. Rio Nuevo Publishers, Tucson, AZ. 567 pp.

Green Ratsnake, *Senticolis triaspis*

Distribution and Biology: *Senticolis triaspis* ranges from southwest New Mexico, southern Arizona, and southern Tamaulipas in Mexico, southward into Costa Rica (Tipton 2005). The species reaches the extreme eastern edge of its range in southwest New Mexico where it is very rare and seldom encountered. In New Mexico, it is known from only 3 museum specimens (Degenhardt et al. 1996, Garrett and Painter 1992, Painter and Tomberlin 1996) and a very small number of reported observations (NMDGF Files) in southwest Hidalgo County (e.g., Guadalupe Canyon, Post Office Canyon). Sherbrooke (2006) reported the species is mostly terrestrial and spends little time in the canopies of trees. He suggested the species spends much of its time underground with most subterranean retreats under large boulders. The Northern Green Ratsnake, *S. t. intermedia*, occurs in New Mexico.

Current Status: *Senticolis triaspis* receives no formal protection in Mexico. It is protected from unregulated take in Arizona (AGFD 1996).

Threats: This beautiful species is very desirable and valuable in the pet trade and is therefore potentially threatened by overcollecting (Fitzgerald et al. 2004). Habitat alteration through uncontrolled wildfire or increased livestock grazing is also a threat. Specimens of individuals killed on roads are occasionally reported from the Chiricahua Mountains in adjacent Cochise County, Arizona.

Recommendations: *Senticolis triaspis* should maintain its current listing as threatened. NMDGF should coordinate with federal land management agencies and private landowners within the habitat of *S. triaspis* to help design a program of prescribed fire. The primary goal should be to develop a fire management program which emphasizes the need for cool-season, low-intensity fires to reduce the buildup of woody fuels and thus the chance for catastrophic wildfire within the riparian habitat of *S. triaspis*. Routine monitoring of the habitat that supports the small New Mexico population should be implemented to ensure that grazing practices, especially in times of severe drought, do not cause declines. In addition, strict regulations regarding collecting should continue to be enforced.

Literature Cited:

- Arizona Game and Fish Dept. 1996. Arizona reptile and amphibian regulations. Commission Order 41 and 42. Arizona Game and Fish Dept. Phoenix, AZ.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Fitzgerald, L.A., Painter, C.W., Reuter, A., and Hoover, C. 2004. Collection, trade, and regulation of reptiles and amphibians of the Chihuahuan Desert ecoregion. TRAFFIC North America, Washington, D.C.: World Wildlife Fund. 75 pp + appendices.
- Garrett, C.M. and C.W. Painter. 1992. Geographic Distribution: *Senticolis triaspis intermedia*. Herpetol. Review 23(4):124.
- Painter, C.W. and B.R. Tomberlin. 1996. Status of Guadalupe Canyon herpetofauna, Hidalgo County, New Mexico. Summary of 1995 studies. Unpubl. Rept. BLM, Las Cruces District, 12 p.
- Sherbrooke, W.C. 2006. habitat use and activity patterns of two green ratsnakes (*Senticolis triaspis*) in the Chiricahua Mountains, Arizona. / Herpetological Review 37(1):34-37.
- Tipton, B.L. 2005. Snakes of the Americas: Checklist and Lexicon. Krieger Publishing Co., Malabar, Florida. xiv + 477 pp.

Narrow-headed Gartersnake, *Thamnophis rufipunctatus*

Distribution and Biology: The Narrow-headed Gartersnake, *Thamnophis rufipunctatus*, ranges from north-central Arizona southeastward to southwestern New Mexico, and from northern Chihuahua to northern Durango, Mexico. Elevation ranges from 701-2430 m (Rossman et al. 1996). In New Mexico, the species is confined to Catron, Grant, and Hidalgo counties where it reaches the northern and eastern edge of its overall distribution. It is a habitat specialist, occurring only in shallow, swift-flowing, rocky rivers and streams of the San Francisco and Gila River drainages (Fitzgerald 1986; Degenhardt et al. 1996). It feeds almost exclusively on fish (Fleharty 1967). Extensive surveys (Holycross et al. 2006; Hibbitts et al. 2009) suggest a disappearance of the species from the area of the San Francisco Hot Springs in Catron County near Glenwood, the site of a previously robust population. During 2009, populations of *T. rufipunctatus* under investigation at the Heart Bar Wildlife Management Area, Catron Co. NM, and the Gila River Bird Area near Cliff, Grant Co., NM were found to be extirpated or at very low density. Jennings and Christman (2009) speculated that the American Bullfrog, *Rana catesbeiana*, may play a significant role in this decline. Subsequent work (in 2017) has documented a continued decline at this site with a slight increase over the previous year (Jennings et al. 2017). Initial surveys in the lower box of the Gila River drainage did not detect the species.

Thamnophis rufipunctatus are aquatic specialists that feed almost exclusively on fish, use specific habitats for foraging (clear, rock-boulder strewn streams), having evolved several mechanisms for increased underwater visual and foraging capabilities, and display very low dispersal capacity (Fleharty 1967; Schaeffel and de Queiroz 1990; Alfaro 2002; Hibbitts and Fitzgerald 2005). Given these specializations and life history characteristics, *T. rufipunctatus* is likely to be highly susceptible to environmental change, especially climate change (Wood et al. 2011). Because of its specialized diet, a salvage operation was conducted in 2012 following the Whitewater-Baldy fire to move as many *T. rufipunctatus* as possible out of Whitewater Creek to Saliz Creek before post-fire flooding scoured the creek of all fish. Two of the salvaged snakes in Saliz Creek were recaptured in 2015, none in 2016, and one was recaptured in 2017 along with four juveniles, indicating reproduction at that site by translocated snakes (Christman and Jennings 2015, Jennings and Christman 2016, Jennings et al. 2017). No snakes or fish were caught in the Whitewater Creek in 2015 (Christman and Jennings 2015) and that population of *T. rufipunctatus* may be on the verge of being extirpated (R. Jennings, WNMU, E. Nowak, NAU, *pers. comm.*). Knowledge of captive rearing is extremely limited for this animal but breeding has occurred at both the Phoenix Zoo and at a facility at Northern Arizona University in Flagstaff, AZ.

Current Status: Wood et al. 2011 reported that three separate species actually exist within the *T. rufipunctatus* complex, thus elevating the subspecies *T. r. rufipunctatus* in New Mexico to full species; separate from those in the Sierra Madre of Mexico. *Thamnophis rufipunctatus* is listed as a Species of Concern by USFWS (USFWS 2008). The species, along with the northern Mexican gartersnake (*T. eques*) has now been listed by USFWS for federal protection as threatened under the U.S. Endangered Species Act (USFWS 2014). It is a species of wildlife of special concern in Arizona (AGFD 1996). The pre- and post-monsoon seasonal habitat use of this species in the Tularosa River, Catron County, NM continues to be investigated.

Threats: Major threats to this species are wildfire, post-fire flooding impacts on prey base, changes in water-use practices and overgrazing of streamside vegetation that results in alteration of habitat, including heavy siltation, stream channelization, and the elimination of undercut banks. Hibbitts et al. (2009) suggested that siltation which causes impaction of streambed rocks and eliminates habitat played a role in the disappearance of a robust population of the species at San Francisco Hot Springs. There is indirect evidence that the introduction of American Bullfrog (*Rana catesbeiana*) has eliminated *T. rufipunctatus* from its native habitat in some areas, e.g., Wall Lake in Catron County, NM (Fleharty 1967; Schwalbe and Rosen 1988; Jennings and Christman 2009). Invasive crayfish pose a significant threat to this animal, through direct predation on neonate snakes, predation on the fish species the snake uses for prey, and alteration of habitat (USFWS 2014, R. Jennings, E. Nowak, and B. Christman, *pers. comm.*). One population of narrow-headed gartersnakes in Diamond Creek was found to be at very low levels, while the density of crayfish were at very high levels (Jennings and Christman 2016). Nowak and Santana-Bendix (2002; 2003a, 2003b) reported declines of this species in central Arizona based on the presence of non-native “spiny-rayed” fishes (i.e., the sunfishes *Micropterus* and *Lepomis*, family Centrarchidae), habitat destruction and modification due to increased recreation and siltation, and localized mortality due to channel-altering flood events, direct predation by

humans, and roadkills. Additionally, disease may be a concern, and the USFWS has funded recent collection of samples for disease testing (M. Christman, USFWS, *pers. comm.*).

Given the small size of populations, their apparent isolation from each other, and the rapidity with which populations are disappearing, *T. rufipunctatus* appears to be highly vulnerable to extinction (Wood et al. 2011). The urgency of this crisis and the vulnerability of populations is exemplified by the rapid (<10 years) mysterious disappearance of one of the most robust U.S. populations, along the San Francisco River, New Mexico (Hibbitts et al. 2009). Although the primary causes of range-wide declines are attributed to the introduction of non-native species and habitat alteration, additional pressures may be due to intrinsic negative genetic effects.

Recovery Plan Status: This species has a state Recovery Plan, accepted by the New Mexico Game Commission in 2007. Major recovery efforts since 2012 Review included a Share With Wildlife project to continue study habitat use by the species, another Share With Wildlife project to aid in captive rearing of the species, collaboration with an Arizona-New Mexico gartersnake working group, and public outreach. Future recovery efforts will focus on securing funding for research as presently not enough is understood about the biology of the species, the top priority in the state Recovery Plan. No new methods or strategies have been developed toward the recovery of the species and therefore no revision to the state Plan is called for at this time. The USFWS is presently developing a recovery outline for the species and the state recovery plan should be reviewed for any necessary changes.

Recommendations: *Thamnophis rufipunctatus* should maintain its current listing as threatened at this time, but if the pattern of declines and extirpations continue the species should be considered for uplisting to endangered. NMDGF should continue funding to complete a study of the current status of this species in southwest New Mexico. Although the population at San Francisco Hot Springs is believed to be extirpated, efforts should continue at this and nearby sites to obtain specimens for disease testing. Microhabitat characteristics of the San Francisco Hot Springs site should be compared to those collected during earlier studies at the same site. In addition, strict regulations regarding collecting should continue to be enforced. NMDGF should continue to support staff participation in the interagency Mexican and Narrow-headed Garter Snake Conservation Working Group.

Literature Cited:

- Alfaro, M.E. 2002. Forward attack modes of aquatic feeding garter snakes. *Functional Ecology* 16:204–215.
- Arizona Game and Fish Dept. 1996. *Wildlife of Special Concern in Arizona*. (Public Review Draft). Arizona Game and Fish Dept. Phoenix, AZ. 40 p.
- Christman, B. L., and R. D. Jennings. 2015. Summary of 2015 monitoring for the Narrow-headed Gartersnake (*Thamnophis rufipunctatus*), at the Tularosa River, Upper Middle Fork Gila River, Whitewater Creek and Saliz Creek. Unpubl. rept. 6 p.
- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. *Amphibians and Reptiles of New Mexico*. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Fitzgerald, L.A. 1986. A preliminary status survey of *Thamnophis rufipunctatus* and *Thamnophis eques* in New Mexico. Unpubl. Rept. New Mexico Dept. Game and Fish, Santa Fe. 12 p.
- Fleharty, E.D. 1967. Comparative ecology of *Thamnophis elegans*, *T. cyrtopsis*, and *T. rufipunctatus* in New Mexico. *Southwest. Nat.* 12(3):207-230.
- Hibbitts, T.J. and L.A. Fitzgerald. 2005. Morphological and ecological convergence in two natricine snakes. *Biological Journal of the Linnaean Society*, 85, 363–371
- Hibbitts, T.J., C.W. Painter, and A.T. Holycross. 2009. Ecology of a population of the Narrow-headed Gartersnake (*Thamnophis rufipunctatus*) in New Mexico: catastrophic decline of a river specialist. *Southwest. Nat.* 54(4):461-467.
- Holycross, A.T., W.P. Burger, E.J. Nirgo, and T.C. Brennan. 2006. Surveys for *Thamnophis eques* and *Thamnophis rufipunctatus* in the Gila River watershed of Arizona and New Mexico. Unpubl. Rept. submitted to Arizona Game and Fish Dept. 105 pp.
- Jennings, R.D. and B.L. Christman. 2009. Progress Report. Pre-monsoonal and post monsoonal habitat use of the Narrow-headed Gartersnake, *Thamnophis rufipunctatus*, along the Gila River. Unpubl. Rept. submitted to Share with Wildlife, NM Dept Game and Fish, Santa Fe. 7 pp.
- Jennings, R.D. and B.L. Christman. 2016. Population status of narrow-headed gartersnakes (*Thamnophis rufipunctatus*) in the Gila National Forest, Catron County New Mexico 2016. Unpubl. Rept. Submitted to NM Dept. Game and Fish, Santa Fe, NM. 16 pp.

- Jennings, R.D., B.L. Christman, and J.T. Giermakowski. 2017. Survey and monitoring of the narrow-headed gartersnake, *Thamnophis rufipunctatus*, to forward its recovery. Interim report submitted to NM Dept. Game and Fish, Santa Fe, NM. 1 pp.
- Nowak, E.M. and M.A. Santana-Bendix. 2002. Status, distribution, and management recommendations for the narrow-headed gartersnake (*Thamnophis rufipunctatus*) in Oak Creek, Arizona. Unpubl. Rept submitted to Arizona Game and Fish Dept., Heritage Grant I99007. 56 p.
- Nowak, E.M. and M.A. Santana-Bendix. 2003a. Distribution, ecology, and management recommendations for the narrow-headed gartersnake (*Thamnophis rufipunctatus*) in Oak Creek, Arizona – part 1 of 2. *Sonoran Herpetologist* 16(10):86-89.
- Nowak, E.M. and M.A. Santana-Bendix. 2003b. Distribution, ecology, and management recommendations for the narrow-headed gartersnake (*Thamnophis rufipunctatus*) in Oak Creek, Arizona – part 2 of 2. *Sonoran Herpetologist* 16(11):98-101.
- New Mexico Department of Game and Fish. 2007. Narrow-headed Gartersnake (*Thamnophis rufipunctatus*) Recovery Plan. NM Dept. Game and Fish, Conservation Services Division, Santa Fe, NM. 22 p.
- Rossman, D.A. N.B. Ford, and R.A. Seigel. 1996. *The Garter Snakes: Evolution and Ecology*. Univ. Oklahoma Press, Norman. xx + 332 pp.
- Schaeffel, F and A. deQueiriz. 1990. Alternative mechanisms of enhanced underwater vision in the gartersnakes *Thamnophis melanogaster* and *T. couchii*. *Copeia* 1990(1):50-58.
- Schwalbe, C.R. and P.C. Rosen. 1988. Preliminary report on the effect of bullfrogs on wetland herpetofaunas in southeastern Arizona. Pp. 166-173 in R. C. Szaro, K. E. Severson, and D. R. Patton (eds.). *Management of Amphibians, Reptiles, and Small Mammals in North America*. USDA Forest Serv., Rocky Mt. Forest Range Exp. Station. Gen. Tech. Rept. RM-166, Ft. Collins, CO. 458 p.
- U.S. Fish and Wildlife Service. 2008. List of Candidate and Species of Concern; Southwest Region Ecological Service. http://www.fws.gov/southwest/es/New_Mexico/SBC.cfm.
- U.S. Fish and Wildlife Service. 2014. Endangered and Threatened Wildlife and Plants; Threatened Status for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake; Final Rule. *Federal Register* 79: 38678-38746.
- Wood, D.A., A.G. Vandergast, J.A. Lemos- Espinal, R.N. Fisher, and A.T. Holycross. 2011. Refugial isolation and divergence in the Narrowheaded Gartersnake species complex (*Thamnophis rufipunctatus*) as revealed by multilocus DNA sequence data. *Molecular Ecology* (2011) 20, 3856–3878.

Western Ribbonsnake, *Thamnophis proximus*

Distribution and Biology: In New Mexico, *Thamnophis proximus* occurs as isolated and disjunct populations mostly east of the Pecos River. The species reaches the western limit of its range in eastern New Mexico and is one of the least-known and little-studied snakes in the state (Degenhardt et al. 1996; Rossman et al. 1996). The subspecies, the Arid Land Ribbonsnake, *T. p. diabolicus*, occurs in New Mexico. The species is strongly associated with brushy habitats in close proximity to aquatic situations. The species feeds mainly on amphibians and occasionally small fish. It is generally uncommon where it occurs in New Mexico, with the possible exception of Bitter Lake National Wildlife Refuge near Roswell.

Current Status: *Thamnophis proximus* does not receive formal protection in Texas, although it is listed as threatened by the Republic of Mexico (SEMARNAT 2010). Rossman et al. (1996) suggest that there is no information on population status of this species outside of the United States and state that the ecology of Mexican populations remain essentially unstudied. A mark-recapture study of this species initiated at Bitter Lake NWR during 1997 has shown the species to be more abundant on the refuge than previously thought (G. Warrick, Refuge Biologist data files; NMDGF files).

Threats: Major threats to *T. proximus* are changes in water use practices that could result in alteration of habitat. Illegal take may be of concern in the Spring River population near metropolitan Roswell and at 10-mile Dam along the Pecos River east of Loving. Road-killed individuals are occasionally encountered on the tour loop roads at Bitter Lake NWR.

Recommendations: *Thamnophis proximus* should maintain its current listing as threatened. A public awareness program should be initiated at Bitter Lake NWR to alert people of the presence of this species and the potential of

the species to be encountered on the roadways. Additional state-wide surveys should be initiated to determine the extent and status of the population at historic sites and in additional potential habitat, and more information on the ecology of this subspecies would benefit its recovery. In addition, strict regulations regarding collecting should continue to be enforced.

Literature Cited:

- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Rossman, D.A. N.B. Ford, and R.A. Seigel. 1996. The Garter Snakes: Evolution and Ecology. Univ. Oklahoma Press, Norman. xx + 332 pp.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.

Mottled Rock Rattlesnake, *Crotalus lepidus lepidus*

Distribution and Biology: In New Mexico, this montane rattlesnake is known only from the Guadalupe Mountains in Eddy County and extreme eastern Otero County where it reaches the northern edge of its range (Degenhardt et al. 1966; Price 2009). *Crotalus l. lepidus* is a localized inhabitant of the Guadalupe Mountains, rarely found away from rocky canyons or hillsides (Swinford 1992). Two subspecies of Rock Rattlesnake, *C. l. lepidus* and *C. l. klauberi*, occur in New Mexico; only *C. l. lepidus* is protected. A zone of intergradation between these poorly diagnosed subspecies may occur in the San Andres Mountains on White Sands Missile Range in Sierra and Doña Ana counties. Morphological traits generally used to distinguish *C. l. lepidus* from *C. l. klauberi* include the presence of mottling, the presence of a postocular stripe, paired nuchal blotches, and faded anterior bands.

Current Status: *Crotalus l. lepidus* does not receive formal protection in Texas, although it is a Species Subject to Special Protection in the Republic of Mexico (SEMARNAT 2010).

Threats: Much of the habitat for *C. l. lepidus* in New Mexico occurs in Carlsbad Caverns National Park, therefore it appears to be secure except for illegal take and road mortality within the Park. Outside of the Park, the steep, rocky habitat is generally unsuitable for livestock grazing, oil and gas exploration, or other development. Mining may have localized effects. Overcollecting, e.g., at Sitting Bull Falls, may reduce populations in areas well known to snake collectors, especially given the information that has appeared in the popular herpetocultural literature (e.g., Swinford 1989, 1990, Fitzgerald et al. 2004).

Recommendations: *Crotalus l. lepidus* should maintain its current listing as threatened. Populations of *C. l. lepidus* at Sitting Bull Falls should be closely monitored for any evidence of illegal take or overcollecting.

Literature Cited:

- Degenhardt, W.G., C.W. Painter, and A.H. Price. 1996. Amphibians and Reptiles of New Mexico. Univ. New Mexico Press, Albuquerque. xix + 431 p.
- Fitzgerald, L.A., Painter, C.W., Reuter, A., and Hoover, C. 2004. Collection, trade, and regulation of reptiles and amphibians of the Chihuahuan Desert ecoregion. TRAFFIC North America, Washington, D.C.: World Wildlife Fund. 75 pp + appendices.
- Price, M.S. 2009. A guide to the rock rattlesnakes of the United States. ECO Publishing, Rodeo, NM. 160 pp.
- Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT). 2010. NORMA Oficial Mexicana NOM-059-SEMARNAT-2010, Protección ambiental—Especies nativas de México de flora y fauna silvestres—Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio—Lista de especies en riesgo. Diario Oficial de la Federación. 30 Diciembre 2010. 2: 1-77.
- Swinford, G.W. 1989. Captive reproduction of the banded rock rattlesnake *Crotalus lepidus klauberi*. Pp. 99-110 in M.J. Uricheck (ed.). 13th International Herpetological Symposium on Captive Propagation and Husbandry. Phoenix, Arizona.
- Swinford, G.W. 1990. Collecting the banded rock rattlesnake (*Crotalus lepidus klauberi*) in the mountains of southern New Mexico. Purpose: Captive breeding. Vivarium 3(1):8-10.

Swinford, G.W. 1992. Status of the mottled rock rattlesnake, *Crotalus lepidus lepidus* in southeastern New Mexico. Unpubl. Rept. New Mexico Dept. Game and Fish. Santa Fe. 17 pp.

FISHES

ENDANGERED

Chihuahua chub, *Gila nigrescens*

Distribution: Chihuahua chub is native to the Mimbres, Guzmán, and Bustillos basins of southwest New Mexico and northwest Chihuahua (Smith and Miller 1986; Miller 2006). It generally occurs in stream and ciénega habitats and almost always occurs in deep pool habitats associated with instream cover such as uprooted trees (Propst and Stefferud 1994). In New Mexico, Chihuahua chub is limited mainly to a 15 km reach of the Mimbres River and associated spring habitats (Propst 1999).

Current Status: Chihuahua chub was state listed as endangered in New Mexico in 1976 and was federally listed as threatened in 1983 (USFWS 1983). A federal recovery plan for the species has been approved (USFWS 1986). Chihuahua chub has declined significantly throughout its native range (Propst and Stefferud 1994). In Chihuahua, it was found mainly in remote stream reaches where there was little or no modification of habitat by human activities and nonnative predatory fishes were absent. Stream reaches in the Guzmán Basin in the early 1990s are now void of the species (R.L. Mayden, pers. com.). Ash-laden flows from the 1995 Pigeon Fire reduced Chihuahua chub abundance in the Mimbres River substantially. Non-native predatory fish, including brown trout, rainbow trout, and bass, appear to have been eradicated from the river by flooding and ash flows resulting from the Silver Fire in 2013.

A spring system associated with the Mimbres River normally supports the largest wild population (ca. 300) of the species in the U.S., and individuals have been taken from this population to maintain a brood and refuge stock at the Southwestern Native Aquatic Resources and Recovery Center (SNARRC). However, in early 2010, fewer than 60 individuals were captured in the spring, and most were <100 mm total length. In 2015 the USFWS led an effort to improve chub habitat in the spring system. The chubs in Mimbres River springs periodically have heavy infestations of yellow grub (*Clinostomum marginatum*) (J.J. Landye, pers. comm.), and this ectoparasite may occasionally cause elevated mortality of spring inhabitants. Invasion of springs by largemouth bass (*Micropterus salmoides*) necessitated several efforts to remove these nonnative predators.

The Nature Conservancy (TNC) and New Mexico Department of Game and Fish have properties on the Mimbres River that are managed, in part, to provide habitat for Chihuahua chub. In 2016 the Department engineered and constructed habitat improvements for Chihuahua chub across the entirety of the river on the property, and in 2017 similar habitat work was completed on TNC property. McKnight Creek, below the waterfall barrier, was stocked with Chihuahua chub (1993 and 1997), however the population did not survive due to river drying. The Mimbres River population has been augmented in most years since 1999 with fish reared at Southwestern Native Aquatic Resources and Recovery Center. In 2009, a population of Chihuahua chub was discovered in the Mimbres River near the Cooney Place (J.A. Monzingo, pers. com.). This population has been genetically evaluated to ascertain its likely origin, but results were not conclusive (Osborne et al. 2010). The New Mexico population in the Mimbres drainage does contain unique genetic information not found in Mexico populations (Osborne et al. 2012). Department surveys after the 2013 Silver Fire found no Chihuahua chub in the Mimbres River, although some individuals may have survived in off-channel spring habitats. The NMDGF and TNC properties on the Mimbres River have been stocked and recent surveys indicate Chihuahua chub are persisting in those reaches. Chihuahua chub will continue to be stocked in the Mimbres River as they are available.

Overall, Chihuahua chub numbers were negatively impacted throughout the river by the 2013 Silver Fire and subsequent flooding, apparently persisting only in Moreno Springs. However, habitat improvement in the springs and on the Department's and TNC's property, ongoing stocking efforts from the broodstock at SNARRC, the eradication of non-native predatory fish, and recent discovery of post-fire recolonization in other parts of the river make future population growth likely. Recent surveys indicate increased numbers of Chihuahua chub at Department and TNC properties, and documented occupancy upstream to Monument Canyon (B. Ferguson, pers. com.).

Threats: Modification and destruction of riverine habitats (dewatering, channelizing, and removal of woody riparian vegetation) are impediments to recovery of Chihuahua chub in the Mimbres River. Nonnative fishes, particularly rainbow trout (*Oncorhynchus mykiss*), usurp Chihuahua chub habitat and prey upon them. However, this potential threat appears to have been negated in the Mimbres River since the 2013 Silver Fire. Longfin dace (*Agosia chrysogaster*) may displace young Chihuahua chub from shoreline habitats. Escapement of nonnative fishes (e.g., largemouth bass) from Bear Canyon Reservoir is a potential threat to spring and riverine Chihuahua chub populations, but installation of a fish screen at outflow of the reservoir has diminished this threat and bass have not been recorded in the spring in recent years. The yellow grub infestation of chubs in spring habitats may present health risk to this population.

Recommendations: No change in listing status is recommended. Cooperative efforts with The Nature Conservancy, U.S. Fish and Wildlife Service, and U.S. Forest Service to improve status of the species should continue. The NMDGF Mimbres Property should continue to be managed for benefit of Chihuahua chub. Lands having suitable, or potential, Chihuahua chub habitat and water rights in Mimbres Valley should be obtained from willing sellers. The fish barrier at Bear Canyon Reservoir should be maintained to ensure there is no escapement of nonnative fishes, particularly centrarchids, from Bear Canyon Reservoir. Cooperative efforts among The Nature Conservancy, U.S. Forest Service, and NMDGF to protect and conserve aquatic habitats of the Mimbres River catchment should continue. The U.S. Fish and Wildlife Service should be encouraged to continue maintenance of captive population and brood stock at SNARRC. Regulations regarding use of bait fishes should be strictly enforced.

Literature Cited:

- Miller, R.R. 2006. Freshwater fishes of México. The University of Chicago Press, Chicago, IL.
- Osborne, M., A. Sharp, J. Monzingo, D.L. Propst, and T.F. Turner. 2012. Genetic analysis suggests high conservation value of peripheral populations of Chihuahua chub (*Gila nigrescens*). *Conservation Genetics* 13:1317-1328.
- Osborne, M., A. Sharp, and T. Turner. Baseline Genetic Studies of the Chihuahua Chub (*Gila nigrescens*). Final report to Share with Wildlife Program, New Mexico Dept. Game and Fish, Santa Fe, NM, 20 pp.
- Propst, D.L. 1999. Threatened and endangered fishes of New Mexico. Technical Report No. 1, New Mexico Department of Game and Fish, Santa Fe.
- Propst, D.L., and J.A. Stefferud. 1994. Distribution and status of Chihuahua chub (Teleostei: Cyprinidae: *Gila nigrescens*), with notes on its ecology and associated species. *The Southwestern Naturalist* 39:224-234.
- Propst, D.L., and Y.M. Paroz. 2007. Conservation of Chihuahua chub. Final Report. Federal Aid E-2-13-16 Project. New Mexico Department of Game and Fish, Santa Fe.
- Smith, M.L., and R.R. Miller. 1986. The evolution of the Rio Grande basin as inferred from its fish fauna. Pp. 457-485. In C.H. Hocutt and E.O. Wiley (eds.). *The zoogeography of North American freshwater fishes*. John Wiley & Sons, New York, NY.
- U.S. Fish and Wildlife Service. 1986. Chihuahua chub recovery plan. U.S. Fish and Wildlife Service, Albuquerque, NM.

Roundtail chub, *Gila robusta*

Distribution: In 2016 the American Fisheries Society and American Society of Ichthyologists and Herpetologists (AFS/ASIH) Joint Committee on the Names of Fishes determined roundtail chub, Gila chub, and headwater chub to be the same species (Page et al. 2016). In previous biennial reviews these three species are separated but have now been combined to recognize them all as one species, the roundtail chub. Roundtail chub formerly occupied the Colorado River and its tributaries from Wyoming south to the confluence of the Little Colorado River (Arizona), tributaries of the Colorado River downstream of the Little Colorado River, and headwaters of the Río San Pedro in northwestern Mexico (Minckley, 1973; Hendrickson et al., 1981; Tyus et al., 1982; Hendrickson, 1983; Mueller and Marsh, 2002; Miller, 2006). Throughout much of its range, the species was historically common (Minckley, 1973; Holden and Stalnaker, 1975). In New Mexico, roundtail chub occurred in the San Juan, Zuni (a Little Colorado River tributary), San Francisco, and Gila River drainages (Baird and Girard, 1853; Koster, 1957; Bestgen and Propst, 1989; Platania, 1990). In these streams, the species was most common in moderate to slow-velocity areas near vegetated shorelines and debris piles.

Current Status: Roundtail chub was listed as state threatened in New Mexico in 1975 and uplisted to state endangered in 1996. The Navajo Nation lists roundtail chub as endangered (Mikesic et al. 2005). Although roundtail chub remains comparatively common in portions of the upper Colorado River drainage (Tyus et al. 1982), it has declined considerably in the lower portion of the Colorado River drainage (Bestgen and Propst 1989; Rinne and Minckley 1991; Mueller and Marsh 2002; Minckley and Marsh 2009). In New Mexico, the species is rare in the San Juan River (Paroz et al. 2007; Schleicher 2016) and extirpated from the Zuni River drainage (Propst et al. 2001). The species exists in the Gila River basin of New Mexico in Turkey Creek, as well as the West, East, and Middle Forks of the Gila River (Carman 2006; Paroz et al. 2006; Paroz et al. 2007). Historically the East fork maintained robust populations with a variety of size classes, but adults have been absent or rare in these locations recently (Paroz et al. 2006; Paroz and Propst 2007). The species has been repatriated into Mule Creek, a San Francisco River tributary, from the population in Harden Cienega, Arizona. In 2009, the USFWS proposed roundtail chub in the Lower Colorado River Basin as a Distinct Population Segment as a candidate for listing (USFWS 2009). The USFWS completed a species status review for the distinct population segment of roundtail chub in Lower Colorado River Basin in 2015 and proposed that it be listed as threatened under the U.S. Endangered Species Act (USFWS 2015; U.S. Office of the Federal Register 2015). The listed determination for roundtail chub in the Lower Colorado River Basin was withdrawn in 2017 after the AFS/ASIH Joint Committee on Names of Fishes considered *Gila intermedia*, headwater *Gila nigra*, and roundtail chubs to be a single species, *Gila robusta* (U.S. Office of the Federal Register 2017).

Threats: Habitat modification (channelization, dams, removal of woody riparian vegetation, discharge manipulation, and seasonal stream desiccation) and establishment of nonnative predators are the primary factors contributing to the imperiled status of the species.

Recovery Plan Status: The roundtail chub is included in the Colorado River Basin Chubs recovery plan (previously separated as three species) approved by the New Mexico Game Commission in 2006. Monitoring of the species occurs annually in the San Juan River and Gila River forks. Major recovery efforts included stocking roundtail chub into the San Juan River in 2009. In 2011, roundtail chub were salvaged from Turkey Creek due to threats posed by the Miller Fire in Gila National Forest. Salvaged roundtail chub were temporarily housed at the Southwestern Native Aquatic Resources and Recovery Center, U.S. Fish and Wildlife Service, in Dexter, New Mexico. Some of these fish were retained for museum specimens and the others were restocked into Turkey Creek in April 2012. The most recent survey of Turkey Creek was in 2018, and indicated that the population continues to persist. In June 2012, a repatriation of roundtail chub to Mule Creek was initiated. Roundtail chub were stocked in Mule Creek in 2012, 2013, and 2014. The most recent survey of Mule Creek was in 2018, and found roundtail chub persisting.

Recommendations: No change in listing status is recommended. Implementation of the Colorado River Basin Chubs Recovery Plan should continue. Strategies such as removal of nonnative species and habitat protection and restoration are priorities for conservation of current populations.

Literature Cited:

- Baird, S.F. and C. Girard. 1853. Descriptions of some new fishes from the River Zuni. Proceedings of the Academy of Natural Sciences, Philadelphia 6:368-369.
- Bestgen, K.R. and D.L. Propst. 1989. Distribution, status, and notes on the ecology of *Gila robusta* (Cyprinidae) in the Gila River drainage, New Mexico. The Southwestern Naturalist 34:402-412.
- Carman, S.M. 2006. Colorado River Basin Chubs (Roundtail Chub *Gila robusta*, Gila Chub *Gila intermedia*, and Headwater Chub *Gila nigra*) Recovery Plan. Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe, NM.
- Hendrickson, D.A. 1983. Distribution records of native and exotic fishes in Pacific Drainages of northern Mexico. Arizona-Nevada Academy of Sciences 18:33-39.
- Hendrickson, D.A., W.L. Minckley, R.R. Miller, D.J. Siebert, and P.H. Minckley. 1981. Fishes of the Río Yaqui Basin, México and United States. Arizona-Nevada Academy of Science 15:65-106.
- Holden, P.B. and C.B. Stalnaker. 1975. Distribution and abundance of mainstream fishes of the Middle and Upper Colorado River basins, 1967-1973. Transactions of the American Fisheries Society 104:217-231.
- Koster, W.J. 1957. Guide to the fishes of New Mexico. The University of New Mexico Press, Albuquerque.

- Mikesic, D., J. Nystedt, and D. Roth. 2005. Navajo Nation Endangered Species List Species Accounts. Navajo Natural Heritage Program, Department of Fish and Wildlife, Window Rock, AZ.
- Miller, R.R., 2006. Freshwater fishes of México. The University of Chicago Press, Chicago, IL.
- Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix.
- Minckley, W.L. and B.D. DeMarías. 2000. Taxonomy of chubs (Teleostei, Cyprinidae, Genus *Gila*) in the American Southwest with comments on conservation. *Copeia* 2000:251-256.
- Minckley, W.L., and P.C. Marsh. 2009. Inland Fishes of the Greater Southwest: Chronicle of a Vanishing Biota. University of Arizona Press, Tucson.
- Mueller, G.A. and P.C. Marsh. 2002. Lost, a desert river and its native fishes: A historical perspective of the lower Colorado River. U.S. Geological Survey Information Technology Report USGS/BRD/ITR—2002—0010.
- Platania, S.P. 1990. Biological summary of the 1987 to 1989 New Mexico-Utah. Ichthyofaunal study of the San Juan River. New Mexico Department of Game and Fish, Santa Fe, NM.
- Page, L. M., C. C. Baldwin, H. Espinosa-Pérez, C. R. Gilbert, K. E. Hartel, R. N. Lea, N. E. Mandrak, J. J. Schmitter-Soto, and H. J. Walker. 2016. Taxonomy of *Gila* in the Lower Colorado River Basin of Arizona and New Mexico. Report to the Arizona Game and Fish Department.
- Paroz, Y.M., and D.L. Propst. 2007. Distribution of spikecadd, loach minnow, and chub species in the Gila River Basin, New Mexico 1908-2007. Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe, NM.
- Paroz, Y.M., D.L. Propst, S.M. Carman, and N.D. Zymonas. 2007. Small-bodied fishes monitoring, San Juan River (September – October 2006). San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque.
- Paroz, Y.M., D.L. Propst, and J.A. Stefferud. 2006. Long-term monitoring of fish assemblages in the Gila River Drainage, New Mexico. Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe.
- Propst, D.L., A.L. Hobbes, and T.L. Stroh. 2001. Distribution and notes on the biology of Zuni bluehead sucker, *Catostomus discobolus yarrowi*, in New Mexico. *The Southwestern Naturalist* 46:158-170.
- Rinne, J.N. and W.L. Minckley. 1991. Native fishes of arid lands: A dwindling resource of the desert southwest. USDA Forest Service General Technical Report RM-206. U.S. Forest Service, Fort Collins, CO.
- Schleicher, B.J. 2016. Long term monitoring of sub-adult and adult large-bodied fishes in the San Juan River: 2015. Final Report to the San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Schwemm, M.R. 2006. Genetic variation in the *Gila robusta* complex (Teleostei: Cyprinidae) in the Lower Colorado River MSc thesis\, Arizona State University, Tempe.
- Tyus, H.M., B.D. Burdick, R.A. Valdez, C.M. Haynes, T.A. Lytle, and C.R. Berry. 1982. Fishes of the Upper Colorado River Basin: Distribution, abundance, and status. Pp. 12-70. *In* W.H. Miller, H.M. Tyus, and C.A. Carlson (eds.). Fishes of the Upper Colorado River System: Present and future. Western Division of the American Fisheries Society, Bethesda, MD.
- Utah Division of Natural Resources (UDNR). Range-wide conservation agreement and strategy for Roundtail chub *Gila robusta*, bluehead sucker *Catostomus discobolus*, and flannelmouth sucker *Catostomus latipinnis*. Prepared for Colorado River Fish and Wildlife Council. 65 pp.
- U.S. Fish and Wildlife Service (USFWS). 2015. Species status assessment report for the Headwater Chub and Lower Colorado River distinct population segment of Roundtail Chub. U.S. Fish and Wildlife Service, Region 2, Albuquerque, New Mexico.
- U.S. Office of the Federal Register. 2015. Threatened species status for the Headwater Chub and a distinct population segment of the Roundtail Chub, proposed rule. *Federal Register* 80:194 (7 October 2015).
- U.S. Office of the Federal Register. 2017. Threatened species status for the Headwater Chub and a distinct population segment of the Roundtail Chub, proposed rule; withdrawal. *Federal Register* 82:66 (7 April 2017).

Rio Grande silvery minnow, *Hybognathus amarus*

Distribution: Rio Grande silvery minnow formerly occupied mainstem habitats of the Rio Grande from near its confluence with the Rio Chama in northern New Mexico downstream to the Gulf of Mexico and the Pecos River from near Santa Rosa downstream to its confluence with the Rio Grande (Bestgen and Platania 1991). In New Mexico, the species was most common in the Rio Grande between Cochiti Pueblo and Elephant Butte Reservoir and

in the Pecos River between Fort Sumner and Carlsbad (Bestgen and Platania 1991). Within these stream reaches, it was most commonly found in main channel run habitats over sand substrates and seasonally in low-velocity areas such as backwaters and embayments.

Current Status: Rio Grande silvery minnow was state listed as endangered in New Mexico in 1979 and federally listed as endangered in 1994 (USFWS 1994). A recovery plan for the species was approved in 1999 (USFWS 1999), and a revision was completed in 2010 (USFWS 2010). The species currently occupies about 5% of its historical range. It was extirpated from the Pecos River (Bestgen et al. 1989) and from the Rio Grande upstream of Cochiti Dam and downstream from the upper extent of Elephant Butte Reservoir (Edwards and Contreras-Balderas 1991; Bestgen and Propst 1996). In its current range between Algodones and Elephant Butte Reservoir, it is typically most common between San Acacia and Elephant Butte Reservoir, in part because the canal system and diversion dams at San Acacia, Isleta, and Angostura allow downstream movement but prevent upstream passage (Platania and Dudley 2003; Dudley and Platania 2007). However, the San Acacia reach is also most susceptible to bouts of channel drying that cause extensive mortality (Caldwell et al. 2009). Rio Grande silvery minnow is typically rare between Albuquerque and Isleta and uncommon between Isleta and San Acacia, although its abundance varies considerably seasonally and annually (Dudley and Platania 2008). Since 2001, Rio Grande silvery minnows have been salvaged from drying river reaches, although relocation is now restricted to those fish most likely to survive stress of handling and transport (USFWS 2007; Caldwell et al. 2009). Stocking efforts in the Albuquerque reach since 2000 have augmented the population (Osborne et al. 2006), but genetic analyses indicate that an exceedingly low number of Rio Grande silvery minnow effectively produce offspring that survive to adults (Alò and Turner 2005; Osborne et al. 2005; Turner et al. 2006). Considerable effort has been expended on behalf of the species by the Middle Rio Grande Endangered Species Collaborative Program (MRGESCP). However, drought and extended seasonal drying of substantial reaches of the river have frustrated efforts of the Program, and survival of Rio Grande silvery minnow in the wild is low in most years. Population levels declined substantially from the early 1990s to 2005. During 2005, abundance of Rio Grande silvery minnow increased in response to an extended period of elevated discharge associated with snowmelt runoff, but abundance subsequently declined with low snowpack levels in 2006 (Dudley and Platania 2008). During 2012 and 2013 densities of silvery minnow became very low likely in response to extended drought conditions. Large numbers of hatchery-reared fish were used to augment the population in 2012. However, poor survival of hatchery fish and poor recruitment resulted in continued low densities reported from 2013 monitoring. Additionally, the majority of the fish captured during 2013 monitoring were of hatchery origin indicating that the wild population is reaching extremely low densities (Dudley et al. 2013; Dudley and Platania 2013).

Threats: Habitat modification (channelization, channel incision, stream desiccation, modified thermal regimes, and impoundments), barriers to movement (i.e., diversion dams), and loss of natural flow regimes are the primary factors threatening the persistence of Rio Grande silvery minnow. Long-term forecasts predict decreased quantity and increasing demand on Rio Grande water (Agency Technical Workgroup 2005), exacerbated in the near term by new consumptive withdrawals by the cities of Albuquerque and Santa Fe. Nonnative fishes (predators and competitors) may also negatively impact surviving Rio Grande silvery minnow populations, particularly when habitat becomes constricted. Interspecific competition from plains minnow *Hybognathus placitus*, introduced from the Canadian and Red rivers in Oklahoma via bait bucket transfer, likely contributed to extinction of Rio Grande silvery minnow from the Pecos River (Moyer et al. 2005; Hoagstrom et al. 2010).

Recommendations: No change in listing status is recommended. NMDGF should continue to actively participate with the U.S. Fish and Wildlife Service and other entities to implement the Rio Grande Silvery Minnow Recovery Plan (USFWS 2010). The primary focus of the revised plan is to prevent extinction of the species. Surface flows should be maintained permanently in the Rio Grande from Angostura Diversion to Elephant Butte Reservoir. Augmentation of extant wild populations with hatchery-reared Rio Grande silvery minnow should be continued, and hatchery stocks should be managed to ensure sufficient genetic diversity to support augmentation and establishment of wild populations for recovery. Beginning in 2008, USFWS began an effort to restore Rio Grande silvery minnow to the Big Bend reach of the Rio Grande along the border of Texas and Mexico. The species should also be restored to its historical range in the Pecos River between Fort Sumner and Brantley Reservoir. Status of Rio Grande silvery minnow should be closely monitored. Regulations regarding use of bait fishes should be strictly enforced for the Rio Grande.

Literature Cited:

- Agency Technical Workgroup. 2005. Potential effects of climate change on New Mexico. State of New Mexico. 47 pp.
- Alò, D., and T.F. Turner. 2005. Effects of habitat fragmentation on effective population size in the endangered Rio Grande silvery minnow. *Conservation Biology* 19:1138-1148.
- Bestgen, K.R. and S.P. Platania. 1991. Status and conservation of the Rio Grande silvery minnow, *Hybognathus amarus*. *The Southwestern Naturalist* 36:225-232.
- Bestgen, K.R., S.P. Platania, J.E. Brooks, and D.L. Propst. 1989. Dispersal and life history traits of *Notropis girardi* (Cypriniformes: Cyprinidae) introduced into the Pecos River, New Mexico. *American Midland Naturalist* 122:228-235.
- Bestgen, K.R. and D.L. Propst. 1996. Redescription, geographic variation, and taxonomic status of Rio Grande silvery minnow, *Hybognathus amarus* (Girard, 1856). *Copeia* 1996:41-55.
- Caldwell, C.A., S.J. Cho, and W.J. Remshardt. 2009. Effects of propagation, augmentation, and salvage activities on recovery and survival of Rio Grande silvery minnow (*Hybognathus amarus*). Final report to the U.S. Bureau of Reclamation and the Middle Rio Grande Endangered Species Collaborative Program, Albuquerque, NM. Dudley, R.K., S.P. Platania, and G.C. White. 2013. Rio Grande silvery minnow population monitoring program results from December 2011 to October 2012. Middle Rio Grande Endangered Species Act Collaborative Program, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Dudley, R.K., and S.P. Platania. 2007. Rio Grande silvery minnow population monitoring program results from October 2005 to October 2006. Middle Rio Grande Endangered Species Act Collaborative Program, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Dudley, R.K., and S.P. Platania. 2013. Rio Grande silvery minnow population monitoring program results from October 2013. Middle Rio Grande Endangered Species Act Collaborative Program, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Edwards, R.J. and S. Contreras-Balderas. 1991. Historical changes in the ichthyofauna of the lower Rio Grande (Río Bravo del Norte), Texas and Mexico. *The Southwestern Naturalist* 36:201-212.
- Hoagstrom, C.W., N.D. Zymonas, S.R. Davenport, D.L. Propst, and J.E. Brooks. 2010. Rapid species replacement between fishes of the North American plains: a case history from the Pecos River. *Aquatic Invasions* 5:141-153.
- Moyer, G.R., M.J. Osborne, and T.F. Turner. 2005. Genetic and ecological dynamics of species replacement in an arid-land river. *Molecular Ecology* 14:1263-1273.
- Osborne, M.J., M.A. Benavides, and T.F. Turner. 2005. Genetic heterogeneity among pelagic egg samples and variance in reproductive success in an endangered freshwater fish, *Hybognathus amarus*. *Environmental Biology of Fishes* 73:463-472.
- Osborne, M.J., M.A. Benavides, D. Alò and T.F. Turner. 2006. Genetic effects of hatchery propagation and rearing in the endangered Rio Grande silvery minnow, *Hybognathus amarus*. *Reviews in Fisheries Science* 14:127-138.
- Platania, S.P. and R.K. Dudley. 2003. Summary of the biology of Rio Grande silvery minnow, an endangered species in the middle Rio Grande, New Mexico. *The Rio Grande Silvery Minnow: Science and Policy in the Bosque Symposium*.
- Turner, T.F., M.J. Osborne, G.R. Moyer, M.A. Benavides, and D. Alò. 2006. Life history and environmental variation interact to determine the effective population to census size ratio. *Proceedings of the Royal Society Series B* 273:3065-3073.
- U.S. Fish and Wildlife Service. 1994. Endangered and threatened wildlife and plants: Final rule to list the Rio Grande silvery minnow as an endangered species. *Federal Register* 59:36988-36995.
- U.S. Fish and Wildlife Service. 1999. Rio Grande silvery minnow (*Hybognathus amarus*) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, NM.
- U.S. Fish and Wildlife Service. 2007. Rio Grande silvery minnow salvage protocol. U.S. Fish and Wildlife Service, Albuquerque, NM.
- U.S. Fish and Wildlife Service. 2010. Rio Grande silvery minnow (*Hybognathus amarus*) recovery plan. U.S. Fish and Wildlife Service, Albuquerque, NM.

Arkansas River shiner, *Notropis girardi*

Distribution: The historical range of the Arkansas River shiner included plains streams of the Arkansas River drainage in Arkansas, Kansas, New Mexico, Oklahoma, and Texas (Cross and Collins 1975; Gilbert 1980; Matthews and Hill 1980). In New Mexico, the species occurred in the Canadian River drainage from the vicinity of Sabinoso downstream to the Texas border (Sublette et al. 1990; Pittenger and Schiffmiller 1997). Arkansas River shiners

occupy stream reaches characterized by extremes in discharge and are commonly found in main channel shallow habitats with slow velocity and shifting sand and small gravel substrates (Bonner 2000; SWCA 2004).

Current Status: Arkansas River shiner was listed as state endangered in New Mexico in 1976. It was listed as federally threatened by the U.S. Fish and Wildlife Service in 1998 (USFWS, 1998). Critical habitat, including 51.8 km of the Canadian River in New Mexico, was designated for the species in 2001 (U.S. Office of the Federal Register 2001). In 2005, the Canadian River in New Mexico was excluded as critical habitat after the completion of a Cooperative Management Plan for the species within this portion of critical habitat (U.S. Office of the Federal Register 2005). Arkansas River shiner is absent or declining across much of its historical range (Cross et al. 1983; Larson 1988). In New Mexico, the species is currently found only in Revuelto Creek and the Canadian River downstream of Ute Dam, but is relatively abundant within these reaches (Dudley et al. 2012). Arkansas River shiner was established in the Pecos River during the past 20 years, probably via bait bucket transfer, and is moderately common in the river between Fort Sumner and Brantley Reservoir (Bestgen et al. 1989, Platania et al. 2005). The population of Arkansas River shiner in the Pecos River is not protected by the Department or by the U.S. Fish and Wildlife Service.

Threats: Desiccation of occupied habitat by water diversions and withdrawals and loss of flow spikes are probably the major threats to the species. Degradation of water quality also presents a threat to the species.

Recommendations: No change in listing status is recommended. Efforts should be made to restore Arkansas River shiner to areas of historical occupancy, particularly reaches of the Canadian River upstream of Ute Reservoir. Baitfish regulations should be strictly enforced in the Canadian River basin. Programs to protect flows in the Canadian River where Arkansas River shiner currently and historically occurred should be enforced (Canadian River Municipal Water Authority 2005). The Department should continue involvement in the USFWS recovery program.

Literature Cited:

- Bestgen, K.R., S.P. Platania, J.E. Brooks, and D.L. Propst. 1989. Dispersal and life history traits of *Notropis girardi* (Cypriniformes: Cyprinidae), introduced into the Pecos River, New Mexico. *American Midland Naturalist* 122:228-235.
- Bonner, T.H. 2000. Life history and reproductive ecology of the Arkansas River shiner and peppered chum in the Canadian River, Texas and New Mexico. Dissertation. Texas Tech University, Lubbock, TX.
- Canadian River Municipal Water Authority. 2005. Arkansas River shiner (*Notropis girardi*) management plan for the Canadian River from U.S. Highway 54 at Logan, New Mexico to Lake Meredith, Texas.
- Cross, F.B. and J.T. Collins. 1975. Fishes in Kansas. Public Education Series No. 3, The University of Kansas Museum of Natural History, Lawrence, KS.
- Cross, F.B., O.T. Gorman, and S.G. Huloeur. 1983. The Red River shiner, *Notropis bairdi*, in Kansas with notes on depletion of its Arkansas River cognate, *Notropis girardi*. *Transactions of the Kansas Academy of Science* 86:93-98.
- Dudley, R.K., W.H. Brandenburg, M.A. Farrington, L.E. Renfro, S.P. Platania, and D.L. Propst. 2012. Distribution and conservation status of fishes in the South Canadian River Drainage, New Mexico. Final Report to New Mexico Share with Wildlife Program, New Mexico Department of Game and Fish, Santa Fe, NM.
- Gilbert, C.R. 1980. *Notropis girardi*. Hubbs and Ortenburger, Arkansas River shiner. P.268 *In* D.S. Lee, C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. (eds.). Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh, NC.
- Larson, R.D. 1988. Present status and distribution of the Arkansas River shiner, *Notropis girardi*, (Pisces: Cyprinidae), and possible causes for its decline. Unpubl. MS thesis. Oklahoma State University, Stillwater, OK.
- Matthews, W.J. and L.G. Hill. 1980. Habitat partitioning in the fish community of a southwestern river. *The Southwestern Naturalist* 25:51-66.
- Pittenger, J.S. and G. Schiffmiller. 1997. Ichthyofaunal decline in Ute Creek, South Canadian River drainage, New Mexico. *The Southwestern Naturalist* 42:112-117.
- Platania, S.P., K.B. Gido, and W.H. Brandenburg. 2005. Life history and ecology of an introduced population of Arkansas River shiner. Final Report. Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe, NM.

- SWCA. 2004. Distribution and abundance of fishes of the Canadian River below Ute Dam, Quay County, New Mexico, with emphasis on the federally threatened Arkansas River Shiner, *Notropis girardi*. Final Synthesis Report, October 2004. Prepared for the New Mexico Interstate Stream Commission. SWCA Environmental Consultants, Albuquerque, NM.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.
- U.S. Fish and Wildlife Service (USFWS). 1998. Final rule to list the Arkansas River basin population of the Arkansas River shiner (*Notropis girardi*) as threatened. Federal Register 63(225):64777-64799.
- U.S. Office of the Federal Register. 2001. Final designation of critical habitat for the Arkansas River basin population of the Arkansas River shiner. Federal Register 66:65(4 April 2001):18002-18034.
- U.S. Office of the Federal Register. 2005. Final designation of critical habitat for the Arkansas River basin population of the Arkansas River shiner (*Notropis girardi*), final rule. Federal Register 70:197(13 October 2005):59808-59846.

Southern redbelly dace, *Phoxinus erythrogaster*

Distribution: The southern redbelly dace is native to the upper and middle Mississippi River drainage, Great Lakes drainages, and Ohio River drainage (Becker 1983). Isolated native populations, likely remnants of a wider Pleistocene distribution, occur in Arkansas, Colorado, Kansas, New Mexico, and Oklahoma (Miller and Robison 1973; Cross and Collins 1975; Woodling 1985; Robison and Buchanan 1988; Sublette et al. 1990). In New Mexico, the species occurs in the Canadian River, primarily in spring habitats associated with the upper Mora River, Coyote Creek, and tributaries to Black Lake (Sublette et al. 1990; Platania et al. 2007). The disjunct and widely separated distribution of remaining populations of redbelly dace is likely the result of post-Pleistocene warming (Platania et al. 2007). The species prefers spring-fed systems and small streams with cool clear water and dense aquatic vegetation (Pfleiger 1971; Boschung and Mayden 2004).

Current status: Southern redbelly dace was listed as state endangered in New Mexico in 1975. The species appears to be stable in Coyote Creek, but populations within the Mora River appear to have declined (Platania et al. 2007; Dudley et al. 2012). Viable populations of southern redbelly dace still presumably occupy several small tributaries that feed into Black Lake (Sublette et al. 1990; Dudley et al. 2012).

Threats: Excessive grazing probably impacted the historical range of this species. Modifications of spring systems for water development, sedimentation, and introduction of nonnative predators, particularly brown trout *Salmo trutta*, are currently the primary threats to southern redbelly dace in New Mexico.

Recommendations: No change in listing is recommended. Recently completed studies (Platania et al. 2007; Dudley et al. 2012) to characterize status of fishes in the Canadian River drainage provide an accurate and current assessment of the status of southern redbelly dace in New Mexico. In addition, a New Mexico Share with Wildlife funded study (Platania et al. 2007) to characterize the life history of southern redbelly dace was completed and information from it will improve management and conservation of the species. The potential for the Department to purchase habitats occupied by southern redbelly dace in Mora River valley should be explored, and if available, purchased. Regulations regarding use of bait fishes should be strictly enforced in the Canadian River basin.

Literature Cited:

- Becker, G.C. 1983. Fishes of Wisconsin. The University of Wisconsin Press, Madison, WI.
- Boschung, H.T., Jr. and R.L. Mayden. 2004. Fishes of Alabama. Smithsonian Institution, Washington, D.C.
- Cross, F.B. and J.T. Collins. 1975. Fishes in Kansas. Public Education Series No. 3, The University of Kansas Museum of Natural History, Lawrence, KS.
- Dudley, R.K., W.H. Brandenburg, M.A. Farrington, L.E. Renfro, S.P. Platania, and D.L. Propst. 2012. Distribution and conservation status of fishes in the South Canadian River Drainage, New Mexico. Final Report to New Mexico Share with Wildlife Program, New Mexico Department of Game and Fish, Santa Fe, NM.
- Miller, R.J. and H.W. Robison. 1973. The fishes of Oklahoma. Oklahoma State University Press, Stillwater, OK.
- Pfleiger, W.L. 1975. The fishes of Missouri. Missouri Department of Conservation, Jefferson City, MO.

- Platania, S.P., L.E. Renfro, and R.K. Dudley. 2007. Life history of southern redbelly dace, *Phoxinus erythrogaster*, an imperiled New Mexico cyprinid; 2006 report of activities. New Mexico Share with Wildlife, Final Report to New Mexico Department of Game and Fish, Santa Fe, NM.
- Robison, H.W. and T.M. Buchanan. 1988. Fishes of Arkansas. The University of Arkansas Press, Fayetteville, AR.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.
- Woodling, J. 1985. Colorado's little fish: A guide to the minnows and other lesser known fishes in the State of Colorado. Colorado Division of Wildlife, Denver, CO.

Colorado pikeminnow, *Ptychocheilus lucius*

Distribution: Colorado pikeminnow formerly inhabited the Colorado River system from its mouth in Baja California upstream to Wyoming (Minckley et al. 1986; Mueller and Marsh 2002). Seasonal migrations of the species have been documented (Tyus and McAda 1984). A large-bodied fish, growing to lengths greater than 1.5 m, it was the largest native predator in the system. Historically, it was moderately common to abundant in much of the Colorado River system (Minckley 1973; Minckley and Marsh 2010). In New Mexico, its native range included at least the San Juan River (Koster 1960; Platania et al. 1991) and perhaps the Gila River (LaBounty and Minckley 1972).

Current Status: Colorado pikeminnow was state-listed as endangered in New Mexico in 1975 and as endangered by U.S. Fish and Wildlife Service in 1967. The Navajo Nation lists Colorado pikeminnow as endangered (Mikesic et al. 2005). Currently, Colorado pikeminnow persists mainly in the Green River in Utah (Holden and Stalnaker 1975) and Yampa, Gunnison, and Colorado rivers in Colorado (Tyus and Karp 1989; Osmundson and Kaeting 1989). A small population of the species persists in the San Juan River in New Mexico and Utah (Platania et al., 1991). In 1996 through 1999, age-0 Colorado pikeminnow were stocked in the San Juan River and survival of these individuals documented for several months (Trammell 2000). After a 2 year hiatus, stocking of age-0 Colorado pikeminnow resumed in 2002, and has continued through 2017 (Furr 2018). Older fish (age-2 through age-5) have also been stocked opportunistically. Individuals from these stockings survived at least 1 year (Golden and Holden 2005; Ryden 2007), but it is uncertain how successfully they will recruit into the adult population. Relative abundance of Colorado pikeminnow in the San Juan River increased until 2011, but a decreasing trend has been occurring since (Durst 2016). Although the number of fish in the San Juan River has recently shown a decreasing trend, low numbers of larval Colorado pikeminnow have been collected in the San Juan River in 5 of the past 6 years (Farrington et al. 2016), indicating that at least minimal reproduction is occurring in the system. Young-of-year Colorado pikeminnow were also captured in 2016 and 2017, the first captures of wild young-of-year fish since the 1990s (Zeigler and Ruhl 2018). A recovery plan for the species has been approved (USFWS 1991) and recovery efforts in the San Juan River are accomplished under the auspices of the San Juan River Basin Recovery Implementation Program (SJRRIP).

Threats: Fragmentation of range, water depletion, modification of natural flows, contaminants, competition and predation by nonnative fishes, and loss of prey base are the primary threats to Colorado pikeminnow.

Recommendations: No change in listing status is recommended. The Department should continue to work through the SJRRIP to support and implement actions to recover Colorado pikeminnow. Efforts to remove or suppress nonnative fish populations in the San Juan River drainage, focusing on those that prey upon Colorado pikeminnow, should continue. Augmentation of the Colorado Pikeminnow population in the San Juan River should continue. Because it was likely an important prey of Colorado pikeminnow, recent efforts to restore roundtail chub *Gila robusta* to San Juan River by stocking individuals provided to the Department by Colorado Division of Wildlife should continue. Studies to determine reasons for low survivorship of stocked Colorado pikeminnow should be undertaken. Strict regulations regarding use of bait fishes and stocking of nonnative nonsalmonid fishes should be adopted and implemented in the San Juan River basin.

Literature Cited:

- Durst, S. 2016. 2015 integrated PIT tag database summary of Colorado Pikeminnow and razorback sucker in the San Juan River. Final report to the Bureau of Reclamation. 29pp.

- Golden, M.E. and P.B. Holden. 2005. Retention, growth, and habitat use of stocked Colorado pikeminnow in the San Juan River: 2003-2004 annual report. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Farrington, M.A., R.K. Dudley, J.L. Kennedy, S.P. Platania, and G.C. White. 2016. Colorado Pikeminnow and razorback sucker larval fish survey in the San Juan River during 2015. Final report to the San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Furr, D.W. 2016. San Juan River razorback sucker *Xyrauchen texanus* & Colorado Pikeminnow *Ptychocheilus Lucius* population augmentation: 2018. Final report to the San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Holden, P.B. and C.B. Stalnaker. 1975. Distribution and abundance of mainstream fishes of the Middle and Upper Colorado River basins, 1967-1973. *Transactions of the American Fisheries Society* 104:217-231.
- Koster, W.J. 1960. *Ptychocheilus lucius* (Cyprinidae) in the San Juan River, New Mexico. *The Southwestern Naturalist* 5:174-175.
- LaBounty, J.F. and W.L. Minckley. 1972. Native fishes of the upper Gila River system, New Mexico. pp. 134-146. *In* Symposium on rare and endangered wildlife of the southwestern United States. New Mexico Department of Game and Fish, Santa Fe, NM.
- Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, AZ.
- Minckley, W.L., D.A. Hendrickson, and C.E. Bond. 1986. Geography of western American freshwater fishes: Description and relationships to intracontinental tectonism. Pp. 519-613. *In* C.H. Hocutt and E.O. Wiley (eds.). Zoogeography of North American freshwater fishes. John Wiley & Sons, New York, NY.
- Minckley, W.L., and P.C. Marsh. 2009. *Inland Fishes of the Greater Southwest: Chronicle of a Vanishing Biota*. University of Arizona Press, Tucson.
- Nelson, J.S., E. J. Crossman, H. Espinoza-Perez, C.R. Gilbert, N.N. Lea, and J.D Williams. 1998. Recommended changes in common fish names. *Fisheries* 23:37.
- Osmundson, D.B. and L.R. Kaeting. 1989. Studies of Colorado squawfish and razorback Sucker use of the “15 mile reach” of the upper Colorado River as part of conservation measures for the Green Mountain and Ruedi Reservoir watersheds. Colorado River Fishery Project, U.S. Fish and Wildlife Service, Grand Junction, CO.
- Platania, S.P., K.R. Bestgen, M.A. Moretti, D.L. Propst, and J.E. Brooks. 1991. Status of Colorado squawfish and razorback sucker in the San Juan River, New Mexico and Utah. *The Southwestern Naturalist* 36:147-150.
- Ryden, D. W. 2006. Augmentation of Colorado pikeminnow in the San Juan River 2006. San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Trammell, M. 2000. Evaluation of reintroduction of young of year Colorado pikeminnow in the San Juan River: 1999 annual report. San Juan River Basin Recovery Implementation Program. U.S. Fish and Wildlife Service, Albuquerque, NM.
- Tyus, H.M. and C.A. Karp. 1989. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado. U.S. Fish and Wildlife Service Biological Report 89:1-27.
- Tyus, H.M. and C.W. McAda. 1984. Migration, movement, and habitat preferences of Colorado squawfish, *Ptychocheilus lucius* (Cyprinidae) in the Green, White, and Yampa rivers, Colorado and Utah. *The Southwestern Naturalist* 29:289-299.
- U.S. Fish and U.S. Fish and Wildlife Service. 1991. Colorado squawfish recovery plan. U.S. Fish and Wildlife Service, Denver, CO.
- Zeigler, M. P., and M. E. Ruhl. 2018. Small-bodied fishes monitoring in the San Juan River: 2017. Final Report to the San Juan River Basin Recovery Implementation Program, U.S. Fish and Wildlife Service, Albuquerque, New Mexico.

Loach minnow, *Tiaroga cobitis*

Distribution: Loach minnow is endemic to the Gila River drainage of southwest New Mexico, southeast and east-central Arizona, and northeast Sonora (Miller and Winn, 1951; Minckley, 1973; Miller, 2006, Minckley and Marsh 2010). In New Mexico, the minnow was historically found throughout warmwater reaches of the San Francisco and Gila rivers, and major tributaries of each (Koster, 1957; Propst et al., 1988; Paroz and Propst, 2007). Loach minnow is found almost exclusively among cobble in riffle habitats where water velocity is rapid (Propst and Bestgen, 1991).

Current Status: Loach minnow was state-listed as threatened in 1975 and uplisted to endangered in 2010. It was federally listed as threatened in 1986 and uplisted to endangered in 2012 (USFWS, 2012). Critical habitat, including

much of its currently occupied habitat in New Mexico, was designated for the species in 2007 and updated in 2012 (USFWS, 2012). A federal recovery plan for the species was finalized in 1991 (USFWS, 1991). Loach minnow has been eliminated from Sonora and much of its historical range in Arizona (Minckley, 1973; Marsh et al., 1990; Rinne and Minckley, 1991; Olden and Poff, 2005; Miller 2006; Minckley and Marsh 2010). In New Mexico, its range in the Gila and San Francisco drainages is fragmented (Propst et al., 1988; Paroz and Propst, 2007). It was recently moderately common in a short reach (<10 km) of the San Francisco River near Glenwood, but was removed from that reach due to the Whitewater-Baldy Fire in 2012. It has been restocked since the fire and has been captured there annually since 2014. It also persists in portions of the San Francisco River between San Francisco Plaza and US 180 bridge upstream of Alma. Large populations persist in an 8 km reach of lowermost West Fork Gila River, and in the lower reaches of the Middle Fork Gila River (NMDGF files). The largest numbers of loach minnow in New Mexico are currently found in the lower half of the Cliff-Gila Valley. Predation by nonnative yellow bullhead *Ameiurus natalis* and smallmouth bass *Micropterus dolomieu*, as well as drought and habitat degradation, have contributed to loach minnow decline (Propst, et al., 2008). The intensity and long-term effects of predation by nonnative fishes, however, is mitigated by environmental variables, such as flow regime (Pilger et al., 2010).

Threats: Range fragmentation, stream desiccation by diversion or pumping, loss of natural flow regime, habitat degradation (channelization and sedimentation), and nonnative fishes (e.g., channel catfish *Ictalurus punctatus*, yellow bullhead, smallmouth bass, and red shiner *Cyprinella lutrensis*) are primary threats to the species (Propst et al. 2008, Stefferud et al. 2011). Elevated sediment loads, caused by extensive wildfires in uplands, likely contributed to local declines (particularly West Fork Gila River and lower San Francisco River) occasionally since the late 1990s.

Recommendations: The natural flow regime of the Gila River (including the San Francisco River) should be maintained; additional water depletions or diversions within occupied or historical loach minnow habitat should not be allowed. Nonnative fishes should be removed or abundances suppressed. Nonnative warmwater fishes should not be stocked in or near occupied habitats. Cooperative efforts with Arizona Game and Fish Department and The Nature Conservancy, as well as U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, and U.S. Forest Service, to conserve loach minnow should continue. Regulations regarding use of bait fishes should be strictly enforced by NMDGF.

Literature Cited:

- Koster, W.J. 1957. Guide to the fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.
- Marsh, P.C., J.E. Brooks, D.A. Hendrickson, and W.L. Minckley. 1990. Fishes of Eagle Creek, Arizona, with records for threatened spikedace and loach minnow (Cyprinidae). *Journal of Arizona-Nevada Academy of Science* 23:107-116.
- Miller, R.R., 2006. Freshwater fishes of México. The University of Chicago Press, Chicago, IL.
- Miller, R.R. and W.E. Winn. 1951. Additions to the known fish fauna of Mexico: Three species and one subspecies from Sonora. *Journal of the Washington Academy of Science* 41:83-84.
- Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, AZ.
- Minckley, W.L., and P.C. Marsh. 2009. Inland Fishes of the Greater Southwest: Chronicle of a Vanishing Biota. University of Arizona Press, Tucson.
- Paroz, Y.M. and D.L. Propst. 2007. Distribution of spikedace, loach minnow, and chub species in the Gila River basin, New Mexico, 1908-2007. New Mexico Department of Game and Fish. Santa Fe.
- Pilger, T.J., K.B. Gido, and D.L. Propst. 2010. Diet and trophic niche overlap of native and nonnative fishes in the Gila River, U.S.A.: implications for native fish conservation. *Ecology of Freshwater Fish* 19:300-321.
- Propst, D.L. and K.R. Bestgen. 1991. Habitat and biology of the loach minnow, *Tiaroga cobitis*, in New Mexico. *Copeia* 1991: 29-39.
- Propst, D.L., K.R. Bestgen, and C.W. Painter. 1988. Distribution, status, biology, and conservation of the loach minnow (*Tiaroga cobitis*) in New Mexico. *Endangered Species Report No. 17*, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Propst, D.L., K.B. Gido, and J.A. Stefferud. 2008. Natural flow regimes, nonnative fishes, and persistence of native fish assemblages in arid-land systems. *Ecological Applications* 18: 1236-1252.
- Rinne, J.N. and W.L. Minckley. 1991. Native fishes of arid lands: A dwindling resource of the desert southwest. USDA Forest Service General Technical Report RM-206. U.S. Forest Service, Fort Collins, CO.
- Stefferd, J.A., K.B. Gido, and D.L. Propst. 2011. Spatially variable response of native fish assemblages to discharge, predators and habitat characteristics in an arid-land river. *Freshwater Biology* 56: 1403-1416.

U.S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants: Endangered status and designations of critical habitat for spikedace and loach minnow, final rule. Federal Register 77: 10810-10932.

Zuni bluehead sucker, *Catostomus discobolus yarrowi*

Distribution: Zuni bluehead sucker historically occupied headwater streams of the Little Colorado River in east-central Arizona and west-central New Mexico (Smith et al. 1983; Crabtree and Buth 1987). In New Mexico, the sucker currently is limited to the headwaters of the Zuni River drainage. The species most frequently occurs in streams reaches with cobble and bedrock substrates with slow- to moderate-velocity water (Propst et al., 2001).

Current Status: Zuni bluehead sucker was listed as state endangered in New Mexico in 1975. A state-sponsored recovery plan for the species was approved by New Mexico State Game Commission in December 2004 (Carman 2004). Currently, the species is limited to a few areas in headwater tributaries and springs of the Zuni River basin in New Mexico (Hanson 1980; Propst et al. 2001; Carman 2007). Its status in Arizona is unknown (K.Young, Arizona Game & Fish Department, personal communication). Recent genetic studies indicate that the subspecies is sufficiently distinct from other populations of bluehead sucker and that remaining populations in the Zuni River drainage should be recognized as a separate management unit (Douglas et al. 2013). In 2014, Zuni bluehead sucker was federally listed as endangered under the Endangered Species Act, and critical habitat for the species was designated in 2016 (U.S. Office of the Federal Register 2014, 2016).

Threats: Habitat degradation, mainly excessive siltation of streams, and loss of wetted habitat are the primary threats to the species. While efforts are ongoing to restore the Zuni River watershed, increased development in the area may exacerbate these threats. Nonnative predators, such as green sunfish *Lepomis cyanellus* also limit opportunities to expand the range and abundance of Zuni bluehead sucker. The presence and increasing abundance of nonnative crayfish in the basin might reduce habitat suitability for Zuni bluehead sucker.

Recovery Plan Status: The Zuni bluehead sucker recovery plan was approved by the Commission in 2004 (Carman 2004). Major recovery actions have included annual monitoring of existing populations and rearing Zuni bluehead sucker at the City of Albuquerque Native Fish Refugium. The Zuni Pueblo tribal council has prohibited electrofishing in pueblo lands. As a result, recent population status on pueblo lands is uncertain though their presence was confirmed by visual surveys. No revision to the plan is called for at this time.

Recommendations: No change in listing status is recommended. The Zuni Bluehead Sucker Recovery Plan, per guidelines of New Mexico Wildlife Conservation Act, was developed with participation of various stakeholders (e.g., Pueblo of Zuni, U.S. Forest Service, The Nature Conservancy, and private landowners) and implementation should continue (Carman 2004; Carman 2007). Collaborative conservation efforts should be formalized through development of a cooperative agreement. Efforts should be made to improve Zuni River watershed conditions and to provide long-term security for Zuni bluehead sucker habitats. The effects of groundwater pumping on surface flows in Zuni River drainage needs elucidation. Nonnative fishes, particularly green sunfish, should be removed from historical Zuni bluehead sucker habitats. Monitoring and protection of extant populations should continue.

Literature Cited:

- Carman, S.M. 2004. Zuni bluehead sucker (*Catostomus discobolus yarrowi*) recovery plan. Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe, NM.
- Carman, S.M. 2007. Zuni bluehead sucker monitoring and conservation efforts 2007. Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe, NM.
- Crabtree, C.B. and D.G. Buth. 1987. Biochemical systematics of the catostomid genus *Catostomus*: an assessment of *C. clarki*, *C. plebeius*, and *C. discobolus* including the Zuni sucker, *C.d. yarrowi*. Copeia 1987:843-854.
- Douglas, M.R., M.E. Douglas, W.J.B. Anthony, M.A. Davis, and M.R. Bangs. 2013. A population genetic evaluation of bluehead sucker (*Catostomus discobolus*) from the Chuska Mountain and Defiance Plateau drainages (AZ/NM) and the Zuni River (NM). Final Report. 48pp.
- Hanson, B. 1980. Fish survey of the streams in the Zuni River drainage, New Mexico. U.S. Fish and Wildlife Service, Albuquerque, NM.

- Propst, D.L., A.L. Hobbes, and T.L. Stroh. 2001. Distribution and notes on the biology of Zuni bluehead sucker, *Catostomus discobolus yarrowi*, in New Mexico. *The Southwestern Naturalist* 46:158-170.
- Smith G.R., J.G. Hall, R.K. Koehn, and D.J. Innes. 1983. Taxonomic relationships of the Zuni Mountain sucker, *Catostomus discobolus yarrowi*. *Copeia* 1983:37-48.
- U.S. Office of the Federal Register. 2014. Endangered species status for the Zuni Bluehead Sucker, final rule. *Federal Register* 79:142(24 July 2014):43132-43161.
- U.S. Office of the Federal Register. 2016. Designation of critical habitat for the Zuni bluehead sucker, final rule. *Federal Register* 81:109(7 June 2016):36762-36785.

Blue sucker, *Cycleptus elongatus*

Distribution: Blue sucker occurs in larger rivers throughout much of the Mississippi-Missouri River and Gulf Coastal drainages (Gilbert 1980). The historical range of the species in New Mexico was the Pecos River from north of Carlsbad downstream to the New Mexico/Texas border and the lower reaches of the Black River (Sublette et al. 1990). Archaeological evidence suggests that the species also occupied the Rio Grande in New Mexico (Gehlbach and Miller 1961), but no specimens exist to confirm its presence there. Blue sucker is most common in rivers with moderately fast flowing water and deep pools (Moss et al. 1983).

Current Status: Blue sucker was state listed as endangered in New Mexico in 1976. The species has declined throughout much of its native range (Moss et al., 1983; NatureServe 2007). In recent decades in New Mexico, it was regularly found in the Pecos River only between Brantley Dam and Avalon Reservoir, a 15-km river reach, whereas it was rare in the Black River and the Pecos River downstream of Avalon Dam (Zymonas and Propst 2008). Populations of blue sucker have drastically declined since 2002 as a result of recurring outbreaks of toxic golden algae downstream from Brantley Lake. Blue sucker is likely extirpated from the Pecos River, and it is unknown if individuals in the Black River comprise a self-sustaining population. Sampling in 2012 and 2013 suggested that the Black River population persisted in extremely low densities (Caldwell 2013). Recent research has produced evidence that the form of *Cycleptus* inhabiting the Rio Grande drainage (including Pecos River) warrants recognition as a separate species, although it has not been formally described (Burr and Mayden 1999; Bessert 2006).

Threats: Range fragmentation by dams, loss of high-velocity habitats, contaminants, stranding in canals, and toxic conditions caused by golden algae *Prymnesium parvum* are the primary threats to the species in New Mexico. Pecos River fish kills attributed to golden algae occurred below Malaga, NM by 1988 (Rhodes and Hubbs 1992) and from Brantley Lake downstream beginning in 2002. Toxic conditions have recurred sporadically throughout this reach, and in November of 2007, a block delivery of water from Brantley Lake to Texas contained high levels of algal toxins (S. Denny, NMDGF, personal communication). Intensified oil and gas development represents an increasing threat to water quality in the Black River drainage.

Recommendations: No change in listing status is recommended. Permanent flows in Pecos River between Brantley Dam and Avalon Reservoir should be maintained. The causes of golden algae blooms in the lower Pecos River system need to be determined and efforts made to preclude such conditions from occurring in the future. The taxonomic relationship of Pecos River blue sucker with congeners needs elucidation. Following cessation of irrigation releases, blue suckers in canals of the Carlsbad Irrigation District should be rescued and stocked in the Black River or Pecos River between Brantley Dam and Lake Avalon. A captive propagation effort to facilitate conservation and recovery of blue sucker in New Mexico should be supported. Actions to protect the water quality and quantity of the Black River should be promoted. A state recovery plan should be completed to coordinate actions.

Literature Cited:

- Bessert, M. L. 2006. Molecular systematics and population structure in the North American endemic fish genus *Cycleptus* (Teleostei: Catostomidae). Ph.D. dissertation. University of Nebraska – Lincoln, NE.
- Caldwell, J.M. 2013. Movements and distribution of gray redbhorse and Rio Grande blue sucker in the Black River, New Mexico (1 year of data collection). Annual Performance Report to the USFWS for an Endangered Species Act Section 6 grant.

- Burr, B.M. and R.L. Mayden. 1999. A new species of *Cycleptus* (Cypriniformes: Catostomidae) from Gulf Slope drainages of Alabama, Mississippi, and Louisiana, with a review of the distribution, biology, and conservation status of the genus. *Bulletin of the Alabama Museum of Natural History* 20:19-57.
- Gelbach, F.R. and R.R. Miller. 1961. Fishes from archaeological sites in northern New Mexico. *The Southwestern Naturalist* 9:2-8.
- Gilbert, C.R. 1980. *Cycleptus elongatus* (Lesueur), blue sucker. P. 396. In D.S. Lee, C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. (eds.). *Atlas of North American freshwater fishes*. North Carolina Museum of Natural History, Raleigh, N.C. Moss, R.E., J.W. Scanlan, and C.S. Anderson. 1983. Observations on the natural history of the blue sucker (*Cycleptus elongatus*) in the Neosho River. *American Midland Naturalist* 109:15-22.
- NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.2. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: February 22, 2008).
- Rhodes, K., and C. Hubbs. 1992. Recovery of Pecos River fishes from a red tide fish kill. *The Southwestern Naturalist* 37:178-187.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. *The Fishes of New Mexico*. The University of New Mexico Press, Albuquerque, NM.
- Zymonas, N.D. and D.L. Propst. 2008. Ecology of blue sucker and gray redhorse in the lower Pecos River, New Mexico, 2000—2006. Final report. New Mexico Department of Game and Fish, Santa Fe, NM.

Gray redhorse, *Moxostoma congestum*

Distribution: The historical range of gray redhorse included Gulf Coastal drainages of central and west Texas and northwestern Mexico, the Pecos River and Rio Grande in southern New Mexico and Texas, and Mexican tributaries to the Rio Grande (Jenkins 1980; Miller 2006). In New Mexico, it historically occurred in the Rio Grande downstream of Socorro and in the Pecos River (including the Black River) from about Roswell downstream to the Texas/New Mexico border (Sublette et al. 1990). In addition to riverine habitats, gray redhorse also occupied several lower Pecos River impoundments (e.g., Six Mile and Ten Mile reservoirs). Gray redhorse are most commonly found in deep, slow-velocity water over a variety of substrates.

Current Status: Gray redhorse was state listed as threatened in New Mexico in 1976 and uplisted to endangered in 2008. Prior to 2003, gray redhorse occurred only in the Pecos River downstream of Brantley Lake and in the lower reaches of the Black River in New Mexico (Cowley and Sublette 1987; Sublette et al. 1990). Fish kills caused by recurring outbreaks of golden algae since 2002 have drastically diminished the status of gray redhorse in the Pecos River and it is no longer found upstream of Bataan Dam in Carlsbad (Zymonas and Propst 2008). It remained common in the reach between Carlsbad and Six Mile Dam after 2002, but extensive mortality occurred there during golden algae outbreaks in 2007, restricting the population to the small reservoir at Six Mile Dam. Thus, the only viable historic populations in New Mexico occur in the lower Black River from Blue Spring to the Pecos River confluence and Six Mile Reservoir. This represents a contraction to roughly 30% of the species' occupied range within New Mexico since 2002, and to 10% of historically occupied stream length in the New Mexico portion of the Pecos River drainage. Presence of dams and golden algae blooms prevent natural recolonization of formerly occupied Pecos River reaches. Beginning in 2012, individuals from the Black River have been released yearly into the Delaware River as part of a reintroduction project. In 2016 and 2018, multiple juveniles were detected in the Delaware indicating that transplanted individuals are successfully reproducing.

Threats: Range fragmentation by dams, modified flow regimes, contaminants, stranding in canals, and toxic conditions caused by golden algae *Prymnesium parvum* are the primary threats to the species in New Mexico. Pecos River fish kills attributed to golden algae occurred below Malaga, NM by 1988 (Rhodes and Hubbs 1992) and from Brantley Lake downstream beginning in 2002. Toxic conditions have recurred sporadically throughout this reach, and in November of 2007, a block delivery of water sent from Brantley Lake to Texas contained lethal levels of algal toxins (S. Denny, NMDGF, personal communication). Intensified oil and gas development represents an increasing threat to water quality in the Black and Delaware River drainages.

Recommendations: No change in listing status is recommended. Permanent flows in the Pecos River between Brantley Dam and Avalon Reservoir should be maintained. Causes of golden algae blooms in the lower Pecos River

system should be determined, and measures to prevent, or limit, their outbreaks in future should be undertaken. Effects of water quality on recruitment and survival of gray redhorse should be determined, and if deleterious constituents found, their effects ameliorated or eliminated. Actions to protect the water quality and quantity of the Black and Delaware Rivers should be promoted. A state recovery plan should be completed to coordinate actions.

Literature Cited:

- Cowley, D.E. and J.E. Sublette. 1987. Distribution of fishes in the Black River drainage, Eddy County, New Mexico. *The Southwestern Naturalist* 32:213-222.
- Jenkins, R.E. 1980. *Moxostoma congestum*, gray redhorse (Baird and Girard). P. 418. In D.S. Lee, C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. (eds.). *Atlas of North American freshwater fishes*. North Carolina State Museum of Natural History, Raleigh, NC.
- Miller, R.R. 2006. *Freshwater fishes of Mexico*. University of Chicago Press, Chicago, IL.
- Rhodes, K., and C. Hubbs. 1992. Recovery of Pecos River fishes from a red tide fish kill. *The Southwestern Naturalist* 37:178-187.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. *The Fishes of New Mexico*. The University of New Mexico Press, Albuquerque, NM.
- Zymonas, N.D. and D.L. Propst, D.L. 2008. Ecology of blue sucker and gray redhorse in the lower Pecos River drainage in New Mexico 2000—2006. New Mexico Department of Game and Fish, Santa Fe, NM.

Pecos gambusia, *Gambusia nobilis*

Distribution: Pecos gambusia is endemic to springs and spring systems of the Pecos River valley of southeast New Mexico and Trans-Pecos Texas (Hubbs and Springer 1957). Springs and gypsum sinkholes on Bitter Lake National Wildlife Refuge and Blue Spring and its outflow are the only documented areas of historical occurrence in New Mexico (Bednarz 1979; Echelle and Echelle 1980). Pecos gambusia occurs almost exclusively in springs and spring-run habitats with lithic or vegetative cover (Echelle et al. 1989).

Current Status: Pecos gambusia was federally listed as endangered in 1970. It was state-listed as endangered in New Mexico in 1975. A recovery plan for the species was finalized in 1983 (USFWS 1983), and the USFWS began a five-year status review in 2018 (V. Wolf, USFWS, pers comm.). The range of Pecos gambusia has diminished in Texas (Echelle and Echelle 1980), but it still occupies its documented historical New Mexico range.

Threats: Groundwater mining, habitat modification by excessive grazing or spring run dredging, and nonnative predators present the greatest threats to Pecos gambusia. Hybridization with western mosquitofish *Gambusia affinis* may also be a threat (Swenton and Kodric-Brown 2007).

Recommendations: No change in listing status is recommended. Investigations into habitat preferences and hybridization with western mosquitofish should continue. Potential sites for establishing additional populations should be evaluated and, if suitable, stocked with Pecos gambusia.

Literature Cited:

- Bednarz, J. 1979. Ecology and status of the Pecos gambusia, *Gambusia nobilis* (Poeciliidae), in New Mexico. *The Southwestern Naturalist* 24:311-322.
- Echelle, A.A. and A.F. Echelle. 1980. Status of the Pecos gambusia (*Gambusia nobilis*). *Endangered Species Report* No. 10, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Echelle, A.F., A.A. Echelle, and D.R. Edds. 1989. Conservation genetics of a spring-dwelling desert fish, the Pecos gambusia (*Gambusia nobilis*, Poeciliidae). *Conservation Biology* 3:159-169.
- Hubbs, C. and V.G. Springer. 1957. A revision of the *G. nobilis* species group, with descriptions of three new species and notes on their variation, ecology, and evolution. *The Texas Journal of Science* 9:279-327.
- Swenton, D. and A. Kodric-Brown. 2007. Co-existence between two species of *Gambusia*. *End-of-Contract Report*, Share with Wildlife Grant #05-516-0000-0020. Conservation Services Division, New Mexico Department of Game and Fish, Santa Fe, NM.
- USFWS. 1983. *Recovery Plan for Pecos Gambusia (Gambusia nobilis)*. U.S. Fish and Wildlife Service, Region 2, Albuquerque, NM.

Spikedace, *Meda fulgida*

Distribution: Spikedace is endemic to the Gila River drainage of southwest New Mexico, southeast and central Arizona, and perhaps northern-most Sonora (Koster, 1957; Minckley, 1973; Miller and Winn, 1951; Miller, 2006; Minckley and Marsh, 2010). It is found in low- to moderate-gradient warmwater streams in shallow runs with moderate-velocity water over sand and small gravel substrates (Minckley, 1973; Propst et al., 1986). In preferred habitats, it is occasionally found in large aggregations.

Current Status: Spikedace was state-listed as a threatened species in 1975 and uplisted to endangered in 2006. Spikedace was federally listed as threatened in 1986 and uplisted as endangered in 2012 (USFWS 2012). A federal recovery plan for spikedace was finalized in 1991 (USFWS 1991). Critical habitat was designated for the species in much of its occupied habitat in New Mexico (USFWS 2012). Spikedace has been eliminated from most (>90%) of its historical Arizona range and persists there only in Aravaipa Creek (Minckley, 1973; Barber and Minckley, 1966; Eby et al. 2003). No spikedace specimen has been found in Eagle Creek since the late 1980s (Marsh et al., 1990; M. Richardson, USFWS, Phoenix, AZ. Pers. Comm.). It has not been found in the upper Verde River since 1997 (Rinne 2005). In New Mexico, spikedace were eliminated from the San Francisco River drainage (Anderson, 1978; Propst et al., 1986), but coincident with recent repatriation efforts spikedace were captured in 2017 surveys (NMDGF files). The range of the species in the Gila River drainage in New Mexico is fragmented and declining; it is currently found mainly in the lower portions of the Cliff-Gila Valley reach of the Gila River and lower reaches of West Fork Gila River (Paroz and Propst 2007). In both the Cliff-Gila Valley reach and lower West Fork Gila River, its abundance declined from the late 1990s through 2006 (Propst et al. 2008). In 2007, spikedace abundance was higher in lower Cliff-Gila Valley reach than it was in several preceding years (NMDGF files; D. Miller, WNMU, Pers. Comm). Recent surveys failed to find it in East Fork Gila River (Paroz et al. 2006). It apparently was once thought to have been eliminated from Middle Fork Gila River, but was captured again in 2007 and has been captured annually since 2014. In 2017, it was found in several different sites within the lower Middle Fork Gila River (NMDGF files). Spikedace is frequently found near the mouth of the Middle Box upstream of Redrock (Propst et al., 1986; Paroz et al., 2006; Paroz and Propst 2007). Overall, the status of spikedace in New Mexico has declined markedly, both in range and abundance, since the late 1990s.

Threats: Dewatering of riverine habitats by diversion or pumping, ash and sediment flows associated with wildfires, modification of occupied habitats (channelization and removal of woody debris), range fragmentation, and nonnative predators are the primary threats to the species (Paroz and Propst 2007, Stefferud et al. 2011). Range fragmentation (by artificial barriers and stream desiccation) limits the ability of the species to repopulate areas adversely modified by human activity. From 1998 through 2006, drought exacerbated intensity of aforementioned human-caused threats.

Recommendations: No change in listing status is recommended. A natural flow regime in Gila River should be maintained and additional depletions or diversion of the Gila River within occupied or potential spikedace habitats should not occur. Removal of nonnative fishes, particularly predators, should be conducted within currently occupied and potential habitats of spikedace. Stocking of nonnative warmwater fishes should not occur in Gila River drainage. Efforts to restore spikedace to San Francisco River should continue. Cooperative efforts with the Arizona Game and Fish Department and The Nature Conservancy, as well as U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, and U.S. Forest Service, to conserve spikedace should continue. Recently adopted bait fish regulations should be strictly enforced by NMDGF.

Literature Cited:

- Anderson, R.M. 1978. The distribution and aspects of life history of *Meda fulgida* in New Mexico. Unpubl. MS thesis, New Mexico State University, Las Cruces, NM.
- Barber, W.E. and W.L. Minckley. 1966. Fishes of Aravaipa Creek, Graham and Pinal counties, Arizona. The Southwestern Naturalist 11:313.324.
- Eby, L.A., et al. 2003. Variability and dynamics of a desert stream community. Ecological Applications 13: 1566-1579.
- Koster, W.J. 1957. Guide to the fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.

- Marsh, P.C., J.E. Brooks, D.A. Hendrickson, and W.L. Minckley. 1990. Fishes of Eagle Creek, Arizona, with records for threatened spikedace and loach minnow (Cyprinidae). *Journal of the Arizona-Nevada Academy of Science* 23: 107-116.
- Miller, R.R. and W.E. Winn. 1951. Additions to the known fish fauna of Mexico: three species and one subspecies from Sonora. *Journal of the Washington Academy of Science* 41:83-84.
- Minckley, W.L. 1973. *The fishes of Arizona*. Arizona Game and Fish Department, Phoenix, AZ.
- Minckley, W.L., and P.C. Marsh. 2009. *Inland Fishes of the Greater Southwest: Chronicle of a Vanishing Biota*. University of Arizona Press, Tucson.
- Paroz, Y.M., D.L. Propst, and J.A. Stefferud. 2006. Long-term monitoring of fish assemblages in the Gila River drainage, New Mexico. New Mexico Department of Game and Fish, Santa Fe.
- Paroz, Y.M. and D.L. Propst. 2007. Distribution of spikedace, loach minnow, and chub species in the Gila River Basin, New Mexico, 1908-2007. New Mexico Department of Game and Fish, Santa Fe.
- Propst, D.L., K.R. Bestgen, and C.W. Painter. 1986. Distribution, status, biology, and conservation of the spikedace (*Meda fulgida*) in New Mexico. *Endangered Species Report No. 15*, U.S. Fish and Wildlife Service, Albuquerque, NM.
- Propst, D.L., K.B. Gido, and J.A. Stefferud. 2008. Natural flow regimes, nonnative fishes, and persistence of native fish assemblages in arid-land systems. *Ecological Applications* 18:1236-1252.
- Rinne, J.N. 2005. Changes in fish assemblages in the Verde River, Arizona. Pp. 115-126 *In* Rinne, J.N., R.M. Hughes, and B. Calamusso (eds.). *Historical changes in fish assemblages of large rivers in the Americas*. American Fisheries Society Symposium 45. Bethesda, MD.
- Stefferd, J.A., K.B. Gido, and D.L. Propst. 2011. Spatially variable response of native fish assemblages to discharge, predators and habitat characteristics in an arid-land river. *Freshwater Biology* 56: 1403-1416.
- U.S. Fish and Wildlife Service. 2012. *Endangered and threatened wildlife and plants: Endangered status and designations of critical habitat for spikedace and loach minnow, final rule*. *Federal Register* 77:10810-10932.

Pecos bluntnose shiner, *Notropis simus pecosensis*

Distribution: Pecos bluntnose shiner formerly inhabited the Pecos River from near Santa Rosa downstream to Major Johnson Springs near Carlsbad (Hatch et al. 1985). Historical occurrence of persistent populations in the Texas portion of the Pecos River is doubtful (Platania 1995). The species mainly occurs in pool and run mesohabitats within wide, shallow, sand-bed river reaches (Hoagstrom et al. 2008).

Current Status: Pecos bluntnose shiner was federally listed as threatened in 1987. It was state-listed as threatened in New Mexico in 1976 and uplisted to endangered in 2006. The species has an approved recovery plan (USFWS 1992). Currently, Pecos bluntnose shiner is found in the Pecos River from near Old Fort State Park (near Fort Sumner) downstream to the inflow area of Brantley Reservoir near Carlsbad (Hoagstrom et al. 2008). Within this river reach, the fish tends to be most common upstream of Roswell. Systematic monitoring efforts indicated diminishing numbers beginning in 2002, associated with drought and desiccation of the Pecos River upstream of Roswell. Despite recovery efforts, abundance declined to historically low levels by 2005 (Davenport 2006). Although results of monitoring efforts have been questioned by some entities, an independent review of fish population data collected since 1992 confirmed that the precipitous decline since 2002 reported by NMDGF and USFWS was real and not an artifact of sampling vagaries (Fagan 2005). Pecos bluntnose shiner abundance increased after 2005, likely a consequence of maintenance of continuous flow from Sumner Dam to Brantley Lake (avoidance of intermittency) and increased summer rainfall (NMDGF and USFWS files). Beginning in 2011 shiner abundances again declined and approached historically low levels. The decline was likely due to drought conditions and river drying precluding successful spawning and recruitment (Davenport 2012). Following continuous river surface flows since 2014, the population appears to be recovering (Davenport 2018).

Threats: Primary threats to Pecos bluntnose shiner include large volume, extended duration block releases from reservoirs during the summer reproductive season, seasonal dewatering, artificially depressed river flows, channelization, diminished habitat diversity, non-point pollution from agricultural sources, and range fragmentation. High-volume reservoir releases during the summer spawning season displace large numbers of eggs and larvae into unsuitable habitats (Dudley and Platania 2007; Hoagstrom et al. 2008). Forecasted warmer and drier climatic conditions (Agency Technical Workgroup 2005) threaten to exacerbate stress from habitat constriction. Although

the lower habitat reach (downstream of Roswell) experiences relatively better flows during dry periods, it supports an unbalanced age structure with few individuals in larger, adult size classes (Hoagstrom et al. 2008). However, a numerically small, but multiple-age class, population was found in the Pecos River just upstream of the deserted McMillan Reservoir in 2010.

Recommendations: Based on repetitive declines in abundance and anticipated increased threats to habitat due to drought and other factors (mainly river drying), no change in status is recommended. Multi-agency efforts to manage flows in the Pecos River to meet irrigation needs without imperiling surviving populations of Pecos bluntnose shiner should incorporate restoration or mimicry of natural flows. Permanent surface flows should be maintained throughout the currently occupied range of Pecos bluntnose shiner, and additional water acquisition options should be identified. Short-term, emergency actions such as rescue, salvage, and re-release of fish to the river following drying events should be considered to prevent extirpation of the species in the wild. The USFWS-directed restoration efforts on Bitter Lake National Wildlife Refuge should be emulated at other suitable locations in the lower Pecos River valley, especially on NMDGF lands (e.g., Huey Wildlife Area and Carr Farms). The potential to restore Pecos bluntnose shiner to formerly occupied habitat in the Pecos River upstream of Sumner Reservoir should be investigated. Strict enforcement of bait fish regulations should be followed throughout the Pecos River drainage.

Literature Cited:

- Agency Technical Workgroup. 2005. Potential effects of climate change on New Mexico. State of New Mexico. Davenport, S.R. 2018. Status and trends of Pecos bluntnose shiner report *Notropis simus pecosensis*, Pecos River New Mexico 2017. Report to United States Bureau of Reclamation, Albuquerque, NM.
- Davenport, S.R. 2012. Status and trends of Pecos bluntnose shiner report *Notropis simus pecosensis*, Pecos River New Mexico, Final Report. Report to United States Bureau of Reclamation, Albuquerque, NM.
- Davenport, S.R. 2006. Pecos bluntnose shiner status and trends report, Pecos River, New Mexico, October 2002 through August 2004. Report to U.S. Army Corps of Engineers (Albuquerque), U.S. Fish and Wildlife Service, New Mexico Fishery Resources Office, Albuquerque, NM.
- Dudley, R.K., and S.P. Platania. 2007. Flow regulation and fragmentation imperil pelagic-spawning riverine fishes. *Ecological Applications* 17:2074–2086.
- Fagan, W.F. 2005. Peer review of Pecos bluntnose shiner database and sampling protocol. Final report submitted to U.S. Fish and Wildlife Service, Albuquerque, NM.
- Hatch, M.D., W.H. Baltosser, and C.G. Schmitt. 1985. Life history and ecology of the bluntnose shiner (*Notropis simus pecosensis*) in the Pecos River, New Mexico. *The Southwestern Naturalist* 30:555-562.
- Hoagstrom, C.W., Brooks, J.E., and S.R. Davenport. 2008. Spatiotemporal population trends of *Notropis simus pecosensis* in relation to habitat conditions and the annual flow regime of the Pecos River, 1992-2005. *Copeia* 2008:1-12.
- Platania, S.P. 1995. Distribution, relative abundance, and conservation status of Pecos bluntnose shiner, *Notropis simus pecosensis*. New Mexico Department of Game and Fish, Santa Fe, NM. U.S. Fish and Wildlife Service. 1992. Pecos bluntnose shiner recovery plan. U.S. Fish and Wildlife Service, Albuquerque, NM.

THREATENED

Gila trout, *Oncorhynchus gilae*

Distribution: Historically, Gila trout inhabited cool and coldwater reaches of the Gila (including the San Francisco River) and Verde river drainages in southwest New Mexico and eastern and central Arizona (Miller, 1950; Minckley, 1973; Behnke, 1992; Behnke 2002). In New Mexico, Gila trout formerly occurred in the Gila River from its confluence with Mogollon Creek upstream through its headwaters and in tributaries of the San Francisco River (Propst et al., 1992). Although Gila trout historically inhabited a variety of stream habitats, it now occurs mainly in small headwater streams (Propst et al., 1992); in such streams availability of pool habitat appears to be critical to abundance (Rinne and Medina, 1988; Propst and Stefferud, 1997).

Current Status: Gila trout was listed as endangered by U.S. Fish and Wildlife Service in 1967, but was downlisted to threatened in 2006 (USFWS 2006). Gila trout was listed as endangered in 1975 by New Mexico and was downlisted to threatened in 1988. The Gila Trout Recovery Plan (USFWS 2003) provides detail on what must be accomplished for delisting the species. Gila trout populations were greatly impacted by the recent wildfires and multiple populations were eliminated by post-fire ash flows. In addition to eliminating Gila trout, recent fires have had impacts on streams with nonnative trout populations. Nonnative salmonids were eliminated in two streams, and Gila trout have been repatriated to both. Gila trout currently occupies 3 km of its historical Arizona range and currently occurs in about 120 km of stream in New Mexico. Abundance in occupied habitats is variable, ranging from fewer than 100 adults in the smallest to several thousand adults in the largest (Propst and Stefferud, 1997). Hybridization with rainbow trout, competition with nonnative salmonids, and population and habitat loss as a result of wildfire continue to be major threats to Gila trout. As a result of downlisting and adoption of an Endangered Species Act Section 4d rule that allows NMDGF to implement angling regulations, multiple streams are open to angling.

Threats: Hybridization of extant populations with nonnative rainbow, competition with nonnative salmonids, population and habitat loss as a result of wildfire, and habitat degradation are the primary threats to the species.

Recommendations: No change in listing status is recommended. Cooperative efforts with Arizona Game and Fish Department, U.S. Fish and Wildlife Service, and U.S. Forest Service to restore the species to its historical range should continue. Current efforts to remove nonnative salmonids from Whitewater Creek should be completed and the creek subsequently repatriated with Gila trout. In addition, removal of nonnative salmonids from the Upper West Fork Gila River drainage, and Turkey, Rain, and West Fork Mogollon creeks should be initiated. As soon as nonnative trout are completely removed from each stream, Gila trout should be repatriated. Because of limited distribution and abundance, all reasonable efforts should be undertaken to protect extant Gila trout populations from effects of wildfire and fire-induced ash flows. Stocking of nonnative salmonids in historical range of Gila trout should cease. As additional populations are established, each should be evaluated for sport fishing potential and, if appropriate, be opened to angling.

Literature Cited:

- Behnke, R.J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. American Fisheries Society, Bethesda, MD.
- Behnke, R.J. 2002. Trout and Salmon of North America. The Free Press, New York, NY.
- Miller, R.R. 1950. Notes on the cutthroat and rainbow trouts with the description of a new species from the Gila River, New Mexico. Occasional Papers of the Museum of Zoology, University of Michigan 529:1-42.
- Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, AZ.
- Propst, D.L. and J.A. Stefferud. 1997. Population dynamics of Gila trout in the Gila River drainage of the south-western United States. Journal of Fish Biology 51:1137-1154.
- Propst, D.L., J.A. Stefferud, and P.R. Turner. 1992. Conservation and status of Gila trout, *Oncorhynchus gilae*. The Southwestern Naturalist 37:117-125.
- Rinne, J.N. and A.L. Medina. 1988. Factors influencing salmonid populations in six headwater streams, central Arizona, USA. Polskie Archiwum Hydrobiologii 35:515-532.
- U.S. Fish and Wildlife Service. 2003. Gila (*Oncorhynchus gilae*) Trout Recovery Plan (third revision). Albuquerque, NM.
- U.S. Fish and Wildlife Service. 2007. Endangered and Threatened Wildlife and Plants; Reclassification of the Gila trout (*Oncorhynchus gilae*) from endangered to threatened; Special rule for Gila trout in New Mexico and Arizona. Federal Register 71: 40657-40674.

Mexican tetra, *Astyanax mexicanus*

Distribution: The native range of Mexican tetra extends from Gulf Coastal drainages of eastern and central Mexico northward to the Nueces River of Texas (Birkhead 1980). It occurs in the Rio Grande from its mouth upstream to the Big Bend region and in the Pecos River upstream to Dexter (Koster 1957; Sublette et al. 1990). Mexican tetra tends to be more common in low-velocity pool habitats in small streams and spring systems.

Current Status: Mexican tetra was state listed as threatened in New Mexico in 1976. It is locally common in small streams and springs along the Pecos River near Roswell and also at Blue Spring. Mexican tetra is rare in the mainstem Pecos River, Black River, and Delaware River (NMDGF files; T. Frey, BLM, personal communication).

Threats: Loss of habitat by groundwater mining, diversion of flows from small streams, and outbreaks of toxic golden algae appear to be the main threats to the species in New Mexico.

Recommendations: No change in listing status is recommended. Surveys to document the current distribution and status of the species in New Mexico should be undertaken. The causes of golden algae blooms in lower Pecos River system need to be determined and efforts made to preclude such conditions from occurring in the future. Bait-fish use regulations should be strictly enforced in the entire Pecos River drainage.

Literature Cited:

- Birkhead, W.S. 1980. *Astyanax mexicanus*, Mexican tetra (Filippi). P. 139. In D.S. Lee, C. R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. (eds.). Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh, NC.
- Koster, W.J. 1957. Guide to the fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.

Peppered chub, *Macrhybopsis tetranema*

Distribution: Peppered chub is native to the Arkansas River drainage of Arkansas, Colorado, Kansas, New Mexico, Oklahoma, and Texas (Wallace 1980). In New Mexico, it historically occurred in the Canadian River drainage downstream of the confluence of Ute Creek and in Ute Creek itself (Sublette et al. 1990; Pittenger and Schiffmiller 1997). Peppered chub are found mainly in shallow, permanently flowing plains streams in moderate-velocity habitats with clean sand and small gravel substrate (Miller and Robison 1973; Cross and Collins 1975).

Current Status: In New Mexico, peppered chub was listed as state threatened in 1978. As of 1999, the species had disappeared from approximately 90% of its historical range-wide distribution and believed to persist as only two geographically isolated populations (Luttrell et al. 1999). Peppered chub are now extirpated from Colorado and Oklahoma, and is either extirpated or has declined below detection in Kansas (Pennock et al. 2017). In New Mexico, peppered chub are currently restricted to just the Canadian River downstream of Ute Dam, where they are widely distributed at low densities (Dudley et al. 2012). NMDGF annual monitoring indicates a stable population in the Canadian River.

Threats: Habitat loss through water diversion, groundwater pumping, and regulated reservoir releases are the primary threats to the peppered chub.

Recommendations: No change in listing status is recommended. Permanent flows in Canadian River downstream of Ute Dam should be maintained, and these flows should minimally attempt to mimic a natural hydrograph. Efforts should be made to restore the species to its historical range upstream of Ute Reservoir. Regulations regarding use of bait fishes should be strictly enforced in the Canadian River basin.

Literature Cited:

- Cross, F.B. and J.T. Collins. 1975. Fishes in Kansas. Public Education Series No. 3, The University of Kansas Museum of Natural History, Lawrence, KS.
- Dudley, R.K., W.H. Brandenburg, M.A. Farrington, L.E. Renfro, S.P. Platania, and D.L. Propst. 2012. Distribution and conservation status of fishes in the South Canadian River drainage, New Mexico. Final report to the New Mexico Department of Game and Fish, Santa Fe, NM.
- Luttrell, G.R., A.A. Echelle, W.L. Fisher, and D. J. Eisenhour. 1999. Declining status of two species of the *Macrhybopsis aestivalis* complex (Teleostei: Cyprinidae) in the Arkansas River basin and related effects of reservoirs as barriers to dispersal. *Copeia* 1999:981-989.
- Miller, R.J. and H.W. Robison. 1973. The fishes of Oklahoma. Oklahoma State University Press, Stillwater, OK.
- Pennock, C.A., K.B. Gido, J.S. Perkin, V.D. Weaver, S.R. Davenport, and J.M. Caldwell. 2017.

- Collapsing range of an endemic Great Plains minnow, peppered chub *Macrhybopsis tetranema*. American Midland Naturalist 177:57-68.
- Pittenger, J.S. and G. Schiffmiller. 1997. Ichthyofaunal decline in Ute Creek, South Canadian River drainage, New Mexico. The Southwestern Naturalist 42:112-117.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.
- Wallace, R.K. 1980. *Hybopsis aestivalis* (Girard), speckled chub. P. 180. In D.S. Lee, C.R. Gilbert, C.H. Hocutt, R.E. Jenkins, D.E. McAllister, and J.R. Stauffer, Jr. (eds.). Atlas of North American freshwater fishes. North Carolina State Museum of Natural History, Raleigh, NC.

Suckermouth minnow, *Phenacobius mirabilis*

Distribution: Suckermouth minnow occurs throughout much of the central and lower Mississippi River system, including the Missouri and Ohio rivers drainages as well as tributary rivers to the Gulf of Mexico in Texas (Becker 1983; Hubbs et al. 1991). In New Mexico, the species' historical range includes only the Canadian and Dry Cimarron rivers (Sublette et al. 1990), although it has been introduced, probably via baitbucket, to the Pecos River near Fort Sumner (J.E. Brooks, U.S. Fish and Wildlife Service, personal communication). Suckermouth minnow most commonly occupies shallow, moderate-velocity runs over sand and pea gravel bottoms (Minckley 1959; Deacon 1961; Jenkins and Burkhead 1994).

Current Status: Suckermouth minnow was listed as state threatened in New Mexico in 1976. Although the species is apparently relatively common in the central portion of its range, it has declined considerably on the periphery of its range (Cross et al. 1985; T.P. Nesler, Colorado Parks and Wildlife, personal communication). In New Mexico, suckermouth minnow currently occupy the mainstem Canadian River above Conchas Reservoir and the lower Cimarron and Vermejo rivers, and populations in these reaches appear to be stable (Dudley et al. 2012). The species was not found during recent surveys in the Dry Cimarron River and may be extirpated (S.P. Platania, American Southwest Ichthyological Researchers, personal communication).

Threats: The primary threats to suckermouth minnow are probably excessive sedimentation of run habitats, habitat desiccation, and habitat fragmentation.

Recommendations: No change in listing status is recommended. Bait fish regulations should be strictly enforced in the Canadian River basin.

Literature Cited:

- Becker, G.C. 1983. Fishes of Wisconsin. The University of Wisconsin Press, Madison, WI.
- Cross, F.B., R.E. Moss, and J.T. Collins. 1985. Assessment of dewatering impacts on stream fisheries on the Arkansas and Cimarron rivers. University of Kansas Museum of Natural History, Lawrence, KS.
- Deacon, J.E. 1961. Fish populations following a drought, in the Neosho and Marias des Cygnes rivers of Kansas. University of Kansas Museum of Natural History Publications 13:359-427.
- Dudley, R.K., W.H. Brandenburg, M.A. Farrington, L.E. Renfro, S.P. Platania, and D.L. Propst. 2012. Distribution and conservation status of fishes in the South Canadian River drainage, New Mexico. Final Report to the New Mexico Department of Game and Fish, Santa Fe, NM.
- Hubbs, C., R.J. Edwards, and G.P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. The Texas Journal of Science 43:1-56.
- Jenkins, R.E., and N.M. Burkhead. 1994. Freshwater fishes of Virginia. American Fisheries Society, Bethesda, MD.
- Minckley, W.L. 1959. Fishes of the Big Blue River basin, Kansas. University of Kansas Museum of Natural History Publications 11:401-442.
- Platania, S.P., L.E. Renfro, W.H. Brandenburg, M.A. Farrington, and R.K. Dudley. 2006. Distribution and conservation status of fishes of the South Canadian River drainage, New Mexico. Share with Wildlife, New Mexico Department of Game and Fish, Santa Fe, NM.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.

Pecos pupfish, *Cyprinodon pecosensis*

Distribution: Pecos pupfish formerly occupied the Pecos River and associated floodplain habitats from Bitter Lake National Wildlife Refuge in New Mexico downstream to the confluence of Independence Creek in Texas (Echelle and Echelle 1978; Hoagstrom and Brooks 1999). The species is tolerant of saline conditions and is usually associated with low- to moderate-velocity run and pool habitats (including backwaters) in streams and floodplain gypsum sinkholes (Echelle and Echelle 1978; Hoagstrom and Brooks 1999; Hoagstrom 2009).

Current Status: Pecos pupfish was previously proposed for federal listing as endangered (USFWS 1994). However, the proposal was withdrawn and a conservation agreement for Pecos pupfish was adopted and implemented. The species was state-listed as threatened in 1988 in New Mexico. Strict baitfish regulations were adopted by the State Game Commission in 1998 and a public information brochure on these regulations was published and disseminated in 1999. Pecos pupfish has been eliminated from all of its Texas range except Salt Creek and artificial impoundments used for commercial rearing of shrimp (Wilde and Echelle 1992; Hoagstrom 2003; G.P. Garrett, TPWD, pers. comm.). Reintroduction efforts in 2017 resulted in an additional population established in the wild in Texas (Megan Bean, TPWD, pers. comm.). In New Mexico, it currently occurs in habitats on Bitter Lake National Wildlife Refuge, Bottomless Lakes State Park (Hoagstrom and Brooks 1999; Hoagstrom 2003) and the BLM Overflow Wetlands. It is irregularly found in the mainstem Pecos River (S.R. Davenport, USFWS FWCO, pers. comm.). A Monitoring Plan was developed and finalized in 2010 and monitoring of New Mexico populations began in 2011 (Pittenger 2010). Catch rates have fluctuated year to year but generally appear to be stable. Following a steep two-year decline at Figure Eight Lake, catch rates increased again in 2017 (Hatt 2017).

Threats: Nonnative sheepshead minnow, which hybridizes with Pecos pupfish, is the primary threat to the species. Sheepshead minnow was probably established in the Pecos River by bait introduction. This nonnative is largely responsible for the elimination of the species from much of its Texas range (Echelle and Conner 1989; Echelle et al. 2006) and has become established in the Pecos River of New Mexico downstream of Six Mile Reservoir (Echelle et al. 1997; Echelle and Echelle 2007). Hybridization in New Mexico occurs in Eddy County, but the populations in Chavez County (Bitter Lake National Wildlife Refuge, Bottomless Lakes State Park, BLM Overflow Wetlands) show no evidence of hybridization (Echelle et al. 2006; Echelle and Echelle 2007; Caldwell 2015). Currently much occupied Pecos pupfish habitat is threatened by golden alga *Prymnesium parvum*. Large-scale fish kills attributed to toxins produced by this alga have occurred in the Pecos River in New Mexico and Texas, and most recently (2002 through 2009) from Brantley Reservoir downstream into Texas (Rhodes and Hubbs 1992; Denny 2006; Barkoh and Fries 2010). Although no Pecos pupfish kills have been reported, fish kills in nearby habitats, including Cottonwood and Devil's Inkwell lakes at Bottomless Lakes State Park, have occurred (S. Denny, NMDGF, pers. comm.). Toxic golden alga blooms in occupied off-channel Pecos pupfish habitats would be detrimental to surviving populations. Modification of off-channel habitats, groundwater depletion, seasonal stream dewatering, and contaminants from oil and gas extraction activities also threaten the persistence of the species.

Recommendations: No change in listing status is recommended. Continuation of the Pecos Pupfish Conservation Agreement is necessary. A conservation plan should be developed and implemented. Baitfish regulations for Pecos River need to be rigorously enforced to prevent the further spread of sheepshead minnow and other nonnative fish species. Habitat restoration projects (e.g., fish barriers) that prevent the spread of sheepshead minnow should be considered. Monitoring of the spread of sheepshead minnow and hybridization with Pecos pupfish should continue. Effects of groundwater pumping on sinkhole habitats of Pecos pupfish need to be determined and evaluated. Proposed oil and gas development activities in vicinity of Pecos pupfish habitat should be carefully scrutinized and modified, if necessary, to avoid introduction of contaminants to occupied or potential Pecos pupfish habitats. Neither native nor nonnative sportfishes should be stocked in habitats supporting Pecos pupfish. Pecos pupfish should be established in suitable, secure habitats.

Literature Cited:

- Barkoh, A. and L.T. Fries. 2010. Aspects of the origins, ecology, and control of golden alga *Prymnesium parvum*: introduction to the featured collection. Journal of the American Water Resources Association. 46:1-5.
- Caldwell, J.M. 2015. Pecos Pupfish 2015 Monitoring Report. Report to Pecos Pupfish Conservation Team. New Mexico Department of Game and Fish, Santa Fe, NM.

- Denny, S. 2006. New Mexico Department of Game and Fish, Completion Report, F-69-R, submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Echelle, A.A. and P.J. Conner. 1989. Rapid, geographically extensive genetic introgression after secondary contact between two pupfish species (*Cyprinodon*, Cyprinodontidae). *Evolution* 43:717-727.
- Echelle, A.A. and A.F. Echelle. 1978. The Pecos River pupfish, *Cyprinodon pecosensis* n.sp. (Cyprinodontidae), with comments on its evolutionary origin. *Copeia* 1978:569-582.
- Echelle, A.A., A.F. Echelle, and N.L. Allan. 2006. Distribution and conservation of genetic variation in remnant populations of the Pecos pupfish (*Cyprinodon pecosensis*). Pp 47-61 *In* Ma. De L. Lozano-Vilano and A.J. Contreras-Balderas (eds.). *Studies of North American Desert Fishes in Honor of E.P. (Phil) Pister, Conservationist*. Universidad Autónoma de Nuevo León, Monterrey, NL.
- Echelle, A.A., C.W. Hoagstrom, A.F. Echelle, and J.E. Brooks. 1997. Expanded occurrence of genetically introgressed pupfish (Cyprinodontidae: *Cyprinodon pecosensis* x *variegatus*) in New Mexico. *The Southwestern Naturalist* 42:336-339.
- Echelle, A.F. and A.A. Echelle. 2007. Genetic status of Pecos pupfish populations in New Mexico. Final Report to the New Mexico Department of Game and Fish, Santa Fe, NM and U.S. Bureau of Land Management, Las Cruces, NM.
- Hatt, J.L. Pecos Pupfish 2017 Monitoring Report. Report to Pecos Pupfish Conservation Team. New Mexico Department of Game and Fish, Santa Fe, NM.
- Hoagstrom, C.W. 2003. Historical and recent fish fauna of the lower Pecos River. *Special Publications of the Museum of Texas Tech University* 46: 91-110
- Hoagstrom, C.W. 2009. Causes of impacts of salization in the lower Pecos River. *Great Plains Research* 19: 27-44.
- Hoagstrom C.W. and J.E. Brooks. 1999. Distribution, status, and conservation of the Pecos pupfish, *Cyprinodon pecosensis*. Technical Report No. 2, New Mexico Department of Game and Fish, Santa Fe, NM.
- Pittenger, J.S. 2010. Monitoring plan for Pecos pupfish (*Cyprinodon pecosensis*). Prepared by Blue Earth Ecological Consultants, Inc for New Mexico Department of Game and Fish, Santa Fe, NM.
- Rhodes, K. and C. Hubbs. 1992. Recovery of Pecos River fishes from a red tide fish kill. *The Southwestern Naturalist* 37:178-187.
- U.S. Fish and Wildlife Service. 1994. Endangered and Threatened Wildlife and Plants: Animal Candidate Review for Listing as Endangered or Threatened Species, Proposed Rule. *Federal Register* 59(219):58982-59028.
- Wilde, G.R. and A.A. Echelle. 1992. Genetic status of Pecos pupfish populations after establishment of a hybrid swarm involving an introduced congener. *Transactions of the American Fisheries Society* 121:277-286.

White Sands pupfish, *Cyprinodon tularosa*

Distribution: White Sands pupfish is endemic to the endorheic Tularosa Basin of south-central New Mexico (Miller and Echelle 1975). Although it was formerly believed to have naturally occurred in Mound Spring and possibly Lost River (Miller and Echelle 1975; Jester and Suminski 1982), it is only known to be native to Malpais Spring (and associated playa habitats) and Salt Creek (Pittenger and Springer 1999). Within occupied habitats, White Sands pupfish is common (Pittenger and Springer 1996; Carman 2004; Carman 2010).

Current Status: White Sands pupfish was originally state listed in 1975 as an endangered species in New Mexico before being downlisted to its current state status as threatened. White Sands pupfish occupies its entire, but limited, historical range in the Tularosa Basin. Additional populations were established in Mound Spring and Lost River, also in the Tularosa Basin (Pittenger and Springer 1999). A Cooperative Agreement for the Conservation of White Sands Pupfish (2006) provides for the protection and monitoring of its status. NMDGF, USFWS, White Sands Missile Range (WSMR), Holloman Air Force Base (HAFB), and White Sands National Monument are signatories to the agreement. Monitoring data collected under this Agreement indicate that the species is generally stable (Carman 2010). Catch-per-unit-effort of the Malpais Spring Middle Marsh site has been declining since 2006. However it is currently unknown if the decline is due to habitat changes (vegetation regrowth) resulting from the removal of wild horses. The White Sands Pupfish Conservation Plan (WSMR and HAFB 2015) was completed in 2015 and outlines conservation actions to be carried out over the course of the next several years, including salt cedar removal and the creation of Malpais Springs replicate populations.

Threats: Habitat loss through diminished discharge from springs and salt cedar encroachment, habitat degradation by military activities and weapons testing, and introduction of crayfish and nonnative fishes (particularly predators) are the primary threats to the species (WSMR and HAFB 2015). However, habitat degradation by military activities and weapons testing is addressed in the Cooperative Agreement. Previously, feral horses degraded habitats of White Sands pupfish, but these have been removed from White Sands Missile Range.

Recommendations: No change in listing status is recommended. Management activities under an updated Cooperative Agreement for the Conservation of White Sands pupfish should continue. The Malpais Spring population should be replicated and salt cedar removal should continue. Identification of potential reintroduction sites and establishment of new White Sands pupfish populations should consider the genetic makeup of the species within each evolutionary significant unit.

Literature Cited:

- Carman, S.M. 2004. Status of White Sands pupfish conservation. Abstract, Desert Fishes Council Annual Symposium, 11-15 November 2004, Tucson, AZ.
- Carman, S.M. 2010. White Sands pupfish status report. 2009. Prepared for the White Sands Pupfish Conservation Team. New Mexico Department of Game and Fish, Santa Fe, NM.
- New Mexico Department of Game and Fish. 2006. White Sands Pupfish Cooperative Agreement.. Santa Fe, NM.
- Jester, D.B. and R.R. Suminski. 1982. Age and growth, abundance, and biomass production of White Sands pupfish, *Cyprinodon tularosa* (Cyprinodontidae), in a desert pond. *The Southwestern Naturalist* 27:43-54.
- Miller, R.R. and A.A. Echelle. 1975. *Cyprinodon tularosa*, a new cyprinodontid fish from the Tularosa Basin, New Mexico. *The Southwestern Naturalist* 19:365-377.
- Pittenger, J.S. and C.L. Springer. 1996. White Sands pupfish status report: 1995. New Mexico Department of Game and Fish, Santa Fe, NM.
- Pittenger, J.S. and C.L. Springer. 1999. Native range and conservation of White Sands pupfish (*Cyprinodon tularosa*). *The Southwestern Naturalist* 44:157-165.
- White Sands Missile Range and Holloman Airforce Base. 2015. White Sands pupfish conservation plan. Prepared for White Sands Missile Range and Holloman Airforce Base by Blue Earth Ecological Consultants, Inc., Santa Fe, NM.

Gila topminnow, *Poeciliopsis occidentalis occidentalis*

Distribution: Gila topminnow historically was one of the most common and widespread fishes in lower elevation streams of the Gila River drainage in Arizona (Hubbs and Miller, 1941; Minckley, 1973; Minckley and Marsh, 2010). The only documented historical location of Gila topminnow in New Mexico was a series of stenothermal warm springs along the San Francisco River near Pleasanton (Koster, 1957), but it is likely the species occurred elsewhere in suitable habitats in and along the Gila and San Francisco rivers. Gila topminnow typically occupied vegetated shoreline habitats of streams where water velocities were slow, springs, and spring runs (Minckley et al., 1977).

Current Status: Gila topminnow was federally listed as endangered in 1967. It was state-listed as a threatened species in New Mexico in 1990. Gila topminnow has been eliminated from almost all of its historical range. It currently persists at several scattered locations in Arizona, and the security of these is variable (Weedman and Young, 1997). The New Mexico San Francisco River population was eliminated by drought or floods during the 1950s. In 1989, Gila topminnow was stocked in a pond on the NMDGF Red Rock Wildlife Management Area. That effort was not successful. Gila topminnow was again stocked in Red Rock Wildlife Management Area pond in 2005. That population persisted for nearly a year but aquatic vegetation overtook the pond in late summer 2006 and no fish have been collected since. In cooperation with U.S. Fish and Wildlife Service, NMDGF restored cienega habitats on Red Rock Wildlife Management Area to benefit Gila topminnow. Gila topminnow from Bylas Springs, Arizona, were stocked in 2010 and additional fish from Bubbling Ponds Hatchery, Arizona, were used to augment the population in 2011. The fish have not persisted. In 2008 NMDGF and a private landowner established a population of Gila topminnow in a cienega restored by the landowner. The population has persisted through high and low flows.

Threats: Habitat loss by groundwater mining, stream channelization, stream desiccation, removal of shoreline vegetation, and nonnative western mosquitofish (*Gambusia affinis*) and other nonnative predators, are the primary threats to Gila topminnow.

Recommendations: No change in listing status is recommended. Other suitable sites for repatriation of the species should be located.

Literature Cited:

- Hubbs, C.L. and R.R. Miller. 1941. Studies of the fishes of the order Cyprinodontes. XVII. Genera and species of the Colorado River system. Occasional Papers of the Museum of Zoology, University of Michigan 433:1-9.
- Koster, W.J. 1957. Guide to the fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.
- Minckley, W.L. 1973. Fishes of Arizona. Arizona Game and Fish Department, Phoenix, AZ.
- Minckley, W.L., and P.C. Marsh. 2009. Inland Fishes of the Greater Southwest: Chronicle of a Vanishing Biota. University of Arizona Press, Tucson.
- Minckley, W.L., J.N. Rinne, and J.E. Johnson. 1977. Status of the Gila topminnow and its co-occurrence with mosquitofish. USDA Forest Service Research Paper RM-198. USDA Forest Service Mountain Forest and Range Experiment Station, Fort Collins, CO.
- Weedman, D.A. and K.L. Young. 1997. Status of the Gila topminnow and desert pupfish in Arizona. Nongame and Endangered Wildlife Program Technical Report 118. Arizona Game and Fish Department, Phoenix, AZ.

Greenthroat darter, *Etheostoma lepidum*

Distribution: Greenthroat darter occurs in two disjunct areas: the Edwards Plateau of south-central Texas and the lower Pecos River drainage of New Mexico (Echelle et al. 1984). In New Mexico, the species occurred in mainstream and tributary habitats in the Pecos River valley from Bitter Lake National Wildlife Refuge (BLNWR) downstream to the Texas/New Mexico border (Sublette et al. 1990). Greenthroat darter is found mainly in small stream and spring habitats having clear water, dense aquatic vegetation, and clean gravel and cobble substrates (Page 1983).

Current Status: Greenthroat darter was state listed as threatened in New Mexico in 1975. Although the species remains relatively common in preferred habitats in Texas, its overall range there has declined (Anderson et al. 1995). In New Mexico, greenthroat darter persists primarily in three separate areas: Blue Spring, Rattlesnake Spring, and some springs, spring runs, and impoundments on the middle tract of the BLNWR. The Rattlesnake Spring population was established in the late 1980s as a joint effort of the National Park Service, U.S. Fish and Wildlife Service, and NMDGF, and sampling in 2007 indicated persistence of this population. The species was captured at one of three sampled sites on the BLNWR in 2007 (USFWS, unpublished report). Additionally, greenthroat darters are regularly captured during annual Pecos pupfish monitoring in the Unit 5 spring ditch on the BLNWR (NMDGF files).

Threats: Pumping that lowers groundwater levels, diversion of spring runs, and elevated sediments are the primary threats to greenthroat darter.

Recommendations: No change in listing status is recommended. Systematic surveys to document current status of the species in New Mexico should be completed. The life history of this species in New Mexico needs documentation.

Literature Cited:

- Anderson, A.A., C. Hubbs, K.O. Winemiller, and R.J. Edwards. 1995. Texas freshwater fish assemblages following three decades of environmental change. The Southwestern Naturalist 40:314-321.
- Echelle, A.F., A.A. Echelle, and C. Hubbs. 1984. Systematic review of the percid fish, *Etheostoma lepidum*. Pp. 243-255. In R.A. Seigel, L.E. Hunt, J.L. Knight, L. Malaret, and N.L. Zuschlag (eds.). Vertebrate ecology and systematics, a tribute to Henry S. Fitch. Museum of Natural History, The University of Kansas, Lawrence, KS.
- Page, L.M. 1983. Handbook of darters. TFH Publications Inc., Neptune City, NJ.

Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.

Bigscale logperch, *Percina macrolepida*

Distribution: The historical range of bigscale logperch consisted of Texas Gulf Coastal drainages, the Red River of Texas and Oklahoma, and the Pecos River of Texas and New Mexico (Kuehne and Barbour 1983). In New Mexico, the native range of the species was the Pecos River from the vicinity of Santa Rosa to Fort Sumner, the Pecos River near Carlsbad, and the Black River (Sublette et al. 1990). Bigscale logperch are most commonly found in fast-flowing, non-turbulent, moderately deep water with large cobble substrata (Stevenson 1971).

Current status: Bigscale logperch was state listed as threatened in New Mexico in 1975. The species likely occupies much of its historical New Mexico range, but its abundance has apparently declined. It also inhabits Santa Rosa, Sumner, and Brantley reservoirs and has been introduced (probably via baitbucket transfer) to Ute Reservoir on the Canadian River (the Canadian population is not protected). In 2007 and 2008, the species was collected primarily at the Black River sites and from nearshore habitats in Santa Rosa and Sumner Reservoirs; only one individual was captured from the mainstem Pecos River downstream of Fort Sumner (Archdeacon and Davenport 2010). Bigscale logperch are collected in low densities from the mainstem Pecos River between Fort Sumner and Brantley during annual monitoring efforts for Pecos bluntnose shiner (NMDGF and USFWS files).

Threats: Reduced flows, loss of moderate- to high-velocity reaches by diversion, and reduced water quality are probably the primary threats to bigscale logperch. Toxic blooms of golden algae threaten populations downstream of Brantley Lake in the Pecos River.

Recommendations: No change in listing status is recommended. Systematic surveys to document current status of the species in New Mexico should be completed. The life history of this species in New Mexico needs documentation.

Literature Cited:

- Archdeacon, T.P. and S.R. Davenport. 2010. Occupancy estimation of bigscale logperch in the Pecos River, New Mexico. Submitted to the New Mexico Department of Game and Fish Share with Wildlife Project, Santa Fe, NM.
- Kuehne, R.A. and R.W. Barbour. 1983. The American Darters. The University of Kentucky Press, Lexington, KY.
- Stevenson, M.M. 1971. *Percina macrolepida* (Pisces, Percidae, Etheostominae), a new percid fish of the subgenus *Percina* from Texas. The Southwestern Naturalist 16:65-93.
- Sublette, J.E., M.D. Hatch, and M. Sublette. 1990. The Fishes of New Mexico. The University of New Mexico Press, Albuquerque, NM.

INVERTEBRATES

CRUSTACEA

ENDANGERED

Socorro isopod, *Thermosphaeroma thermophilum*

Distribution: The Socorro isopod is endemic to a small thermal spring located southwest of Socorro, New Mexico (Richardson 1897, Shuster 1981). A captive population exists at the Socorro Isopod Propagation Facility (SIPF) near Socorro, and a refuge population is maintained at the Albuquerque Aquarium.

Current Status: The Socorro isopod was listed as a state (NMDGF Reg. 563) and federal (USFWS 1982) endangered species in 1978. In August 1988, *T. thermophilum* was extirpated in the wild when diminished

discharge of the native spring resulted in habitat desiccation. Spring flow was reestablished in September 1988, which likely flushed isopods from the underground plumbing system into the native spring. The native population was augmented a month later from a captive population housed at the Department of Biology, University of New Mexico. This near extinction event prompted resource agencies to build the Socorro Isopod Propagation Facility (SIPF) near the native habitat. Construction of this facility (1990) expanded the total area occupied by the Socorro isopod which provided opportunity for captive propagation, genetic, and life history studies (Lang et al. 2006, Shuster et al. 2005). Population and habitat monitoring at the native spring and SIPF has occurred monthly since November 1994. Native and captive populations are stable. Recent efforts at the SIPF to increase vertical habitat structure has increased isopod abundance by nearly two-fold than in previous years of monitoring this facility. The isopod population at the native spring remains stable.

Threats: Primary threats include habitat vandalism, modification of spring flows, and potential disruption of thermal ground water discharge from aquifer pumping and surface/sub-surface explosive tests on lands situated west of the Socorro and Magdalena mountains (Lang 2001). Aquatic invasive species pose a threat to all native aquatic biota and ecosystems in New Mexico (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF is actively implementing conservation activities detailed in the federal recovery plan (USFWS 1982), which identifies goals and actions to achieve recovery and delisting of the species. Conservation efforts are coordinated with the U. S. Fish and Wildlife Service, Albuquerque Biological Park, and the private land owner.

Literature Cited:

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Lang, B. K. 2001. New Mexico endangered invertebrates: monitoring and management. New Mexico Department of Game and Fish, Completion Report E-37 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K., D. A. Kelt, and S. M. Shuster. 2006. The role of controlled propagation on an endangered species: demographic effects of habitat heterogeneity among captive and native populations of the Socorro isopod (Crustacea: Flabellifera). *Biodiversity and Conservation* 15:3909-3935.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Shuster, S. M. 1981. Life history characteristics of *Thermosphaeroma thermophilum*, the Socorro isopod (Crustacea: Peracarida). *Biological Bulletin*. 161:291-302.
- Shuster, S. M., M. P. Miller, B. K. Lang, N. Zorich, L. Huynh, and P. Keim. 2005. The effects of controlled propagation on an endangered species: genetic differentiation and divergence in body size among native and captive populations of the Socorro isopod (Crustacea: Flabellifera). *Conservation Genetics* 6:355-368.
- Richardson, H. 1897. Description of a new crustacean of the genus *Sphaeroma* from a warm spring in New Mexico. *Proceedings of the U. S. National Museum* 20:465-466.
- United States Fish and Wildlife Service. 1982. Recovery plan for the Socorro isopod (*Thermosphaeroma thermophilum*). 13 pp.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Noel's amphipod, *Gammarus desperatus*

Distribution: Historically, Noel (1954) and Cole (1981, 1985, 1988a, 1988b) reported this amphipod from three Chaves County sites near Roswell: Lander Springbrook, North Spring (type locality), and Bitter Lake National Wildlife Refuge (BLNWR). Noel's amphipod currently occurs on BLNWR (Bitter Creek, Sago Spring, Unit 6 and 7 spring-ditch, Hunter Marsh, Lower Tract ["Farm"], and Rio Hondo) and on municipal land adjacent to Hunter Marsh (USFWS 2005; Lang 2007, 2010).

Current Status: The Lander Springbrook population was extirpated during the period 1951-1957, whereas loss of the North Spring population occurred during the period 1978-1988 (Cole 1981, 1985, 1988a, 1988b). Extirpation at the type locality prompted the 1990 uplisting from state threatened to endangered under NMDGF Regulation 682. Gammarid amphipods are apparently extirpated from North Spring (Mehlhop 1992, 1993; Lang 2005). Populations on BLNWR have been monitored routinely since 1995. NMDGF (2005) implemented a conservation plan for four state-listed macroinvertebrate species of Chaves County, including *G. desperatus*. The USFWS (2005) listed this species as endangered under the Endangered Species Act. A federal recovery plan is currently being developed and will likely be published in 2016. Acquisition of federal water rights for BLNWR (USDJ 1996, Balleau Groundwater, Inc. 1997) may serve to impart habitat protection for this species. Genetic studies imply the presence of cryptic species of gammarid amphipods on BLNWR (i.e., Hunter Marsh; Gervasio et al. 2004; Seidel et al., 2009; Moore 2012). Deposition of post-fire ash, laden with polycyclic aromatic hydrocarbons resulting from the March 2000 Sandhill Fire at BLNWR, may account for the overall decline of macroinvertebrate populations observed in Bitter Creek at Dragonfly Spring; especially affected was Noel's amphipod (Lang 2005, 2008). Morphologic and genetic studies are ongoing to assess intra- and inter-specific relationships among amphipods of the *Gammarus pecos* species complex (Lang 2008). Monitoring of the Rio Hondo population (lower tract of BLNWR) and the Middle Tract populations is ongoing. In 2015, restoration of the Rio Hondo occurred on the lower tract of BLNWR. An earthen berm was used to redirect the Rio Hondo into its historic channel, allowing the ditch the river previously occupied to be filled only with groundwater produced by naturally occurring spring vents. A backflow preventer was installed at the downstream terminus of the ditch to prevent effluent water from filling the ditch during periods of high flows. The hydrology of the springs is being monitored by the USFWS and monitoring of *G. desperatus* population is conducted seasonally in the restored channel.

Threats: The specific epithet, *desperatus*, refers to what Cole (1981) considered an imperiled situation for the species: the progressive loss of isolated gammarid populations in Chaves County, New Mexico, between 1951-1988 (Cole 1985, 1988a, 1988b). Cole attributed these extirpations to regional ground water depletion and habitat alterations (e.g., artesian spring source diversion, dewatering, capping). Similar factors likely affected localized gammarid populations in west Texas (Lang et al., 2003). While populations of *G. desperatus* are stable under current refuge management plans (Research Management Consultants, Inc. 1998), off-refuge land use practices (e.g., ground water pumping) within areas of the Roswell Artesian Basin (Basin) pose threats to the long-term viability of populations at BLNWR. Regional ground water pumping for agriculture, municipal water supplies, and oil and gas industry operations continue in the Basin (BLM 1994, USFWS 1997). Any increases in ground water extraction similar to aquifer drawdown levels that occurred in the Basin from the 1950's to 1970's could lead to habitat impacts on BLNWR. Oil and gas development is ongoing within areas of the Basin that Balleau Groundwater, Inc. (1996, 1999) identified as primary ground water source-zones for surface waters at BLNWR. In New Mexico, such extractive processes and industry operations can result in aquifer drawdown, alter aquitard hydraulics, and contaminate ground and surface waters (Hennighausen 1969; Jercinovic 1982, 1984; Longmire 1983; Quarles 1983; Boyer 1986; Richard 1988a, 1988b; Rail 1989; Richard and Boehm 1989a, 1989b; Balleau Groundwater, Inc. 1996; Martinez et al. 1998). Amphipod crustaceans are acutely sensitive to ground and surface water contaminants (Eisler 1987; Green and Trett 1989; Pennak 1989; Covich and Thorpe 1991). There is increased risk of degradation of ground and surface water quality posed by septic discharge from urban encroachment in aquifer recharge-discharge areas along the western bounds of BLNWR (USFWS 2005). Illicit dumping of domestic contaminants (e.g., trash, pesticides, herbicides, waste oil, etc.) in sinkholes is known to contaminate ground water resources in karst areas of the United States (White et al. 1995; Zokaites 1997) and in New Mexico (Bitner and Graves 1992; McQuillan et al. 1989). Natural stochastic events, such as fire or drought, could adversely impact extant *G. desperatus* populations at BLNWR. In the short-term, Noel's amphipod is threatened by impoverished aquatic conditions following the March 2000 Sandhill Fire which severely burned reaches of Bitter Creek formerly inhabited by *G. desperatus* (Lang 2002, 2005, 2008; Lang et al. 2003). The long-term impact of these effects, whether adverse or beneficial, on the aquatic biota and riparian corridor of Bitter Creek remain undetermined. Prolonged drought may affect hydrologic conditions on BLNWR by reducing discharge through refuge surface waters while concomitantly increasing salinity and concentrating contaminants. Aquatic invasive species represent a threat to native wildlife and habitats statewide (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Chemical management of aggressive growth of salt grass (*Phragmites australis*) post Sandhill Fire (2005) along Bitter Creek BLNWR has prompted NMDGF to work in collaboration with the USFS to monitor management effects on macroinvertebrates. NMDGF is also working with BLNWR to monitor macroinvertebrates along Rio

Hondo (i.e., lower tract of the refuge) where management plan are to divert flow upstream in the Rio Hondo where state/federal listed macroinvertebrates occur.

Recovery Plan Status: The recovery plan for the four invertebrates species was approved by the Commission in 2005. Monthly and annual population monitoring has occurred since 1995. Under the recovery plan, agency actions accomplished/ongoing include:

1. Genetic assay of amphipods on the Refuge where cryptic speciation has been previously reported;
2. Captive propagation research for springsnails;
3. Genetic assay of springsnails to determine best strategies for reintroduction of snails to rehabilitated native habitat or to newly created habitat on the Refuge;
4. Section 7 consultation for riparian habitat restoration of critical habitat for these species;
5. Inter-agency collaboration to develop a monitoring program for Pecos assiminea; and
6. Reconnaissance surveys to further document the distribution of these species on the Refuge.

No revision to the plan is called for at this time.

A federal recovery plan was published in 2018. The Department provided comments to the draft plan, and publication of the final plan is expected in late 2018 or 2019.

Recommendations: No change in listing status is recommended. In collaboration with the U. S. Fish and Wildlife Service, NMDGF should continue to monitor post-fire effects on the aquatic macroinvertebrates and riparian corridor of Bitter Creek. NMDGF and cooperators should continue implementing strategies of the state conservation plan to alleviate threats and achieve recovery of this species.

Literature Cited:

- Balleau Groundwater, Inc. 1996. Interrelation of groundwater and surface water at Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 16 pp. (with addenda).
- Balleau Groundwater, Inc. 1997. Annotated abstract of water-rights administration Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 22 pp. (with addenda).
- Balleau Groundwater, Inc. 1999. Source-water protection zones for Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 42 pp.
- Bitner, M. J. and T. Graves. 1992. Effect of lot sizes on potential ground-water contaminants from conventional septic-tank systems: numerical modeling. Policy Coordinating Committee. 47 pp.
- Boyer, D. G. 1986. Differences in produced water contaminants from oil and gas operations in New Mexico - implications for regulatory action. Pp. 291-316, *In Proceedings of the Conference on Southwestern Ground Water Issues* (National Water Well Association, Publisher).
- Bureau of Land Management. 1994. Draft resource management plan/environmental impact statement for the Roswell Resource Area, Roswell, New Mexico, and draft resource management plan amendment/environmental impact statement for the Carlsbad Resource Area, Carlsbad, New Mexico. Bureau of Land Management, Roswell, NM.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Cole, G. A. 1981. *Gammarus desperatus*, a new species from New Mexico (Crustacea: Amphipoda). *Hydrobiologia* 76:27-32.
- Cole, G. A. 1985. Analysis of the *Gammarus*-pecos complex (Crustacea: Amphipoda) in and New Mexico, USA. *Journal of the Arizona-Nevada Academy of Science* 20:93-103.
- Cole, G. A. 1988a. Noel's amphipod (*Gammarus desperatus*). Final Report submitted to the New Mexico Department of Game and Fish Endangered Species Program under Professional Service Contract 519-77-02. 6 pp.
- Cole, G. A. 1988b. A report on the status of Amphipoda, including *Gammarus desperatus* in New Mexico. Submitted to the New Mexico Department of Game and Fish Endangered Species Program under Professional Service Contract 519-77-02. 15 pp.
- Covich, A. P. and J. H. Thorp. 1991. Crustacea: introduction and Peracarida. Pp. 665-689, *In Ecology and Classification of North American Freshwater Invertebrates*, James H. Thorp and Alan P. Covich, eds. Academic Press, 911 pp.
- Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a syntopic review. U.S. Fish and Wildlife Service. Contaminant Hazard Reviews Report No. 11, Biological Report 85 (1.11).

- Gervasio, V., D. J. Berg, B. K. Lang, N. Allan, and S. I. Guttman. 2004. Genetic structure of the *Gammarus pecos* species complex (Crustacea: Amphipoda) in Chihuahuan Desert springs. *Limnology and Oceanography* 49(2):520-531.
- Green, J. and M. W. Trett. 1989. *The fate and effects of oil in freshwater*. Elsevier Science Publishing Co., Inc., New York.
- Havlik, M. E. and L. L. Marking. 1987. Effects of contaminants on naiad mollusks (Unionidae): a review. U. S. Fish and Wildlife Service, Resource Publication 164.
- Hennighausen, F. H. 1969. Meters and their effects in the Roswell Artesian Basin in Chaves and Eddy counties, New Mexico. Pp. 29-33, *In* 14th Annual New Mexico Water Conference (Water Resources Institute).
- Jercinovic, D. E. 1982. Assessment of refined petroleum-product contamination problems in surface and ground waters of New Mexico. Water Pollution Control Bureau, New Mexico Environmental Improvement Division, EID/WPC-82/5.
- Jercinovic, D. E. 1984. Petroleum-product contamination of soil and water in New Mexico. New Mexico Environmental Improvement Division, EID/GWH84/2.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. NMDGF Completion Report E-20 (5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2005. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Completion Report E-56-(1-3) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2007. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Annual Report E-56-4 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2008. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Annual Report E-56-5 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2010. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2011. Aquatic mollusks of New Mexico. NMDGF Performance Report E-66-R-1 submitted to the Division of Federal Aid, U. Service, Albuquerque, NM.
- Lang, B. K., V. Gervasio, D. J. Berg, S. I. Guttman, N. L. Allan, M. E. Gordon, and G. Warrick. 2003. Gammarid amphipods of northern Chihuahuan Desert spring systems: an imperiled fauna. Pp. 47-57, *In* Aquatic Fauna of the Northern Chihuahuan Desert, G. P. Garrett and N. L. Allan, Eds. Museum of Texas Tech University, Special Publications Series, Number 46. Lubbock, TX.
- Longmire, P. A. 1983. Petroleum-product contamination of ground and surface water: a literature review. Ground Water Section, Water Pollution Control Bureau, New Mexico Environmental Improvement Division. EID/WPC-83/7.
- Martinez, J. D., K. S. Johnson, and J. T. Neal. 1998. Sinkholes in evaporite rocks. *American Scientist* 86:38-51.
- McQuillan, D. M., M. J. Jasper, and B. H. Swanson. 1989. Ground-water contamination by septic-tank use: a field study in the Albuquerque south Valley - West Mesa Region, Bernalillo County, New Mexico. New Mexico Health and Environment Department, Environmental Improvement Division, Ground Water Bureau.
- Mehlhop, P. 1992. Establishment of a rare mollusc inventory and monitoring program for New Mexico. Progress Report. NMDGF Professional Services Contract 80-519-52.
- Mehlhop, P. 1993. Establishment of a rare mollusc inventory and monitoring program for New Mexico. Year II Progress Report. NMDGF Professional Services Contract No. 80-519-52-Amendment 1.
- Moore, J. N. 2012. Final report to New Mexico Department of Game and Fish for Professional Services Contract 11-516-0000-0023.
- New Mexico Department of Game and Fish. 2005. Recovery and conservation plan for four invertebrate species: Noel's amphipod (*Gammarus desperatus*), Pecos assimineia (*Assimineia pecos*), Koster's springsnail (*Juturnia kosteri*), and Roswell springsnail (*Pyrgulopsis roswellensis*). 80 pp.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Noel, M. 1954. Animal ecology of a New Mexico springbrook. *Hydrobiologia* 6:120-135.
- Pennak, R. W. 1989. *Fresh-water invertebrates of the United States: Protozoa to Mollusca*. 3rd ed. John Wiley & Sons, Inc. 628pp.
- Quarles, J. 1983. *Groundwater contamination in the United States*. University of Pennsylvania Press, Philadelphia.
- Rail, C. D. 1989. *Groundwater contamination: sources, control, and preventative measures*. Technomic Publishing Company, Inc. Lancaster, PA.
- Research Management Consultants, Inc. 1998. Final comprehensive conservation plan and environmental assessment: Bitter Lake National Wildlife Refuge.

- Richard, M. 1988a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: review of the geohydrology in the vicinity of Rattlesnake Springs and the contamination problem. Report 1. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. 1988b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the first field investigation, August 1988. Report 2. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the second field investigation, March, 1988. Report 3. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: final summary of the investigation. Report 4. National Park Service Contract RFQ 7029-8-0025.
- Seidel, R. A., B. K. Lang, and D. J. Berg. 2009. Phylogeographic analysis reveals multiple cryptic species of amphipods (Crustacea: Amphipoda) in Chihuahuan Desert springs. *Biological Conservation* 142:2303-2313.
- United States Department of Justice. 1996. United States of America's statement of claim for reserved surface water and groundwater rights for Bitter Lake National Wildlife Refuge. Roswell Basin Section, RAB 923 and 1793, Denver.
- United States Fish and Wildlife Service. 1997. Biological opinion on the Roswell Resource Area Resource Management Plans. Section 7 Consultation #2-22-96-102.
- United States Fish and Wildlife Service. 2005. Endangered and Threatened Wildlife and Plants; Listing Roswell springsnail, Koster's tryonia, Pecos Assiminea, and Noel's Amphipod as Endangered with Critical Habitat; Final Rule. *Federal Register* 70(152):46303-46333.
- White, B. W., D. C. Culver, J. S. Herman, T. C. Kane, and J. E. Mylroie. 1995. Karst lands: the dissolution of carbonate rock produces unique landscapes and poses significant hydrological and environmental concerns. *American Scientist* 83:450-459.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.
- Zokaites, C. 1997. Living on karst: a reference guide for landowners in limestone regions. Cave Conservancy of the Virginias. 25 pp.

MOLLUSCA

BIVALVIA

ENDANGERED

Paper pondshell, *Utterbackia imbecillis*

Distribution: The paper pondshell is one of the most widely distributed freshwater mussels in North America (Taylor 1983; Williams et al. 1993; Howells et al. 1996), occurring in reservoirs, lakes, rivers, and streams (Gordon and Layzer 1989). An extant population in New Mexico was documented by shells from Conchas Lake, San Miguel County (Taylor 1983); hundreds of miles from the nearest known occurrences in adjacent states (Howells et al. 1996) and northern México (Río Conchos; Johnson 1999). Lang and Mehlhop (1996) documented only one fresh valve of an immature paper pondshell from Ute Creek near Ute Reservoir, Harding County. While this record represents an eastward range extension in New Mexico, the species was not found in Conchas Lake, as reported by Taylor (1983).

Current Status: The paper pondshell was listed as state endangered in 1983 (NMDGF Reg. 624). Historic populations in the Conchas River (i.e., Variadero, San Miguel Co., NM), are apparently extirpated (Lang and Mehlhop 1996), and may represent the source of the Conchas Lake population (Taylor 1983). This mussel has many larval fish hosts, and consequently has been introduced to impounded waters throughout the United States by fish stocking and bait bucket introductions (Howells et al. 1996). In 2007, several live *U. imbecillis* were collected from the middle Rio Grande near Rio Rancho, Sandoval Co., NM (NMDGF files); thus representing an introduction beyond native range. The North American genus *Anodonta* is taxonomically complex (subgenera include:

Anodonta, *Pyganodon*, and *Utterbackia*) with many outstanding questions regarding the phylogenetic status of putative species (Hoeh 1993). Human-mediated dispersal poses questions regarding the exact origin and native status of this species in the lower Canadian River drainage of New Mexico.

Threats: Holocene climate change and habitat modification (stream channelization, dewatering, poor watershed management, and manipulation of natural flows) was likely responsible for loss of native riverine populations (Lang and Mehlhop 1996). Contaminants and the potential for introduction of aquatic invasive species (e.g., Zebra and/or Quagga mussels) represent threats to populations of paper pondshell in Canadian River mainstem impoundments (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005, Burgmer et al. 2007).

Recommendations: No change recommended in listing status. Surveys should be undertaken to document current status of the species in New Mexico. State and federal agencies should take preventative measures to prevent the introduction of Zebra and/or Quagga mussels and other aquatic invasive species to New Mexico's surface waters.

Literature Cited:

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Gordon, M. E. and J. B. Layzer. 1989. Mussels (Bivalvia: Unionidae) of the Cumberland River: review of life histories and ecological relationships. U. S. Fish and Wildlife Service, Biological Report 89 (15).
- Hoeh, W. R. 1993. Phylogenetic relationships among eastern North American *Anodonta* (Bivalvia: Unionidae). *Malacological Review* 23:63-82.
- Howells, R. G., R. W. Neck, and H. D. Murray. 1996. Freshwater mussels of Texas. Texas Parks and Wildlife Department, Austin.
- Johnson, R. I. 1999. Unionidae of the Rio Grande (Rio Bravo del Norte) system of Texas and Mexico. Museum of Comparative Zoology, Harvard University, Occasional Papers on Mollusks 6(77):1-65.
- Lang, B. K. and P. Mehlhop. 1996. Distribution of freshwater mussels (Unionidae) of the Canadian River drainage: New Mexico and Texas. Segment I: Survey of freshwater bivalve mollusks of the Canadian River, New Mexico. National Biological Service, State Partnership Program, Final Report, 39 pp.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Williams, J. E., M. L. Warren, Jr., K. S. Cummings, J. L. Harris, and R. J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. *Fisheries* 18(9):6-22.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P. Van Vuuren. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Texas hornshell, *Popenaias popeii*

Distribution: Texas hornshell is known from Western Gulf and Mexican Gulf coastal drainages of the Rio Grande Basin south to the northern state of Vera Cruz, México (Johnson 1999). In the United States, this mussel occurred in the Rio Grande drainage from North Spring River (Roswell, Chaves County; Cockerell 1902), throughout the lower Pecos River and Rio Grande, downstream to Brownsville, Cameron County, Texas (Metcalf 1982; Neck and Metcalf 1988; Howells et al. 1996). *Popenaias popeii* has declined notably throughout the United States. In New Mexico, this species currently occupies about 12% of its historic range, where an extant population is confined to a 14 km reach of the Black River, Eddy County (Lang 2001). In Texas, *P. popeii* is now known from three extant populations (Howells 2004; Strenth et al. 2004; Burlakova and Karatayev 2010): Rio Grande near Laredo (Webb County), Rio Grande below Big Bend National Park (near John's Marina), and Devils River (Val Verde County).

Current Status: The sporadic occurrence of *P. popeii* in Texas led Strecker (1931) to regard this species as "scarce." The dearth of information in historic and contemporaneous collection records prompted listing this mussel in New Mexico as endangered in 1983. The American Fisheries Society regarded this species as threatened (Williams et al., 1993). Texas hornshell is a candidate for listing (priority 8) under the Endangered Species Act (USFWS 2008). The NMDGF implemented a recovery plan for this species (Carman 2007). Research has focused

on the distribution and abundance, population trends, habitat affinities, life history, reproductive periodicity, salinity tolerances, and genetics of the Black River population (Lang 2001, 2009; Smith 2003; Hoeh 2009; Levine 2009,). Genetic research (Hoeh 2009, Inoue et. al. 2012) showed low levels of mtDNA (*COI*) divergence among New Mexico and Texas populations. Ongoing conservation efforts (Lang 2011) include: population monitoring, habitat studies, , propagation techniques, early life history research (reproductive ecology), molecular genetic study, riparian habitat restoration (erosion control, fencing), and reintroduction to native range in the Delaware River, Eddy County. Recent survey completed in 2013 show that total population size and abundance in NM is 48,006 individuals (density among habitat types: 172 – 326 mussels/ m²; Inoue et. al., 2014).

A total of 44 Texas hornshell were reintroduced to the Delaware River (historic native habitat) in May 2013. The habitat that the 44 individuals were relocated to in 2013 was destroyed in a flood in 2014. These individuals are assumed to have been displaced. However, in 2015, 66 individuals were translocated to alternative relocation sites in the Delaware River. These individuals have survived through June 2016 and the production of glochidia in translocated females suggests that reproductive success is likely. This reintroduction effort is ongoing.

The USFWS, in conjunction with other stakeholders, has developed a Candidate Conservation Agreement (CCA) for Texas hornshell. This document was developed over the course of a year with assistance from NMDGF, BLM, representatives of the oil and gas industry, and private landowners. The CCA provides a mechanism for participants to continue actions that may impact Texas hornshell without undergoing formal consultation with the USFWS by agreeing to carry out conservation actions prior to a listing decision. The Center for Excellence (CHEMM) in Carlsbad will be the permit holder and will administer the CCA.

In addition to the CCA, a Species Status Baseline (SSA) was developed by USFWS to assist in creating a proposed rule regarding the status (i.e. Threatened, Endangered) of Texas hornshell. NMDGF assisted with the development of the SSA by providing data, documents, and other materials as requested by USFWS. The Texas hornshell was listed as federally endangered on February 9, 2018 (USFWS 2018).

Threats: Human-caused modification of riverine ecosystems (e.g., construction of mainstem impoundments, diversion and redistribution of water, water pollution, introduction of exotic mollusks) responsible for the imperilment of freshwater mussels in the eastern United States (Allan and Flecker 1993; Neves 1993; Williams et al. 1993; Ricciardi and Rasmussen 1999; Vaughn and Taylor 1999) likewise accounts for significant loss of mussel populations in the Pecos River of New Mexico and Texas (Taylor 1983; Neck and Metcalf 1988; Howells et al. 1996; Howells 2003; Strenth et al. 2004). In southeastern New Mexico, construction of impoundments (Lake MacMillan, Brantley Reservoir, Lake Avalon) is one of the many factors responsible for extirpation of *P. popeii* from the Pecos River mainstem (Taylor 1983). Low-head dams on the Black River likely prevent movement of glochidial-bearing fish hosts to riverine reaches upstream of Black River Village where this mussel does not occur (Lang 2001). Opportunities for recolonizing reaches downstream of the Carlsbad Irrigation District dam appear limited by altered physicochemical and hydrologic regimes. Ground water depletion and ground and surface water contaminants are considered principal causes of decline in unionid mussels (Metcalf 1982; Taylor 1983; NMDGF 1988; Williams et al. 1993; Neves et al. 1997; Strayer 1999). Contaminants of ground and surface water can adversely impact aquatic mollusks (Havlik and Marking 1987; Green and Trett 1989; Neves et al. 1997; Augspurger et al. 2003). Regional ground water pumping for agriculture and the petroleum industry are ongoing in the Black River basin. Such extractive processes are known to deplete ground water aquifers (Fiedler and Nye 1933; Thomas 1959; Havenor 1968) and to contaminate ground and surface waters in the Pecos and Black River valleys (Hennighausen 1969; Metcalf 1974; Jercinovic 1982, 1984; Longmire 1983; Quarles 1983, Boyer 1986; Rail 1989; Martinez et al. 1998). The Black River basin has experienced repeated problems of ground water depletion and contamination. Water levels of domestic, agricultural/range wells in the area have lowered and even dried-up. Richard (1988a, 1998b) and Richard and Boehm (1989a) documented ground water contamination of domestic and agricultural/range wells from petroleum-derived hydrocarbons and sulfides in the upper Black River valley (i.e., Washington Ranch, Ballard Wells, etc.). Richard and Bohem (1989b) reported “severe” sulfide gas contamination of Blue Spring (ca. 1988) from oil and gas operations (deep-well injection for storage); the contaminant plume originated up-gradient and was likely transported ca. 20 miles down-gradient to Blue Spring, a regionally significant artesian spring that is the primary hydrologic source for the Black River (Hendrickson and Jones 1952). Such long-distance transport of ground water is common in karst evaporite rock (White et al. 1995; Martinez et al. 1998) and raises concerns for surface water quality of the Black River, especially considering the current proliferation of petroleum industry operations in the Black River drainage. Several low-water bridge crossings span the Black

River. Transit of heavy trucks carrying toxic chemicals and petroleum-derived products across these areas could result in surface water contamination from traffic accidents. Fish kills in the lower Pecos River (2002-2007) from Lake Brantley downstream to the Black River confluence have been attributed to toxins produced by golden alga, *Prymnesium parvum*. These toxins are highly lethal to aquatic, gill-breathing fauna such as mollusks (bivalves, snails), crustaceans, fish, and larval stages of amphibians. While there are no known instances of golden alga blooms within the occupied range of Texas hornshell, such a catastrophic event could decimate the species in New Mexico. Over the long-term, insensitive land-use practices (e.g., excessive clearing of native vegetation, prolonged over-grazing, poor soil and water conservation practices, non-point source discharge of pollutants [toxic chemicals, hydrocarbons, sediments], etc.) within a watershed, and the accumulative impacts of such activities, may: (a) increase erosion and sedimentation; (b) exacerbate drainage entrenchment; (c) increase pulse discharge of instream flows, sediments and pollutants into the drainage; and (d) alter stream channel morphology and substrate composition (see references in Wood and Armitage 1997). These environmental perturbations can have profound effects on the overall health of aquatic ecosystems, long-term viability of mussel populations, and habitat suitability of flow refuges colonized by unionid mussels (Williams et al. 1993; Neves et al. 1997; Strayer 1999; Lang 2001). Introduction of aquatic invasive species (e.g., Asian clam, Quagga mussel, Zebra mussel, New Zealand mudsnail, non-native crayfish) threaten unionid populations throughout the United States (Williams et al. 1993; Neves et al. 1997; NMDGF 2008; <http://www.esg.montana.edu/aim/mollusca/nzms/nzmsbib.html>). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recovery Plan Status: The Texas Hornshell (mussel) Recovery Plan was approved by the Commission in 2007. Population monitoring (i.e., mark-and-recapture) has occurred from 1997 to present. Recent line-transect surveys (2011-2012) throughout the 14-km occupied reach of the Black River, Eddy Co., have established estimates of abundance and population size (see **Current Status** above). Genetic data (protein [allozymic], mitochondrial DNA) indicate that populations in NM and TX are not significantly divergent (Inoue et al., 2013). This information combined with past/ongoing mark-and-recapture data will be incorporated into a population viability analysis, as directed under the recovery plan. No revision to the plan is called for at this time.

Recommendations: No change in listing status is recommended. NMDGF and cooperators should continue to implement strategies of the state conservation plan to alleviate threats and to achieve recovery of Texas hornshell. Protection of habitat is critical for conservation of this mussel. Actions required to protect the species include: (a) collaborative efforts by all stakeholders to address outstanding issues of transportation routes across the Black River; (b) increased communication and coordination among state and federal agencies that regulate extractive resource use (ground water, oil and gas) in the Black River basin; (d) reintroduction of species to historic range in the Delaware River; (e) population/habitat monitoring; and (f) continue mark-and-recapture and population genetic studies.

Literature Cited:

- Allan, J. D. and A. S. Flecker. 1993. Biodiversity conservation in running waters. *BioScience* 43:32-43.
- Augspurger, T., A. E. Keller, M. C. Black, W. G. Cope, and F. J. Dwyer. 2003. Water quality guidance for protection of freshwater mussels (Unionidae) from ammonia exposure. *Environmental Toxicology and Chemistry* 22(11):2569-2575.
- Boyer, D. G. 1986. Differences in produced water contaminants from oil and gas operations in New Mexico - implications for regulatory action. Pp. 291-316, *In Proceedings of the Conference on Southwestern Ground Water Issues* (National Water Well Association, Publisher).
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Burlakova, L. E. and A. Y. Karatayev. 2010. Survey of Texas hornshell in Texas. Performance Report to Texas Parks & Wildlife Department under Project No. 40738. 62 pp.
- Carman, S. 2007. Texas hornshell, *Popenaias popeii*, recovery plan. New Mexico Department of Game and Fish. 57 pp.
- Cockerell, T. D. A. 1902. *Unio popei*, Lea, in New Mexico. *The Nautilus* 16:69-70.
- Fiedler, A. G. and S. S. Nye. 1933. Geology and groundwater resources of the Roswell artesian basin, New Mexico. U.S. Geologic Survey, Water Supply Paper 639, 372 pp.
- Green, J. and M. W. Trett. 1989. The fate and effects of oil in freshwater. Elsevier Science Publishing Co., Inc., New York.

- Havenor, K. C. 1968. Structure, stratigraphy, and hydrogeology of the northern Roswell Artesian Basin, Chaves County, New Mexico. New Mexico Institute of Mining and Technology, Bureau of Mines and Mineral Resources Division, Circular 93, 29 pp.
- Havlik, M. E. and L. L. Marking. 1987. Effects of contaminants on naiad mollusks (Unionidae): a review. U. S. Fish and Wildlife Service, Resource Publication 164. Hendrickson, G. E., and R. S. Jones. 1952. Geology and ground-water resources of Eddy County, New Mexico. U.S. Geological Survey, Ground-Water Report 3, 169 pp.
- Hendrickson, G. E., and R. S. Jones. 1952. Geology and ground-water resources of Eddy County, New Mexico. U.S. Geological Survey, Ground-Water Report 3, 169 pp.
- Hennighausen, F. H. 1969. Meters and their effects in the Roswell Artesian Basin in Chaves and Eddy counties, New Mexico. Pp. 29-33, *In* 14th Annual New Mexico Water Conference (Water Resources Institute).
- Hoeh, W. R. 2009. Genetic and species diversity in *Popenaias* (Bivalvia: Unionoida: Unionidae: Lampsilini) populations from New Mexico and Texas. Final Report to New Mexico Department of Game and Fish, Share with Wildlife Program. 4 pp.
- Howells, R. G. 2003. Declining status of freshwater mussels of the Rio Grande, with comments on other bivalves. Pp. 59-73, *In* Aquatic Fauna of the Northern Chihuahuan Desert, G. P. Garrett and N. L. Allan, Eds. Museum of Texas Tech University, Special Publications Series, Number 46. Lubbock, TX.
- Howells, R. G. 2004. Distributional surveys of freshwater mussels in Texas: progress report for 2003. Texas Parks and Wildlife Department, Management Data Series 222, Austin 50 pp.
- Howells, R. G., R. W. Neck, and H. D. Murray. 1996. Freshwater mussels of Texas. Texas Parks and Wildlife Department, Austin.
- Inoue, K., B. Lang, and D. Berg. 2013. Development and characterization of 20 polymorphic microsatellite markers for the Texas hornshell (*Popenaias popeii*; Bivalvia: Unionidae), through next generation sequencing. *Conservation Genetic Resources* 5(1):195-198.
- Inoue, K., T. Levine, B. Lang, and D. Berg. 2014. Freshwater mussel mortality is correlated with river discharge and human water use in a desert stream. *Freshwater Biology* (In Review).
- Jercinovic, D. E. 1982. Assessment of refined petroleum-product contamination problems in surface and ground waters of New Mexico. Water Pollution Control Bureau, New Mexico Environmental Improvement Division, EID/WPC-82/5.
- Jercinovic, D. E. 1984. Petroleum-product contamination of soil and water in New Mexico. New Mexico Environmental Improvement Division, EID/GWH84/2.
- Johnson, R. I. 1999. Unionidae of the Rio Grande (Rio Bravo del Norte) system of Texas and Mexico. *Museum of Comparative Zoology, Harvard University, Occasional Papers on Mollusks*, 6(77):1-65.
- Lang, B. K. 2001. Status of the Texas hornshell and native freshwater mussels (Unionoidea) in the Rio Grande and Pecos River of New Mexico and Texas. Completion Report E-38 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2003. Artificial Culture and Captive Rearing of the Texas hornshell. New Mexico Department of Game and Fish, Performance Report E-51-2 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2011. Texas hornshell population monitoring. Performance Report (E-65-R-1) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Levine, T. D. 2009. Consequences of life history variation in freshwater mussels: demography and host relationships. Ph.D. dissertation. Miami University (Ohio).
- Longmire, P. A. 1983. Petroleum-product contamination of ground and surface water: a literature review. Ground Water Section, Water Pollution Control Bureau, New Mexico Environmental Improvement Division. EID/WPC-83/7.
- Martinez, J. D., K. S. Johnson, and J. T. Neal. 1998. Sinkholes in evaporite rocks. *American Scientist* 86:38-51.
- Metcalf, A. L. 1982. Fossil unionacean bivalves from three tributaries of the Rio Grande. *Proceedings of the Symposium of Recent Benthological Investigations of Texas and Adjacent States*, pp. 43-59.
- Neck, R. W. and A. L. Metcalf. 1988. Freshwater bivalves of the lower Rio Grande, Texas. *The Texas Journal of Science* 40(3):259-268.
- Neves, R. J. 1993. A state-of-the-unionids address. Pp. 1-10, *in* Proceedings of the Upper Mississippi River Conservation Commission Symposium: Conservation and Management of Freshwater Mussels (K. S. Cummings, A. C. Buchanan, and L. M. Koch, Eds.). Upper Mississippi River Conservation Commission, Rock Island, Illinois.

- Neves, R. J., A. E. Bogan, J. D. Williams, S. A. Ahlstedt, and P. W. Hartfield. 1997. Status of aquatic mollusks in the southeastern United States: A downward spiral of diversity. Pp.43-85, *In* Aquatic Fauna in Peril (George W. Benz and David E. Collins, Eds.). Southeast Aquatic Research Institute Special Publication 1. Lenz Design & Communications, Decatur, Georgia.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Quarles, J. 1983. Groundwater contamination in the United States. University of Pennsylvania Press, Philadelphia.
- Rail, C. D. 1989. Groundwater contamination: sources, control, and preventative measures. Technomic Publishing Company, Inc. Lancaster, PA.
- Ricciardi, A. and J. B. Rasmussen. 1999. Extinction rates of North American Freshwater Fauna. *Conservation Biology* 13(5):1220-1222.
- Richard, M. 1988a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: review of the geohydrology in the vicinity of Rattlesnake Springs and the contamination problem. Report 1. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. 1988b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the first field investigation, August 1988. Report 2. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the second field investigation, March, 1988. Report 3. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: final summary of the investigation. Report 4. National Park Service Contract RFQ 7029-8-0025.
- Smith, D. G., B. K. Lang, and M. E. Gordon. 2003. Gametogenetic cycle, reproductive anatomy, and larval morphology of *Popenaias popeii* (Unionoida) from the Black River, New Mexico. *The Southwestern Naturalist* 48(3):333-340.
- Strayer, D. L. 1999. Use of flow refuges by unionid mussels in rivers. *Journal North American Benthological Society* 18:468-476.
- Strecker, J. K. 1931. The distribution of naiades or pearly fresh-water mussels of Texas. Baylor University Museum, Special Bulletin 2:1-7.
- Strenth, N. E., R. G. Howells, and A. Correa-Sandoval. 2004. New records of the Texas hornshell *Popenaias popeii* (Bivalvia: Unionidae) from Texas and northern Mexico. *Texas Journal of Science* 56(3):223-230.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Thomas, H. E. 1959. Causes of depletion of the Pecos River in New Mexico. Contributions to the Hydrology of the United States, Geological Survey Water Supply Paper 619-G. U.S. Government Printing Office, Washington, D.C., 14 pp.
- United States Fish and Wildlife Service. 2008. Endangered and threatened wildlife and plants; review of native species that are candidates for listing as endangered or threatened; annual notice of findings on resubmitted petitions; annual description of progress on listing actions. *Federal Register* 73(238):75176-75244.
- United States Fish and Wildlife Service (USFWS). 2018. Endangered and threatened wildlife and plants: endangered species status for Texas hornshell. *Federal Register* 83(28): 5720-5735.
- Vaughn, C. C. and C. M. Taylor. 1999. Impoundments and the decline of freshwater mussels: a case study of an extinction gradient. *Conservation Biology* 13(4):912-920.
- White, B. W., D. C. Culver, J. S. Herman, T. C. Kane, and J. E. Mylroie. 1995. Karst lands: the dissolution of carbonate rock produces unique landscapes and poses significant hydrological and environmental concerns. *American Scientist* 83:450-459.
- Williams, J. D., M. L. Warren, Jr., K. S. Cummings, J. L. Harris, and R. J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. *Fisheries* 18:6-22.
- Wood, P. J. and P. D. Armitage. 1997. Biological effects of fine sediment in the lotic environment. *Environmental Management* 21(2):203-217.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

GASTROPODA

ENDANGERED

Koster's springsnail, *Juturnia kosteri*

Distribution: Taylor (1987) described this springsnail from Sago Spring, Bitter Lake National Wildlife Refuge (BLNWR). Additional populations on BLNWR include: Lake St. Francis, Bitter Creek, Sago Spring wetland complex, western perimeter of Unit 3, spring-ditch of units 5-7, and the northwest corner of Hunter Marsh (Lang 2002, 2005, 2010; USFWS 2005). The western limit of the species range was from North Spring, Roswell Country Club, where the population has been extirpated (Taylor 1987; Lang 2005).

Current Status: Hershler (2001) reassigned *Tryonia kosteri* Taylor, 1987 to the genus, *Durangonella* Morrison, 1945 on the basis of reproductive anatomy. Phylogenetic analysis of mitochondrial DNA led Hershler et al. (2002) to allocate *D. kosteri* to a new genus, *Juturnia* Hershler, Liu, Stockwell, comprising two other cochliopinid snails from the Rio Grande basin. Koster's springsnail was listed as state threatened in 1983, and uplisted to endangered based on threats posed by impoverished habitat conditions following the March 2000 Sandhill Fire in Bitter Creek (NMDGF 2000). This species is listed as endangered under the Endangered Species Act USFWS (2005). NMDGF has routinely monitored populations on BLNWR since 1995 (Lang 2002, 2005, 2008, 2010). Acquisition of federal water rights for BLNWR (USDJ 1996, Balleau Groundwater, Inc. 1997) may serve to impart habitat protection for this species. NMDGF (2005) implemented a conservation plan for a suite of four state-listed invertebrates of Chaves County, including *J. kosteri*. Lang (2010) documented populations from Hunter Marsh that were previously unreported on BLNWR and on municipal lands located immediately west of BLNWR.

Using genetic (i.e., mtDNA genes COI and ND1) and shell morphometrics, Morningstar et al., (2013) found through phylogenetic analysis that this species formed a monophyletic clade with each isolated population containing low genetic diversity. Also, molecular variance among populations of *J. kosteri* showed significant variation and low variation in shell morphology.

In 2015, restoration of the Rio Hondo occurred on the lower tract of BLNWR. An earthen berm was used to redirect the Rio Hondo into its historic channel, allowing the ditch to be filled only with groundwater produced by naturally occurring spring vents. A backflow preventer was installed at the downstream terminus of the ditch to prevent effluent water from filling the ditch during periods of high flows. Several rock bars were added to the main channel to act as substrate for springsnails. In December 2015, *J. kosteri* were translocated from two sources on the middle tract of BLNWR. The hydrology of the springs is being monitored by the USFWS and monitoring of the *J. kosteri* population is conducted seasonally in the restored channel.

Threats: While populations of *J. kosteri* are stable under current refuge management plans (Research Management Consultants, Inc. 1998), off-refuge land use practices within areas of the Roswell Artesian Basin pose threats to their long-term viability on BLNWR. Regional ground water pumping for agriculture, municipal water supplies, and oil and gas industry operations continue in the Basin (BLM 1994; USFWS 1997). Any increases in ground water extraction similar to aquifer drawdown levels that occurred in the Basin from the 1950's to 1970's could lead to habitat impacts on BLNWR. Oil and gas development is ongoing within areas of the Basin that Balleau Groundwater, Inc. (1996, 1999) identified as primary ground water source-zones for surface waters at BLNWR. Such extractive processes and industry operations can result in aquifer drawdown, alter aquitard hydraulics, and contaminate ground and surface waters in New Mexico (Hennighausen 1969; Jercinovic 1982, 1984; Longmire 1983; Quarles 1983; Boyer 1986; Richard 1988a, 1988b; Rail 1989; Richard and Boehm 1989a, 1989b; Balleau Groundwater, Inc. 1996; Martinez et al. 1998). Aquatic mollusks are acutely sensitive to ground and surface water contaminants (Havlik and Marking 1987; Eisler 1987; Green and Trett 1989; Augspurger 2003). There is increased risk of degradation of ground and surface water quality posed by septic discharge from urban encroachment in aquifer recharge-discharge areas along the western bounds of BLNWR (USFWS 2005). Illicit dumping of domestic contaminants (e.g., trash, pesticides, herbicides, waste oil, etc.) in sinkholes is known to contaminate ground water resources in karst areas of the United States (White et al. 1995; Zokaites 1997) and in New Mexico (Bitner and Graves 1992; McQuillan et al. 1989). Natural stochastic events, such as fire or drought, could adversely impact extant *J. kosteri* populations at BLNWR. Although Lang (2001) demonstrated short-term fire effects on the physicochemical conditions in Bitter Creek following the March 2000 Sandhill Fire, the long-term impact of these

effects, whether adverse or beneficial, on the aquatic biota and riparian corridor remain undetermined (Lang 2002, 2005). Prolonged drought may affect hydrologic conditions on BLNWR by reducing discharge through refuge surface waters while concomitantly affecting aquatic physicochemical conditions and concentrating potential contaminants. Aquatic invasive species represent a threat to native wildlife and habitats at BLNWR (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recovery Plan Status: The recovery plan for these four invertebrates was approved by the Commission in 2005. Monthly and annual population monitoring has occurred since 1995. Under the recovery plan, agency actions accomplished/ongoing include:

7. Genetic assay of amphipods on the Refuge where cryptic speciation has been previously reported;
8. Captive propagation research for springsnails;
9. Genetic assay of springsnails to determine best strategies for reintroduction of snails to rehabilitated native habitat or to newly created habitat on the Refuge;
10. Section 7 consultation for riparian habitat restoration of critical habitat for these species;
11. Inter-agency collaboration to develop a monitoring program for Pecos assiminea; and
12. Reconnaissance surveys to further document the distribution of these species on the Refuge.

A federal recovery plan was published in 2018. The Department provided comments to the draft plan, and publication of the final plan is expected in late 2018 or 2019.

Recommendations: No change in listing status is recommended. In collaboration with the U. S. Fish and Wildlife Service, NMDGF should continue monitoring post-fire effects on aquatic macroinvertebrates and the riparian corridor of Bitter Creek. NMDGF and cooperators should continue to implement strategies of the state conservation plan to alleviate threats and achieve recovery of this species.

Literature Cited:

- Augspurger, T., A. E. Keller, M. C. Black, W. G. Cope, and F. J. Dwyer. 2003. Water quality guidance for protection of freshwater mussels (Unionidae) from ammonia exposure. *Environmental Toxicology and Chemistry* 22(11):2569-2575.
- Balleau Groundwater, Inc. 1996. Interrelation of groundwater and surface water at Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 16 pp. (with addenda).
- Balleau Groundwater, Inc. 1997. Annotated abstract of water-rights administration Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 22 pp. (with addenda).
- Balleau Groundwater, Inc. 1999. Source-water protection zones for Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 42 pp.
- Bitner, M. J. And T. Graves. 1992. Effect of lot sizes on potential ground-water contaminants from conventional septic-tank systems: numerical modeling. Policy Coordinating Committee. 47 pp.
- Boyer, D. G. 1986. Differences in produced water contaminants from oil and gas operations in New Mexico – implications for regulatory action. Pp. 291-316, *In Proceedings of the Conference on Southwestern Ground Water Issues* (National Water Well Association, Publisher).
- Bureau of Land Management. 1994. Draft resource management plan/environmental impact statement for the Roswell Resource Area, Roswell, New Mexico, and draft resource management plan amendment/environmental impact statement for the Carlsbad Resource Area, Carlsbad, New Mexico. Bureau of Land Management, Roswell, NM.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Green, J. and M. W. Trett. 1989. The fate and effects of oil in freshwater. Elsevier Science Publishing Co., Inc., New York.
- Havlik, M. E. and L. L. Marking. 1987. Effects of contaminants on naiad mollusks (Unionidae): a review. U. S. Fish and Wildlife Service, Resource Publication 164.
- Hennighausen, F. H. 1969. Meters and their effects in the Roswell Artesian Basin in Chaves and Eddy counties, New Mexico. Pp. 29-33, *In 14th Annual New Mexico Water Conference* (Water Resources Institute).
- Hershler, R. H. 2001. Systematics of the North and Central American aquatic genus *Tryonia* (Rissooidea: Hydrobiidae). Smithsonian Institution Press, Washington, D. C. Smithsonian Contributions to Zoology, No. 612. 53 pp.

- Hershler, R., H-S Liu, and C. A. Stockwell. 2002. A new genus and species of aquatic gastropods (Rissooidea: hydrobiidae) from the North American Southwest: phylogenetic relationships and biogeography. *Proc. Biol. Soc. Wash.* 115(1):171-188.
- Jercinovic, D. E. 1982. Assessment of refined petroleum-product contamination problems in surface and ground waters of New Mexico. Water Pollution Control Bureau, New Mexico Environmental Improvement Division, EID/WPC-82/5.
- Jercinovic, D. E. 1984. Petroleum-product contamination of soil and water in New Mexico. New Mexico Environmental Improvement Division, EID/GWH84/2.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2005. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Completion Report E-56-(1-3) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2008. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-5 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2010. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Longmire, P. A. 1983. Petroleum-product contamination of ground and surface water: a literature review. Ground Water Section, Water Pollution Control Bureau, New Mexico Environmental Improvement Division. EID/WPC-83/7.
- Martinez, J. D., K. S. Johnson, and J. T. Neal. 1998. Sinkholes in evaporite rocks. *American Scientist* 86:38-51.
- McQuillan, D. M., M. J. Jasper, and B. H. Swanson. 1989. Ground-water contamination by septic-tank use: a field study in the Albuquerque south Valley - West Mesa Region, Bernalillo County, New Mexico. New Mexico Health and Environment Department, Environmental Improvement Division, Ground Water Bureau.
- C. Morningstar, K. Inoue, M. Sei, B. K. Lang and D.J. Berg. 2013. Quantifying morphological and genetic variation of sympatric populations to guide conservation of endangered micro-endemic springsnails. *Aquatic Conservation: Marine and Freshwater Ecosystems*. Published online in Wiley Online Library(wileyonlinelibrary.com). DOI: 10.1002/aqc.2422
- New Mexico Department of Game and Fish. 2000. Threatened and endangered species of New Mexico: biennial review and recommendations. 116 pp.
- New Mexico Department of Game and Fish. 2005. Recovery and conservation plan for four invertebrate species: Noel's amphipod (*Gammarus desperatus*), Pecos assimineia (*Assimineia pecos*), Koster's springsnail (*Juturnia kosteri*), and Roswell springsnail (*Pyrgulopsis roswellensis*). 80 pp.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Quarles, J. 1983. Groundwater contamination in the United States. University of Pennsylvania Press, Philadelphia.
- Rail, C. D. 1989. Groundwater contamination: sources, control, and preventative measures. Technomic Publishing Company, Inc. Lancaster, PA.
- Research Management Consultants, Inc. 1998. Final comprehensive conservation plan and Environmental Assessment: Bitter Lake National Wildlife Refuge.
- Richard, M. 1988a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: review of the geohydrology in the vicinity of Rattlesnake Springs and the contamination problem. Report 1. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. 1988b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the first field investigation, August 1988. Report 2. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the second field investigation, March, 1988. Report 3. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: final summary of the investigation. Report 4. National Park Service Contract RFQ 7029-8-0025.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- United States Department of Justice. 1996. United States of America's statement of claim for reserved surface water and groundwater rights for Bitter Lake National Wildlife Refuge. Roswell Basin Section, RAB 923 and 1793, Denver, CO.

- United States Fish and Wildlife Service. 1997. Biological opinion on the Roswell Resource Area Resource Management Plans. Section 7 Consultation #2-22-96-102.
- United States Fish and Wildlife Service. 2005. Endangered and Threatened Wildlife and Plants; Listing Roswell springsnail, Koster's tryonia, Pecos Assiminea, and Noel's Amphipod as Endangered with Critical Habitat; Final Rule. Federal Register 70(152):46303-46333.
- White, B. W., D. C. Culver, J. S. Herman, T. C. Kane, and J. E. Mylroie. 1995. Karst lands: the dissolution of carbonate rock produces unique landscapes and poses significant hydrological and environmental concerns. *American Scientist* 83:450-459.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.
- Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a syntopic review. U.S. Fish and Wildlife Service. Contaminant Hazard Reviews Report No. 11, Biological Report 85 (1.11).
- Zokaites, C. 1997. Living on karst: a reference guide for landowners in limestone regions. Cave Conservancy of the Virginias. 25 pp.

Alamosa springsnail, *Pseudotryonia alamosae*

Distribution: This endemic springsnail is known only from thermal spring sources forming the perennial headwaters of Alamosa Creek above the Monticello Box, Socorro County (Taylor 1983, 1987).

Current Status: *Pseudotryonia alamosae* was listed as state threatened in 1983, and was uplisted to state endangered based on threats posed by an open pit beryllium mine within the immediate watershed of Alamosa Creek (NMDGF 2000). The Alamosa springsnail is a federal endangered species (USFWS 1991). Based on studies of molecular genetics (Hershler et al. 1999) and reproductive anatomy, Hershler (2001) reassigned *Tryonia alamosae* Taylor, 1987 to a new genus, *Pseudotryonia* Hershler. *Pseudotryonia alamosae* occurs in spring sources and spring-fed tributaries along the north riverbank of Alamosa Creek downstream to approximately 30 meters above the Monticello Box (Lang 2001, 2008). Within this available habitat, the species is most abundant in the lowest velocity, warmest and most stenothermic microhabitats associated with thermal spring vents situated in the upper reach of this perennial spring-fed system. Private land use practices, including salt cedar removal, currently favor persistence of this species in Alamosa Creek.

Threats: Primary threats include local/regional ground water depletion, ground and surface water contamination, direct habitat alteration (stream diversion and impoundment), mineral exploration/mining, and poor watershed management (Taylor 1983; NMDGF 1988; Lang 2001, 2008). Introduction of aquatic invasive species can result in elimination of springsnail populations by predation or habitat degradation (e.g., non-native crayfish; Fernandez and Rosen 1996; NMDGF 2008) or by direct competition for food sources (i.e., New Zealand mudsnail; <http://www.esg.montana.edu/aim/mollusca/nzms/nzmsbib.html>). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF is collaborating with the U. S. Fish and Wildlife Service and the Monticello Community Ditch Association for conservation activities detailed in the federal recovery plan (USFWS 1994). Resource agencies should pursue opportunities to acquire private lands, including mineral and ground water rights, where future beryllium ore exploration or mining may adversely affect ground water aquifers that supply surface waters and spring-fed wetlands of Alamosa Creek.

Literature Cited:

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Fernandez, P. J. and P. C. Rosen. 1996. A microcosm study of the effects of an introduced crayfish (*Orconectes virilis*) on aquatic plants, invertebrates, and herpetofauna from Arizona. Final Report, Part II, IIPAM Project No. I9404, Heritage Program, Arizona Game and Fish Department.
- Hershler, R. H., H. -P. Liu, and M. Mulvey. 1999. Phylogenetic relationships within the aquatic snail genus *Tryonia*: Implications for biodiversity of the North American Southwest. *Molecular Phylogenetics and Evolution* 13(2):377-391.

- Hershler, R. H. 2001. Systematics of the North and Central American aquatic genus *Tryonia* (Rissooidea: Hydrobiidae). Smithsonian Institution Press, Washington, D. C. Smithsonian Contributions to Zoology, No. 612. 53 pp.
- Lang, B. K. 2001. New Mexico endangered invertebrates: monitoring and management. New Mexico Department of Game and Fish, Completion Report E-37 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2008. New Mexico endangered invertebrates: monitoring and management. New Mexico Department of Game and Fish, Performance Report E-37 (5-10), submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-305.
- New Mexico Department of Game and Fish. 2000. Threatened and endangered species of New Mexico: biennial review and recommendations. 116 pp.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- U. S. Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants; final rule to list the Alamosa springsnail and the Socorro springsnail as endangered. Federal Register 76(148):46218-46234.
- United States Fish and Wildlife Service. 1994. Alamosa springsnail (*Tryonia alamosae*) and Socorro springsnail (*Pyrgulopsis neomexicana*) draft recovery plan. Albuquerque, NM. 24 pp.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. Global Change Biology 11:1557-1564.
- Federal Register. 1994. Endangered and threatened wildlife and plants. Federal Register, 50 CFR 17.11 & 17.12. 42 pp.

Chupadera springsnail, Pyrgulopsis chupaderae

Distribution: The Chupadera springsnail is known from two hillside seeps situated along the western flank of the Chupadera Mountains, southeast Socorro County (Taylor 1983, 1987). This species is endemic to Willow Spring (type locality), and once occurred in an unnamed spring located about 0.25 mile north of the type locality.

Current Status: *Pyrgulopsis chupaderae* was listed as state threatened in 1983, and uplisted to endangered (NMDGF 1996) due to habitat overgrazing by cattle which resulted in the apparent extirpation of the species at the unnamed spring. USFWS (2012) designated Chupadera springsnail as endangered along with designation of critical habitat. Despite intensive long-term land use practices at Willow Spring (grazing, spring source diversion, spring run impoundment), the Chupadera springsnail has persisted at the type locality (Taylor 1983; Lang 2002). Population monitoring initiated in 1996 was pre-empted by transference of ownership of Willow Spring in August 1999. Since then annual requests to visit Willow Spring have been repeatedly denied by the landowner. Access to Willow Spring was restored by Turner Endangered Species Fund (TESF) in 2016. A monitoring program has been implemented and is ongoing. Although new trend data is insufficient for determine long-term trends at the time of publication, abundance of the species appears to be similar to that of collections prior to 1999 (TESF, NMDGF unpublished data). There are efforts ongoing to develop a captive rearing program for this springsnail.

Threats: Imminent threats include local/regional ground water depletion, diversion or impoundment of spring flow, loss of riparian vegetation, and overgrazing of the watershed during extended drought (Taylor 1983; NMDGF 1988; Lang 2001b, Lang 2002). These threats could be exacerbated by subdivision development on range lands surrounding Willow Spring. Introduction of aquatic invasive species can result in elimination of springsnail populations by predation or habitat degradation (e.g., non-native crayfish; Fernandez and Rosen 1996, NMDGF 2008) or by direct competition for food sources (i.e., New Zealand mudsnail; <http://www.esg.montana.edu/aim/mollusca/nzms/nzmsbib.html>). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005, Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. Continuation of monitoring efforts to track breeding timing, and the development of a captive propagation program are warranted actions. In addition, continuing to partner on these efforts with TESH, the landowner, Albuquerque BioPark, and the USFWS is vital.

Literature Cited:

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Fernandez, P. J. and P. C. Rosen. 1996. A microcosm study of the effects of an introduced crayfish (*Orconectes virilis*) on aquatic plants, invertebrates, and herpetofauna from Arizona. Final Report, Part II, IIPAM Project No. I9404, Heritage Program, Arizona Game and Fish Department.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-302.
- New Mexico Department of Game and Fish. 1996. Threatened and endangered species of New Mexico: biennial review and recommendations.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- U. S. Fish and Wildlife Service. 2012. Endangered and threatened wildlife and plants; determination of endangered status for the Chupadera Springsnail and designation of critical habitat. Federal Register 77(134): 41088-41106.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Socorro springsnail, *Pyrgulopsis neomexicana*

Distribution: Although this species was evidently described by Pilsbry (1916) from one of three springs of the Socorro Thermal Area (Summers 1976), no empty shells or live specimens have ever been collected from this area, which is located three miles west of Socorro (Landye 1981; Taylor 1983, 1987). Prior to 1971, significant water development and habitat alterations likely resulted in extirpation of the species at the type locality (Landye 1981; Taylor 1987). Taylor (1987) provided a morphological description of this species from a thermal spring located on the southeastern flank of the Magdalena Mountains, Socorro County, while noting uncertainty of taxonomic affinities of this population with those from the Socorro Thermal Area. Taylor (1987) estimated the total population at about 5000 individuals.

Current Status: *Pyrgulopsis neomexicana* was listed as state endangered in 1983. This snail is considered a federal endangered species (USFWS 1991). Lang (2001) last visited Torreon Springs in 1996, and noted that the spring source had been capped by a windmill; at that time live *P. neomexicana* were observed in the spring outflow channel (~2.0l x 0.5w x 0.1d m). The private landowner has since denied site access to monitor and study *P. neomexicana*. Current population status remains unknown.

Threats: Regional/local ground water depletion, spring run dewatering, contamination, and riparian habitat degradation represent principal threats to the population (NMDGF 1988; Lang 2001). Natural stochastic events such as drought could adversely impact this population by reducing spring discharge. Introduction of aquatic invasive species can result in elimination of springsnail populations by predation or habitat degradation (e.g., non-native crayfish; Fernandez and Rosen 1996; NMDGF 2008) or by direct competition for food sources (i.e., New Zealand mudsnail; <http://www.esg.montana.edu/aim/mollusca/nzms/nzmsbib.html>). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendation: No change in listing status is recommended. The remnant population merits resurvey to determine current status. A refuge population should be established at the Albuquerque Biological Park.

Literature Cited

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Fernandez, P. J. and P. C. Rosen. 1996. A microcosm study of the effects of an introduced crayfish (*Orconectes virilis*) on aquatic plants, invertebrates, and herpetofauna from Arizona. Final Report, Part II, IIPAM Project No. I9404, Heritage Program, Arizona Game and Fish Department.
- Landye, J. J. 1981. Current status of endangered, threatened, and/or rare mollusks of New Mexico and Arizona. Endangered Species Office, U. S. Fish and Wildlife Service, Final Report 13.
- Lang, B. K. 2001. New Mexico endangered invertebrates: monitoring and management. New Mexico Department of Game and Fish. Completion Report E-37 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account: A-297.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Pilsbry, H. A. 1916. New species of *Amnicola* from New Mexico and Utah. *The Nautilus* 29:111-112.
- Summers, W. K. 1976. New Mexico thermal waters. New Mexico Bureau of Mines & Mineral Resources, Hydrologic Report 4.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources, Bulletin 116.
- U. S. Fish and Wildlife Service. 1991. Endangered and threatened wildlife and plants; final rule to list the Alamosa springsnail and the Socorro springsnail as endangered. *Federal Register* 76(148):46218-46234.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P. Van Vuuren. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Roswell springsnail, *Pyrgulopsis roswellensis*

Distribution: Taylor (1987) reported three populations of *P. roswellensis* on Bitter Lake National Wildlife Refuge (BLNWR) and a population in North Spring, Roswell Country Club. The trend in species range reduction by extirpation of once widely distributed, but localized, populations is supported by the Pleistocene fossil record and reinventory of known site occurrences (Noel 1954; Taylor 1987; USFWS 2005).

Current Status: Roswell springsnail was listed as state endangered in 1983. This species is endangered under the federal Endangered Species Act (USFWS 2005). Extant populations on BLNWR occur in: Bitter Creek, Sago Spring, and the Unit 7 “spring ditch.” This species is apparently extirpated from North Spring (Lang 2005). The Department has routinely monitored populations on BLNWR since 1995. Acquisition of federal water rights for BLNWR (USDJ 1996; Balleau Groundwater, Inc. 1997) may serve to impart habitat protection for this species. NMDGF (2005) implemented a recovery and conservation plan for a suite of four state-listed invertebrates of Chaves County, including *P. roswellensis*.

Using genetic (i.e., mtDNA genes COI and ND1) and shell morphometric analyses, Morningstar et. al., (2013) found through phylogenetic data that this species formed a monophyletic clade, with each isolated population containing low genetic diversity. Also, molecular variance among populations showed significant variation but low variation in shell morphology.

In 2015, restoration of the Rio Hondo occurred on the lower tract of BLNWR. An earthen berm was used to redirect the Rio Hondo into its historic channel, allowing the ditch the river previously occupied to be filled only with groundwater produced by naturally occurring spring vents. A backflow preventer was installed at the downstream terminus of the ditch to prevent effluent water from filling the ditch during periods of high flows. Several rock bars were added to the main channel to act as substrate for springsnails. In December 2015, *P.*

roswellensis were translocated from one source on the middle tract of BLNWR. The hydrology of the springs is being monitored by the USFWS and monitoring of the *P. roswellensis* population is conducted seasonally in the restored channel.

Threats: While populations of *P. roswellensis* are stable under current refuge management plans (Research Management Consultants, Inc. 1998), off-refuge land use practices within areas of the Roswell Artesian Basin pose threats to their long-term viability on BLNWR. Regional ground water pumping for agriculture, municipal water supplies, and oil and gas industry operations continue in the Basin (BLM 1994; USFWS 1997). Any increases in ground water extraction similar to aquifer drawdown levels that occurred in the Basin from the 1950's to 1970's could lead to habitat impacts on BLNWR. Oil and gas development is ongoing within areas of the Basin that Balleau Groundwater, Inc. (1996, 1999) identified as primary ground water source-zones for surface waters at BLNWR. Such extractive processes and industry operations can result in aquifer drawdown, alter aquitard hydraulics, and contaminate ground and surface waters in New Mexico (Hennighausen 1969; Jercinovic 1982, 1984; Longmire 1983; Quarles 1983; Boyer 1986; Richard 1988a, 1988b; Rail 1989; Richard and Boehm 1989a, 1989b; Balleau Groundwater, Inc. 1996; Martinez et al. 1998). Aquatic mollusks are acutely sensitive to ground and surface water contaminants (Havlik and Marking 1987; Eisler 1987; Green and Trett 1989; Augspurger 2003). There is increased risk of degradation of ground and surface water quality posed by septic discharge from urban encroachment in aquifer recharge-discharge areas along the western bounds of BLNWR (USFWS 2005). Illicit dumping of domestic contaminants (e.g., trash, pesticides, herbicides, waste oil, etc.) in sinkholes is known to contaminate ground water resources in karst areas of the United States (White et al. 1995; Zokaites 1997) and in New Mexico (Bitner and Graves 1992; McQuillan et al. 1989). Natural stochastic events, such as fire or drought, could adversely impact extant *P. roswellensis* populations at BLNWR. Although Lang (2001) demonstrated short-term fire effects on the physicochemical conditions in Bitter Creek following the March 2000 Sandhill Fire, the long-term impact of these effects, whether adverse or beneficial, on the aquatic biota and riparian corridor remain undetermined (Lang 2002, 2005). Prolonged drought may affect hydrologic conditions on BLNWR by reducing discharge through refuge surface waters while concomitantly affecting aquatic physicochemical conditions and concentrating potential contaminants. Aquatic invasive species represent a threat to native wildlife and habitats at BLNWR (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recovery Plan Status: The recovery plan for these four invertebrates was approved by the Commission in 2005. Monthly and annual population monitoring has occurred since 1995. Under the recovery plan, agency actions accomplished/ongoing include:

1. Genetic assay of amphipods on the Refuge where cryptic speciation has been previously reported;
2. Captive propagation research for springsnails;
3. Genetic assay of springsnails to determine best strategies for reintroduction of snails to rehabilitated native habitat or to newly created habitat on the Refuge;
4. Section 7 consultation for riparian habitat restoration of critical habitat for these species;
5. Inter-agency collaboration to develop a monitoring program for Pecos assiminea; and
6. Reconnaissance surveys to further document the distribution of these species on the Refuge.

A federal recovery was published in 2018. The Department provided comments to the draft plan, and publication of the final plan is expected in late 2018 or 2019.

Recommendations: No change in listing status is recommended. In collaboration with the U. S. Fish and Wildlife Service, NMDGF should continue monitoring post-fire effects on aquatic macroinvertebrates and the riparian corridor of Bitter Creek. NMDGF and cooperators should continue to implement strategies of the state recovery and conservation plan to alleviate threats and achieve recovery of this species.

Literature Cited:

- Balleau Groundwater, Inc. 1996. Interrelation of groundwater and surface water at Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 16 pp. (with addenda).
- Balleau Groundwater, Inc. 1997. Annotated abstract of water-rights administration Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 22 pp. (with addenda).
- Balleau Groundwater, Inc. 1999. Source-water protection zones for Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 42 pp.

- Bitner, M. J. and T. Graves. 1992. Effect of lot sizes on potential ground-water contaminants from conventional septic tank systems: numerical modeling. Policy Coordinating Committee. 47 pp.
- Boyer, D. G. 1986. Differences in produced water contaminants from oil and gas operations in New Mexico - implications for regulatory action. Pp. 291-316, *In Proceedings of the Conference on Southwestern Ground Water Issues* (National Water Well Association, Publisher).
- Bureau of Land Management. 1994. Draft resource management plan/environmental impact statement for the Roswell Resource Area, Roswell, New Mexico, and draft resource management plan amendment/environmental impact statement for the Carlsbad Resource Area, Carlsbad, New Mexico. Bureau of Land Management, Roswell, NM.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a syntopic review. U.S. Fish and Wildlife Service. Contaminant Hazard Reviews Report No. 11, Biological Report 85 (1.11).
- Green, J. and M. W. Trett. 1989. The fate and effects of oil in freshwater. Elsevier Science Publishing Co., Inc., New York.
- Havlik, M. E. and L. L. Marking. 1987. Effects of contaminants on naiad mollusks (Unionidae): a review. U. S. Fish and Wildlife Service, Resource Publication 164.
- Hennighausen, F. H. 1969. Meters and their effects in the Roswell Artesian Basin in Chaves and Eddy counties, New Mexico. Pp. 29-33, *In 14th Annual New Mexico Water Conference* (Water Resources Institute).
- Morningstar et. al., (2013) found through phylogenetic analysis that this species formed a monophyletic clade, with each isolated population containing low genetic diversity. Also, molecular variance among populations of *J. kosteri* showed significant variation and low variation in shell morphology.
- Jercinovic, D. E. 1982. Assessment of refined petroleum-product contamination problems in surface and ground waters of New Mexico. Water Pollution Control Bureau, New Mexico Environmental Improvement Division, EID/WPC-82/5.
- Jercinovic, D. E. 1984. Petroleum-product contamination of soil and water in New Mexico. New Mexico Environmental Improvement Division, EID/GWH84/2.
- Lang, B. K. 2001. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish, Annual Performance Report E-20-8 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish, Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2005. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Completion Report E-56-(1-3) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2010. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2011. Aquatic mollusks of New Mexico. NMDGF Performance Report E-66-R-1 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Longmire, P. A. 1983. Petroleum-product contamination of ground and surface water: a literature review. Ground Water Section, Water Pollution Control Bureau, New Mexico Environmental Improvement Division. EID/WPC-83/7.
- Martinez, J. D., K. S. Johnson, and J. T. Neal. 1998. Sinkholes in evaporite rocks. *American Scientist* 86:38-51.
- McQuillan, D. M., M. J. Jasper, and B. H. Swanson. 1989. Ground-water contamination by septic-tank use: a field study in the Albuquerque south Valley - West Mesa Region, Bernalillo County, New Mexico. New Mexico Health and Environment Department, Environmental Improvement Division, Ground Water Bureau.
- C. Morningstar, K. Inoue, M. Sei, B. K. Lang and D.J. Berg. 2013. Quantifying morphological and genetic variation of sympatric populations to guide conservation of endangered micro-endemic springsnails. *Aquatic Conservation: Marine and Freshwater Ecosystems*. Published online in Wiley Online Library(wileyonlinelibrary.com). DOI: 10.1002/aqc.2422
- New Mexico Department of Game and Fish. 2005. Recovery and conservation plan for four invertebrate species: Noel's amphipod (*Gammarus desperatus*), Pecos assimineia (*Assimineia pecos*), Koster's springsnail (*Juturnia kosteri*), and Roswell springsnail (*Pyrgulopsis roswellensis*). 80 pp.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Noel, 1954. Animal ecology of a New Mexico springbrook. *Hydrobiologia* 6:120-135.

- Quarles, J. 1983. Groundwater contamination in the United States. University of Pennsylvania Press, Philadelphia.
- Rail, C. D. 1989. Groundwater contamination: sources, control, and preventative measures. Technomic Publishing Company, Inc. Lancaster, PA.
- Research Management Consultants, Inc. 1998. Final comprehensive conservation plan and environmental assessment: Bitter Lake National Wildlife Refuge.
- Richard, M. 1988a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: review of the geohydrology in the vicinity of Rattlesnake Springs and the contamination problem. Report 1. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. 1988b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the first field investigation, August 1988. Report 2. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the second field investigation, March, 1988. Report 3. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: final summary of the investigation. Report 4. National Park Service Contract RFQ 7029-8-0025.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- United States Fish and Wildlife Service. 1997. Biological opinion on the Roswell Resource Area Resource Management Plans. Section 7 Consultation #2-22-96-102.
- United States Fish and Wildlife Service. 2005. Endangered and Threatened Wildlife and Plants; Listing Roswell springsnail, Koster's tryonia, Pecos Assiminea, and Noel's Amphipod as Endangered with Critical Habitat; Final Rule. Federal Register 70(152):46303-46333.
- White, B. W., D. C. Culver, J. S. Herman, T. C. Kane, and J. E. Mylroie. 1995. Karst lands: the dissolution of carbonate rock produces unique landscapes and poses significant hydrological and environmental concerns. American Scientist 83:450-459.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. Global Change Biology 11:1557-1564.
- Zokaïtes, C. 1997. Living on karst: a reference guide for landowners in limestone regions. Cave Conservancy of the Virginias. 25 pp.

Pecos assiminea, Assiminea pecos

Distribution: This amphibious snail occurred historically in isolated populations in New Mexico (Bitter Lake National Wildlife Refuge [BLNWR] and North Spring, Roswell County Club, Chaves County), Texas (Diamond Y Preserve, Pecos County), and sporadically throughout the Bolsón de Cuarto Ciénegas, Coahuila, México (Taylor 1983, 1987). The species shows a pattern of localized extinctions throughout its historic range. Taylor (1987) reported extirpation of *A. pecos* from North Spring and at the type locality (Unit 7) on BLNWR. Extant populations on BLNWR occur in marsh habitats along Bitter Creek, Sago Spring wetland complex near Sinkhole #31, and the “spring ditch” of units 7 and 15 (USFWS 2005). Additional populations were located at East Sandia Spring, Reeves County, Texas (Lang 2002), and in Hunter Marsh, BLNWR (Lang 2010).

Current Status: *Pecos assiminea* was listed as state endangered in 1983. This species is considered as endangered under the Endangered Species Act (USFWS 2005). Populations on BLNWR have been routinely monitored since 1995. In Texas, populations of *A. pecos* occur on lands (Diamond Y Spring Preserve, East Sandia Spring) under stewardship of The Nature Conservancy. Acquisition of federal water rights for BLNWR (USDJ 1996; Balleau Groundwater, Inc. 1997) may serve to impart habitat protection for this species. NMDGF (2005) implemented a recovery and conservation plan for a suite of four state-listed invertebrates of Chaves County, including *A. pecos*. Molecular genetic and morphometric studies of the *A. pecos* species complex retained the binomial for all populations in the United States and described the Mexican population as a new species, *Assiminea cienegensis* (Hershler et al. 2007). Staff of BLNWR are currently monitoring all known populations on the Refuge.

Threats: While populations of *A. pecosensis* are stable under current refuge management plans (Research Management Consultants, Inc. 1998), off-refuge land use practices within areas of the Roswell Artesian Basin pose threats to their long-term viability on BLNWR. Regional ground water pumping for agriculture, municipal water

supplies, and oil and gas industry operations continue in the Basin (BLM 1994; USFWS 1997). Any increases in ground water extraction similar to aquifer drawdown that occurred in the Basin from the 1950's to 1970's could lead to habitat impacts on BLNWR. Oil and gas development is ongoing within areas of the Basin that Balleau Groundwater, Inc. (1996, 1999) identified as primary ground water source-zones for surface waters at BLNWR. Such extractive processes and industry operations can result in aquifer drawdown, alter aquitard hydraulics, and contaminate ground and surface waters in New Mexico (Hennighausen 1969; Jercinovic 1982, 1984; Longmire 1983; Quarles 1983; Boyer 1986; Richard 1988a, 1988b; Rail 1989; Richard and Boehm 1989a, 1989b; Balleau Groundwater, Inc. 1996; Martinez et al. 1998). Aquatic mollusks are acutely sensitive to ground and surface water contaminants (Havlik and Marking 1987; Eisler 1987; Green and Trett 1989; Augspurger 2003). There is increased risk of degradation of ground and surface water quality posed by septic discharge from urban encroachment in aquifer recharge-discharge areas along the western bounds of BLNWR (USFWS 2005). Illicit dumping of domestic contaminants (e.g., trash pesticides, herbicides, waste oil, etc.) in sinkholes is known to contaminate ground water resources in karst areas of the United States (White et al. 1995; Zokaites 1997) and in New Mexico (Bitner and Graves 1992; McQuillan et al. 1989). Natural stochastic events, such as frequent fires or drought, could adversely impact extant *A. pecos* populations at BLNWR. Contrary to Taylor (1987), it appears that *A. pecos* is tolerant of fire, and that intensity, duration and frequency of fire are principal factors that likely determine the species' ability to recover in response to variable fire regimes (Lang 2002). Prolonged drought may affect hydrologic conditions on BLNWR by reducing discharge through refuge surface waters which could result in desiccation of riparian habitats occupied by this species. Aquatic invasive species represent a threat to native wildlife and habitats at BLNWR (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recovery Plan Status: The recovery plan for these four invertebrates was approved by the Commission in 2005. Monthly and annual population monitoring has occurred since 1995. Under the recovery plan, agency actions accomplished/ongoing include:

1. Genetic assay of amphipods on the Refuge where cryptic speciation has been previously reported;
2. Captive propagation research for springsnails;
3. Genetic assay of springsnails to determine best strategies for reintroduction of snails to rehabilitated native habitat or to newly created habitat on the Refuge;
4. Section 7 consultation for riparian habitat restoration of critical habitat for these species;
5. Inter-agency collaboration to develop a monitoring program for Pecos assiminea; and
6. Reconnaissance surveys continue to further document the distribution of these species on the Refuge.

A federal recovery plan is currently being developed and will likely be published in 2016. No revision to the plan is called for at this time.

Recommendations: No change in listing status is recommended. In collaboration with the U. S. Fish and Wildlife Service, NMDGF should continue monitoring post-fire effects on aquatic macroinvertebrates and the riparian corridor of Bitter Creek. NMDGF and cooperators should continue to implement strategies of the state recovery and conservation plan to alleviate threats and achieve recovery of this species.

Literature Cited:

- Balleau Groundwater, Inc. 1996. Interrelation of groundwater and surface water at Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 16 pp. (with addenda).
- Balleau Groundwater, Inc. 1997. Annotated abstract of water-rights administration Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 22 pp. (with addenda).
- Balleau Groundwater, Inc. 1999. Source-water protection zones for Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 42 pp.
- Bitner, M. J. and T. Graves. 1992. Effect of lot sizes on potential ground-water contaminants from conventional septic-tank systems: numerical modeling. Policy Coordinating Committee. 47 pp.
- Boyer, D. G. 1986. Differences in produced water contaminants from oil and gas operations in New Mexico implications for regulatory action. Pp. 291-316, *In Proceedings of the Conference on Southwestern Ground Water Issues* (National Water Well Association, Publisher).
- Bureau of Land Management. 1994. Draft resource management plan/environmental impact statement for the Roswell Resource Area, Roswell, New Mexico, and draft resource management plan

- amendment/environmental impact statement for the Carlsbad Resource Area, Carlsbad, New Mexico. Bureau of Land Management, Roswell, NM.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a syntopic review. U. S. Fish and Wildlife Service. Contaminant Hazard Reviews Report No. 11, Biological Report 85 (1.11).
- Green, J. and M. W. Trett. 1989. The fate and effects of oil in freshwater. Elsevier Science Publishing Co., Inc., New York.
- Havlik, M. E. and L. L. Marking. 1987. Effects of contaminants on naiad mollusks (Unionidae): a review. U. S. Fish and Wildlife Service, Resource Publication 164.
- Hennighausen, F. H. 1969. Meters and their effects in the Roswell Artesian Basin in Chaves and Eddy counties, New Mexico. Pp. 29-33, *In* 14th Annual New Mexico Water Conference (Water Resources Institute).
- Hershler, R., H.-P. Liu, B. K. Lang. 2007. Genetic and morphologic variation of the Pecos assiminea, an endangered mollusk of the Rio Grande region, United States and Mexico (Caenogastropoda: Risssooidea: Assimineidae). *Hydrobiologia* 579:317-335.
- Jercinovic, D. E. 1982. Assessment of refined petroleum-product contamination problems in surface and ground waters of New Mexico. Water Pollution Control Bureau, New Mexico Environmental Improvement Division, EID/WPC-82/5.
- Jercinovic, D. E. 1984. Petroleum-product contamination of soil and water in New Mexico. New Mexico Environmental Improvement Division, EID/GWH84/2.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish, Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2010. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Longmire, P. A. 1983. Petroleum-product contamination of ground and surface water: a literature review. Ground Water Section, Water Pollution Control Bureau, New Mexico Environmental Improvement Division. EID/WPC-83/7.
- Martinez, J. D., K. S. Johnson, and J. T. Neal. 1998. Sinkholes in evaporite rocks. *American Scientist* 86:38-51.
- McQuillan, D. M., M. J. Jasper, and B. H. Swanson. 1989. Ground-water contamination by septic-tank use: a field study in the Albuquerque south Valley - West Mesa Region, Bernalillo County, New Mexico. New Mexico Health and Environment Department, Environmental Improvement Division, Ground Water Bureau.
- New Mexico Department of Game and Fish. 2005. Recovery and conservation plan for four invertebrate species: Noel's amphipod (*Gammarus desperatus*), Pecos assiminea (*Assiminea pecos*), Koster's springsnail (*Juturnia kosteri*), and Roswell springsnail (*Pyrgulopsis roswellensis*). 80 pp.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Quarles, J. 1983. Groundwater contamination in the United States. University of Pennsylvania Press, Philadelphia.
- Rail, C. D. 1989. Groundwater contamination: sources, control, and preventative measures. Technomic Publishing Company, Inc. Lancaster, PA.
- Research Management Consultants, Inc. 1998. Final comprehensive conservation plan and environmental assessment: Bitter Lake National Wildlife Refuge.
- Richard, M. 1988a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: review of the geohydrology in the vicinity of Rattlesnake Springs and the contamination problem. Report 1. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. 1988b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the first field investigation, August 1988. Report 2. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the second field investigation, March, 1988. Report 3. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: final summary of the investigation. Report 4. National Park Service Contract RFQ 7029-8-0025.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.

- United States Department of Justice. 1996. United States of America's statement of claim for reserved surface water and groundwater rights for Bitter Lake National Wildlife Refuge. Roswell Basin Section, RAB 923 and 1793, Denver.
- United States Fish and Wildlife Service. 1997. Biological opinion on the Roswell Resource Area Resource Management Plans. Section 7 Consultation #2-22-96-102.
- United States Fish and Wildlife Service. 2005. Endangered and Threatened Wildlife and Plants; Listing Roswell springsnail, Koster's tryonia, Pecos Assiminea, and Noel's Amphipod as Endangered with Critical Habitat; Final Rule. Federal Register 70(152):46303-46333.
- White, B. W., D. C. Culver, J. S. Herman, T. C. Kane, and J. E. Mylroie. 1995. Karst lands: the dissolution of carbonate rock produces unique landscapes and poses significant hydrological and environmental concerns. *American Scientist* 83:450-459.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.
- Zokaites, C. 1997. Living on karst: a reference guide for landowners in limestone regions. Cave Conservancy of the Virginias. 25 pp.

Wrinkled marshsnail, *Stagnicola caperata*

Distribution: While this widespread species is stable over much its North American range, populations are disjunct in New Mexico, Texas, and higher elevations of some western states where declines or local extinctions have been documented (Bequaert and Miller 1973; Taylor 1983a, 1983b). Extirpation of the BLNWR population between 1983-1985 was attributed to extensive wetland habitat loss, alteration, and sewage contamination from the Roswell wastewater treatment plant (Taylor 1983a; NMDGF 1988). However recent surveys have reconfirmed the presence of this species at BLNWR and at localities in the Jemez Mountains (i.e., Valles Caldera National Preserve, Vermejo Park Ranch) in New Mexico.

Current Status: The wrinkled marshsnail was listed as state endangered in 1983. Lang (2005, 2010) reported this species from live specimens in: Hunter Marsh, BLNWR (including municipal land adjacent to the west); vernal grassland pools, Valle Grande, Valles Caldera National Preserve; and in high-elevation snowmelt pools near Big Costilla Peak, Taos County. Collections (2005) have occurred from the type locality, New Harmony, IN, but this collection occurred during a dried pool and may not serve well for genetic comparisons between NM/TX populations versus more eastern populations based on shell morphology.

Recent genetic analysis (mt.DNA: 16S rRNA [16S], cytochrome COI, and NADH dehydrogenase I (ND1) indicate that low-elevation populations in NM and Texas were significantly different when compared to high-elevation populations in NM (Morningstar 2012).

Threats: Water contamination from sewage effluent and habitat modification, including wetland desiccation and removal of wetland vegetation (e.g., wildland fire, prescribed burning, cutting, excessive grazing pressure) represent primary threats (Taylor 1983a; NMDGF 1988). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should continue to conduct statewide surveys of high-elevation vernal pools and low-elevation ephemeral marsh habitats, and work with land managers to provide continued protection for known populations. Genetic and morphologic studies are recommended to assess taxonomic affinities of low- and high-elevation populations in New Mexico and west Texas relative to populations in the eastern United States.

Literature Cited:

- Bequaert, J. C. and W. B. Miller. 1973. The mollusks of the Arid Southwest with an Arizona checklist. University of Arizona Press, Tucson. 271 pp.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.

- Lang, B. K. 2005. Macroinvertebrates of Bitter Lake National Wildlife Refuge. New Mexico Department of Game and Fish, Completion Report E-56-(1-3) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2010. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Cayla Morningstar. 2012. Molecular phylogenetic and morphological analyses of the state endangered wrinkled marshsnail *Stagnicola caperata* (Say, 1829). Annual Report to New Mexico Department of Game & Fish under *Share with Wildlife* contract, 12-516-0000-XXXX..
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-264.
- Taylor, D. W. 1983a. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor, D. W. 1983b. Status survey of aquatic molluscs in Diamond Y Draw, Pecos County, Texas. Report to USFWS, 24 pp.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Florida mountainsnail, *Oreohelix florida*

Distribution: *Oreohelix florida* is endemic to the Florida Mountains, Luna County, NM (Metcalf and Smartt 1997). Pilsbry (1915) first reported this species as “*Oreohelix strigosa* var.” from two fossil specimens. In his species description, Pilsbry (1939) considered it a subspecies of *O. metcalfei*. Metcalf (1974) elevated *florida* to full species rank based on unique shell characteristics. Additional state records from the Santa Rita and Tres Hermanas mountains, Cooke Peak, and Apache Hills are also of fossil specimens (Metcalf and Smartt 1997).

Current Status: The Florida mountainsnail was listed as state endangered in 1990. This species is known only from fossil shells; no live snails were found despite numerous malacological explorations during the late 1900’s (Metcalf and Smartt 1997; Lang 2000). The apparent extinction of *O. florida*, and other primitive oreohelicids in southern and eastern New Mexico, might be attributed to climatic deterioration during the Holocene or natural extinction processes on small “montane islands” (MacArthur 1972; Metcalf and Smartt 1997).

Threats: Threats are not easily identified because an extant population has not been documented. However, land snails occupying high-elevation limestone outcrops are at risk from climate change, natural catastrophe (e.g., rock slides, wildfires), prescribed burning, and soil disturbance from mining and logging (NMDGF 1988; Sullivan 1997; Lang 2000).

Recommendations: Inventory of high-elevation limestone outcrops is recommended on “montane islands” along the international border of New Mexico and México. In the unlikely event an extant population is discovered, then habitat protection would be paramount.

Literature Cited:

- Lang, B. K. 2000. Status and distribution of terrestrial snails of southern New Mexico. New Mexico Department of Game and Fish, Completion Report E-36 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- MacArthur, R. M. 1972. *Geographical Ecology: Patterns in the Distribution of Species*. Princeton University Press. 269 pp.
- Metcalf, A. L. 1974. Peripheral species of the *Oreohelix* Cockerell complex (Pulmonata: Oreohelicidae). *The Nautilus* 88:94-100.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Pp.1-69, *In* Land Snails of New Mexico. (A. L. Metcalf and R. A. Smartt, Eds.). New Mexico Museum of Natural History and Science Bulletin 10.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-116.

- Pilsbry, H. A. 1915. Mollusca of the southwestern states, IV: the Hacheta Grande, Florida, and Peloncillo Mountains, New Mexico. *Proceeding of the Academy of Natural Sciences of Philadelphia* 67:323-350.
- Pilsbry, H. A. 1939. Land mollusca of North America (north of Mexico). *Academy of Natural Sciences of Philadelphia* 3(1):418-419, 514-515.
- Sullivan, R. M. 1997. Inventory of some terrestrial snails of southern New Mexico, with emphasis on state listed and federal candidate species of Doña Ana, Otero, and Socorro counties. Final Report submitted to the NMDGF under Professional Services Contract 96-516.64

BIVALVIA

THREATENED

Lake fingernailclam, *Musculium lacustre*

Distribution: *Musculium lacustre* is known from Central and South America, Hawaii, Japan, Australasia, and Europe (Herrington 1962, Mackie 2007). Populations in North America occur most frequently in high-elevation, deep-water marshes from Canada and Alaska south to the Sierra Nevada of California, and in the Rock Mountains of southern Utah (Burch 1975). In New Mexico, the lake fingernailclam is reported from Upper Cieneguilla Creek, Colfax County, near Angel Fire Recreation Area (Taylor 1983).

Current Status: The lake fingernailclam was listed as state threatened in 1983. The sole New Mexico population occurs on private land managed for recreational uses. The current status of *M. lacustre* in New Mexico is unknown.

Threats: Threats include contaminants from forest fire retardants (McDonald and Hamilton 1995) and habitat modification due to land development (NMDGF 1988). Poor watershed management could increase sedimentation of the wetland complex (Taylor 1983, NMDGF1988). Aquatic invasive species pose a threat to all native aquatic biota and ecosystems in New Mexico (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should continue aquatic surveys to determine the statewide distribution of sphaeriid clams.

Literature Cited:

- Burch, J. B. 1975. Freshwater sphaeriacean clams (Mollusca: Pelecypoda) of North America. U. S. Environmental Protection Agency, Biota of Freshwater Ecosystems, Identification Manual No. 3. 96 pp.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Herrington, H. B. 1962. A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). Museum of Zoology, University of Michigan, Miscellaneous Publications No. 118.
- McDonald, S. F. and S. J. Hamilton. 1995. Fire retardant and foam suppressant chemicals may be toxic to aquatic invertebrates and algae. National Biological Service. NBS Information Bulletin 35.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-318.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Mackie, G. L. 2007. Biology of Freshwater Corbiculid and Sphaeriid Clams of North America. Ohio Biological Survey, Columbus, OH. 436 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Swamp fingernailclam, *Musculium partumeium*

Distribution: The swamp fingernailclam is widespread throughout southern Canada and the United States, south to Nuevo Leon, México (Herrington 1962; Burch 1975; Mackie 2007). In New Mexico, this species is known only from private land in Road Canyon Creek, Union County (Taylor 1983; NMDGF 1988).

Current Status: *Musculium partumeium* was listed as state threatened in 1983. The current status of this species in New Mexico is unknown.

Threats: Primary threats to species persistence include poor watershed management, stream modification (channelization, diversion, dewatering), and water pollution (NMDGF 1988). Aquatic invasive species pose a threat to all native aquatic biota and ecosystems in New Mexico (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should continue aquatic surveys to determine the statewide distribution of sphaeriid clams.

Literature Cited:

- Burch, J. B. 1975. Freshwater sphaeriacean clams (Mollusca: Pelecypoda) of North America. U. S. Environmental Protection Agency, Biota of Freshwater Ecosystems, Identification Manual No. 3. 96 pp.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Herrington, H. B. 1962. A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). Museum of Zoology, University of Michigan, Miscellaneous Publications No. 118.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-319.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Mackie, G. L. 2007. Biology of Freshwater Corbiculid and Sphaeriid Clams of North America. Ohio Biological Survey, Columbus, OH. 436 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.
- Burch, J. B. 1975. Freshwater sphaeriacean clams (Mollusca: Pelecypoda) of North America. U. S. Environmental Protection Agency, Biota of Freshwater Ecosystems, Identification Manual No. 3. 96 pp.

Long fingernailclam, *Musculium transversum*

Distribution: Native range includes most of temperate and subtropical North America, from Labrador west to the Northwest Territories, south to central México (Herrington 1962; Burch 1975; Mackie 2007). New Mexico populations are known from sites within the Canadian River Basin (Conchas River, Cabra Springs, Ute Creek near Gladstone) and Dry Cimarron River Basin (Clayton Lake, Road Canyon Creek; Taylor 1983; NMDGF 1988). The largest known population in New Mexico was extirpated from the Pecos River below Carlsbad (Taylor 1983).

Current Status: The long fingernailclam was listed as state threatened in 1983. While the statewide status of this species is unknown, an extant population occurs in the Black River (Lang 2005).

Threats: Taylor (1983) attributed extirpation of the Pecos River population to irrigation water diversions. Additional threats could include stream modification (channelization, dewatering), water pollution, and poor watershed stewardship (NMDGF 1988). Aquatic invasive species pose a threat to all native aquatic biota and ecosystems in New Mexico (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should continue aquatic surveys to determine the statewide distribution of sphaeriid clams.

Literature Cited

- Burch, J. B. 1975. Freshwater sphaeriacean clams (Mollusca: Pelecypoda) of North America. U. S. Environmental Protection Agency, Biota of Freshwater Ecosystems, Identification Manual No. 3. 96 pp.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Herrington, H. B. 1962. A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). Museum of Zoology, University of Michigan, Miscellaneous Publications No. 118.
- Lang, B. K. 2005. Texas hornshell population monitoring. New Mexico Department of Game and Fish, Performance Report T-30-P-1 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-320.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Mackie, G. L. 2007. Biology of Freshwater Corbiculid and Sphaeriid Clams of North America. Ohio Biological Survey, Columbus, OH. 436 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Lilljeborg's peaclam, *Pisidium lilljeborgi*

Distribution: In North America, this circumboreal species occurs in lakes and rivers from the Arctic south across the northern United States (Herrington 1962; Burch 1975; Mackie 2007). *Pisidium lilljeborgi* is found in high-elevation lakes of California (Trinity Alps), Utah (Uinta Mountains), and New Mexico (Sangre de Cristo Mountains, Nambe Lake, Santa Fe County; Taylor 1983). The New Mexico population represents the most southern and highest elevational occurrence in either North America or Eurasia (Taylor 1983, NMDGF 1988). Nambe Lake is a glacial cirque located in the Santa Fe National Forest, and is managed as a water reservoir for the City of Santa Fe.

Current Status: Lilljeborg's peaclam was listed as state threatened in 1983. The current status of this species is unknown in New Mexico.

Threats: Due to its restricted distribution, the Nambe Lake population is vulnerable to contaminants from fire suppressant chemicals and natural stochastic events (fire, sedimentation) (Taylor 1983; NMDGF 1988; McDonald and Hamilton 1995). Reservoir drawdown practices and drought conditions could affect the Nambe Lake population. Aquatic invasive species pose a threat to all native aquatic biota and ecosystems in New Mexico (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should continue surveys of high-elevation, aquatic habitats to determine the statewide distribution of sphaeriid clams.

Literature Cited

- Burch, J. B. 1975. Freshwater sphaeriacean clams (Mollusca: Pelecypoda) of North America. U. S. Environmental Protection Agency, Biota of Freshwater Ecosystems, Identification Manual No. 3. 96 pp.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Herrington, H. B. 1962. A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). Museum of Zoology, University of Michigan, Miscellaneous Publications No. 118.
- Mackie, G. L. 2007. Biology of Freshwater Corbiculid and Sphaeriid Clams of North America. Ohio Biological Survey, Columbus, OH. 436 pp.
- McDonald, S. F. and S. J. Hamilton. 1995. Fire retardant and foam suppressant chemicals may be toxic to aquatic invertebrates and algae. National Biological Service. NBS Information Bulletin 35.

- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-333.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Sangre de Cristo peaclam, *Pisidium sanguinichristi*

Distribution: This narrowly distributed peaclam is endemic to a single, high-elevation (10,485 ft) glacial cirque (Middle Fork Lake) at the base of Bull of the Woods Mountain, Taos County. The Sangre de Cristo peaclam colonizes muddy shallows along the lake perimeter and a short reach of the lake outflow (i.e., Middle Fork Creek; Taylor 1983, 1987; NMDGF 1988). This peaclam can be considered among the most narrowly restricted of all known North American pisidia and perhaps worldwide (Lang 2002).

Current Status: The Sangre de Cristo peaclam was listed as state threatened in 1983. Annual surveys began in July 1995 under a multi-agency conservation effort initiated by the U. S. Forest Service (1996). A total of 42 sites was surveyed from 1995-1999 in the northern Sangre de Cristo Mountains to determine the species' range. Only six valves out of an abundance of *Pisidium* voucher material (i.e., exceeding ca. 750 specimens) collected from Middle Fork Lake remotely resembled *P. sanguinichristi* specimens (B. Lang, NMDGF; Dr. G. L. Mackie, University of Guelph, Canada: *pers. obs.*). No pisidia collected from any other sites during this 4-year survey were referable to *P. sanguinichristi*. Based on the apparent absence of *P. sanguinichristi* from the type locality, and the lack of discernable differences in shell shape and hinge dentition between paratype *P. sanguinichristi* and the conchologically similar and co-occurring congener, *Pisidium milium*, the NMDGF (1996) requested taxonomic assessment of the putative *P. sanguinichristi* as a valid species. A mitochondrial DNA study comparing the nominal species with *P. milium* yielded inconclusive results because this biochemical analysis was restricted to a comparison of DNA extracted from shell proteins (Wilson et al. 1998). The taxonomic validity of this species merits further study (Lang 2002). The TL was re-surveyed in 2011. These collections are need to compared with previously sampled material, including paratypes, to assess the taxonomic validity of this species.

Threats: Whereas the remoteness and ownership of Middle Fork Lake (Carson National Forest) affords some measure of protection, the site experiences intense periods of seasonal recreational use (USFS 1996). Threats include: shoreline destabilization (erosion and sedimentation due to foot and vehicular traffic), contamination from chemicals used in fish stocking and forest fire suppressants, placer mining runoff, and natural stochastic events (fire, drought; Taylor 1983; NMDGF 1988; McDonald and Hamilton 1995; USFS 1996). Aquatic invasive species pose a threat to all native aquatic biota and ecosystems in New Mexico (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. The NMDGF should continue sphaeriid clam surveys in high-elevation, wetland habitats throughout the Sangre de Cristo Mountains. In the event live peaclams referable to *P. sanguinichristi* are located, genetic studies comparing *P. sanguinichristi* with *P. milium* would be in order. While a study comparing shell characteristics of these congeners may help resolve outstanding taxonomic questions, considerable ecophenotypic variation in shell morphology and hinge dentition of sphaeriid clams manifested by local environmental influences could render such an effort futile (Herrington 1962; Mackie 2007). Moreover, genetic study is contingent upon securing an adequate sample size of the putative *P. sanguinichristi*.

Literature Cited:

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish, Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.

- Mackie, G. L. 2007. Biology of Freshwater Corbiculid and Sphaeriid Clams of North America. Ohio Biological Survey, Columbus, OH. 436 pp.
- McDonald, S. F. and S. J. Hamilton. 1995. Fire retardant and foam suppressant chemicals may be toxic to aquatic invertebrates and algae. National Biological Service. NBS Information Bulletin 35.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-334.
- New Mexico Department of Game and Fish. 1996. Status of aquatic and terrestrial mollusks. Completion Report submitted to the U. S. Fish and Wildlife Service, Albuquerque, NM.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- United States Forest Service. 1996. Habitat conservation assessment for the Sangre de Cristo peaclam (*Pisidium sanguinichristi*).
- Wilson, A. B., W. T. Claxton, and G. L. Mackie. 1998. mtDNA COI sequencing of *Pisidium milium* and *P. sanguinichristi*: Does molecular data support species-level designations? Final Report under Professional Services Contract, 5 pp.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.
- Herrington, H. B. 1962. A revision of the Sphaeriidae of North America (Mollusca: Pelecypoda). Museum of Zoology, University of Michigan, Miscellaneous Publications No. 118.

GASTROPODA

THREATENED

Gila springsnail, *Pyrgulopsis gilae*

Distribution: The Gila springsnail is endemic to springs of variable temperature regimes in the Gila River basin, Grant County (Taylor 1983, 1987). Previously, *Pyrgulopsis gilae* was known from ten populations throughout this drainage (Taylor 1983, 1987; Mehlhop 1993; Lang 2002; NMDGF 2008a). Field surveys conducted in 2008 and 2009 expanded on this species distribution. Currently, *P. gilae* occurs in 43 populations scattered throughout the East Fork Gila River and Middle Fork Gila River (Catron and Grant counties), including one site (Alum Spring, Grant County) on the Gila River mainstem (Lang 2010).

Current Status: This springsnail was listed as state threatened in 1985 (NMDGF Regulation 624). Based on recent discovery of many previously unknown populations (Lang 2010) and of lack of threats to these populations (USFWS 2011), this species was removed as a candidate for listing under the Endangered Species Act. All known populations occur on U. S. Forest Service lands and private inholdings within the Gila National Forest and in the Gila Wilderness. Hershler and Liu (2010) suggested continuance of morphologic and genetic studies of this species throughout its currently understood range to address further possibilities of taxonomic revisions for three, geographically-distinct “sub-groups.”

Recent study comparing among-population genetic divergence (mtDNA) suggests that *P. gilae* populations in the upper East Fork Gila River and those occurring in the Middle Fork Gila River are genetically distinct from populations in the lower East Fork Gila River and the Gila River mainstem. The upper East Fork Gila River and Middle Fork Gila River populations may merit unique species level recognition (Hershler and Liu 2010).

Threats: Based on surveys conducted since 2001, all indications are that populations of Gila springsnail are stable. While no direct threats can be currently identified (USFWS 2011), possible environmental stressors could include: natural stochastic events (drought, forest fire, sedimentation, flooding), wetland habitat degradation from recreational bathing, poor watershed management, and water contamination from recreational bathing and fire

suppressant chemicals (Taylor 1983, 1987; NMDGF 1988; Mehlhop 1993; McDonald and Hamilton 1995; Lang 2002, 2010). Introduction of non-native crayfish and the New Zealand mudsnail can adversely impact springsnails and aquatic habitats (Fernandez and Rosen 1996; NMDGF 2008b, <http://www.esg.montana.edu/aim/mollusca/nzms/nzmsbib.html>). Long-term persistence of this species is contingent upon protection of spring sources, their outflows, and the riparian corridor immediately adjacent to these habitats. Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should monitor extant populations and expand aquatic surveys to include unexplored reaches within the Gila River basin. Recommend allocation of funding to continue taxonomic assessment of *P. gilae* among geographically isolated populations throughout the Gila River basin. Any significant genetic and/or morphologic divergence may warrant taxonomic re-evaluation of the species, which may confer specific management recommendations particular to genetically distinct populations relative to current ownership and land-use practices.

Literature Cited:

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Fernandez, P. J. and P. C. Rosen. 1996. A microcosm study of the effects of an introduced crayfish (*Orconectes virilis*) on aquatic plants, invertebrates, and herpetofauna from Arizona. Final Report, Part II, IIPAM Project No. I9404, Heritage Program, Arizona Game and Fish Department.
- Hershler, R. and H-P. Liu. 2010. Genetic variation of threatened springsnails from the Gila River basin, NM. Final Report to New Mexico Department of Game and Fish under Professional Services Contract No. 10-516-0000-00010. 16pp.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish, Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Lang, B. K. 2010. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- McDonald and Hamilton. 1995. Fire retardant and foam suppressant chemical may be toxic to aquatic invertebrates and algae. NBS Information Bulletin, No. 35.
- Mehlhop, P. 1993. Establishment of a rare mollusc inventory and monitoring program for New Mexico. Year II Progress Report. NMDGF Professional Services Contract No. 80-519-52-Amendment 1.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-298.
- New Mexico Department of Game and Fish. 2008a. Threatened and endangered species of New Mexico: biennial review and recommendations.
- New Mexico Department of Game and Fish. 2008b. New Mexico aquatic invasive species management plan. 107 pp.
- United States Fish and Wildlife Service. 2011. Endangered and threatened wildlife and plants; review of native species that are candidates for listing as endangered or threatened; annual notice of findings on resubmitted petitions; annual descriptions of progress on listing actions. Federal Register 76(207):66370-66439.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Pecos springsnail, *Pyrgulopsis pecosensis*

Distribution: *Pyrgulopsis pecosensis* is endemic to two perennial tributaries of the Black River, Eddy County, New Mexico: Blue Spring (type locality) and Castle Spring (Taylor 1987).

Current Status: The Pecos springsnail was listed as state threatened in 1983. Acquisition of Blue Spring surface water rights (72-5-28 NMSA 1995) and the “...lack of oil and gas reserves in the area...” prompted reclassification of *P. pecosensis* as a federal candidate for listing under the Endangered Species Act to a species of concern (USFWS 1996). This acquisition of surface water rights from Blue Spring was a temporary state lease. Contrary to this reclassification, the Black River valley has experienced repeated problems of ground water depletion and contamination. Water levels of domestic and agricultural/range wells in this watershed have lowered and even dried-up (residents of Black River Village and environs, *pers. com.*). Pecos springsnail is apparently extirpated from Castle Spring (Landye 1981, NMDGF 1988, Mehlhop 1992). Lang (2002, 2004) reported persistence of *P. pecosensis* in Blue Spring from springhead sources downstream through the middle reach of the spring run. This population has been monitored annually since 1997 and is currently stable (Lang 2011). *P. pecosensis* and Blue Spring are afforded protections in the CCA developed specifically for Texas hornshell. This CCA was developed by USFWS in conjunction with many stakeholders, including NMDGF, private landowners, and representatives from the oil and gas industry.

Threats: Taylor (1983) identified ground water depletion as the primary threat to extant populations of *P. pecosensis*. Extirpation of the Castle Spring population was attributed to a number of factors including flood scour, ground water depletion, and possible contamination from an upstream livestock tank (Landye 1981; NMDGF 1988; Mehlhop 1992). Regional ground water withdrawals for agriculture and oil and gas industry operations (exploration, storage, transfer and refining) are ongoing in the Black River valley and adjacent aquifers in Eddy County (BLM 1997). Such extractive processes and industry operations are known to deplete aquifers and to contaminate ground and surface waters in New Mexico (Hennighausen 1969; Jercinovic 1982, 1984; Longmire 1983; Quarles 1983; Boyer 1986; Richard 1988a, 1988b; Rail 1989; Richard and Boehm 1989a, 1989b; Balleau Groundwater, Inc. 1996; Martinez et al. 1998). Aquatic mollusks are acutely sensitive to ground and surface water contaminants (Havlik and Marking 1987; Eisler 1987; Green and Trett 1989; Augspurger et al. 2003). Richard (1988a, 1988b) and Richard and Boehm (1989a, 1989b) documented ground water contamination of domestic and agricultural/range wells in the upper Black River valley (i.e., Washington Ranch, Ballard Wells) by petroleum-derived hydrocarbons and sulfides. Richard and Boehm (1989b) reported “severe” sulfide contamination of Blue Spring, a regionally significant artesian spring that is a primary hydrologic source for the Black River (Hendrickson and Jones 1952). These authors indicated that gas contamination originating up-gradient was likely transported about 20 miles down-gradient to Blue Spring. Such long distance transport of ground water is common in karst, evaporite rock (White et al. 1995; Martinez et al. 1998). This raises long-term concerns for surface water quality of the Blue Spring wetland complex and the Black River, especially considering the proliferation of petroleum industry operations in the Black River valley. Oil and gas industry operations within the immediate watershed of Blue Spring are ongoing. Prolonged drought could reduce flow through the system, resulting in habitat loss while also increasing salinity and potentially concentrating contaminants. Introduction of non-native crayfish and the invasive New Zealand mudsnail can adversely impact springsnails and aquatic habitats (Fernandez and Rosen 1996; NMDGF 2008; <http://www.esg.montana.edu/aim/mollusca/nzms/nzmsbib.html>). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should develop a state recovery plan for this species. A “Candidate Conservation Agreement” (USFWS 1997) could provide a mechanism for species and habitat conservation compatible with past and present land-use practices. Continue annual habitat and population monitoring of *P. pecosensis* in Blue Spring.

Literature Cited:

- Augspurger, T., A. E. Keller, M. C. Black, W. G. Cope, and F. J. Dwyer. 2003. Water quality guidance for protection of freshwater mussels (Unionidae) from ammonia exposure. *Environmental Toxicology and Chemistry* 22(11):2569-2575.
- Balleau Groundwater, Inc. 1996. Interrelation of groundwater and surface water at Bitter Lake National Wildlife Refuge. A report prepared for the U.S. Department of Justice. 16 pp. (with addenda).
- Boyer, D. G. 1986. Differences in produced water contaminants from oil and gas operations in New Mexico – implications for regulatory action. Pp. 291-316, *In Proceedings of the Conference on Southwestern Ground Water Issues* (National Water Well Association, Publisher).
- Bureau of Land Management. 1997. Carlsbad Approved Resource Management Plan, Amendment and Record of Decision, Carlsbad Resource Area, Roswell District, New Mexico. BLM-NM-PT-98-004-1610.

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a syntopic review. U.S. Fish and Wildlife Service. Contaminant Hazard Reviews Report No. 11, Biological Report 85 (1.11).
- Fernandez, P. J. and P. C. Rosen. 1996. A microcosm study of the effects of an introduced crayfish (*Orconectes virilis*) on aquatic plants, invertebrates, and herpetofauna from Arizona. Final Report, Part II, IIPAM Project No. 19404, Heritage Program, Arizona Game and Fish Department.
- Green, J. and M. W. Trett. 1989. The fate and effects of oil in freshwater. Elsevier Science Publishing Co., Inc., New York.
- Havlik, M. E. and L. L. Marking. 1987. Effects of contaminants on naiad mollusks (Unionidae): a review. U. S. Fish and Wildlife Service, Resource Publication 164.
- Hendrickson, G. E., and R. S. Jones. 1952. Geology and ground-water resources of Eddy County, New Mexico. U.S. Geological Survey, Ground-Water Report 3, 169 pp.
- Hennighausen, F. H. 1969. Meters and their effects in the Roswell Artesian Basin in Chaves and Eddy counties, New Mexico. Pp. 29-33, *In* 14th Annual New Mexico Water Conference (Water Resources Institute).
- Jercinovic, D. E. 1982. Assessment of refined petroleum-product contamination problems in surface and ground waters of New Mexico. Water Pollution Control Bureau, New Mexico Environmental Improvement Division, EID/WPC-82/5.
- Jercinovic, D. E. 1984. Petroleum-product contamination of soil and water in New Mexico. New Mexico Environmental Improvement Division, EID/GWH84/2.
- Landye, J. J. 1981. Current status of endangered, threatened, and/or rare mollusks of New Mexico and Arizona. Endangered Species Office, U.S. Fish and Wildlife Service, Final Report 13.
- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish, Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2004. Aquatic mollusks of Bitter Lake National Wildlife Refuge. New Mexico Department of Game and Fish, Annual Performance Report E-56-2 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2011. Aquatic mollusks of Bitter Lake National Wildlife Refuge. New Mexico Department of Game and Fish, Annual Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Longmire, P. A. 1983. Petroleum-product contamination of ground and surface water: a literature review. Ground Water Section, Water Pollution Control Bureau, New Mexico Environmental Improvement Division. EID/WPC-83/7.
- Martinez, J. D., K. S. Johnson, and J. T. Neal. 1998. Sinkholes in evaporite rocks. *American Scientist* 86:38-51.
- Mehlhop, P. 1992. Establishment of a rare mollusc inventory and monitoring program for New Mexico. Progress Report. NMDGF Professional Services Contract 80-519-52.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-299.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107pp.
- Quarles, J. 1983. Groundwater contamination in the United States. University of Pennsylvania Press, Philadelphia.
- Rail, C. D. 1989. Groundwater contamination: sources, control, and preventative measures. Technomic Publishing Company, Inc. Lancaster, PA.
- Richard, M. 1988a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: review of the geohydrology in the vicinity of Rattlesnake Springs and the contamination problem. Report 1. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. 1988b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the first field investigation, August 1988. Report 2. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989a. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: report of the second field investigation, March, 1988. Report 3. National Park Service Contract RFQ 7029-8-0025.
- Richard, M. and A. Boehm. 1989b. Natural gas contamination at Rattlesnake Springs, Carlsbad Caverns National Park: final summary of the investigation. Report 4. National Park Service Contract RFQ 7029-8-0025.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.

- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- U. S. Fish and Wildlife Service. 1996. Endangered and Threatened Species; Reclassification of 96 Candidate Taxa. Federal Register, 61(40):7457-7463.
- U. S. Fish and Wildlife Service. 1997. Announcement of Draft Policy for Candidate Conservation Agreements; Notice of Review. Federal Register 62(113):32183-32188.
- White, B. W., D. C. Culver, J. S. Herman, T. C. Kane, and J. E. Mylroie. 1995. Karst lands: the dissolution of carbonate rock produces unique landscapes and poses significant hydrological and environmental concerns. American Scientist 83:450-459.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. Global Change Biology 11:1557-1564.

New Mexico springsnail, *Pyrgulopsis thermalis*

Distribution: *Pyrgulopsis thermalis* is endemic to 13 thermal springs along the lower East Fork Gila River, and also occurs in Alum Spring (type locality), Gila River mainstem, Grant County (Taylor 1983, 1987; Mehlhop 1993; Lang 2010). This species prefers thermal spring waters with temperatures ranging from 33 to 39° C (Taylor 1987), but has been found in lower abundance at 19.5° C (Lang 2010).

Current Status: The New Mexico springsnail was listed as state threatened in 1983. Based on recent discovery of many previously unknown populations (Lang 2010), the lack of threats to these populations prompted the USFWS (2011) to remove this species as a candidate for listing under the Endangered Species Act. Stable populations have been reported consistently over past 18 years (Mehlhop 1992, 1993; Lang 2010). All known populations occur on U. S. Forest Service lands and private inholdings within the Gila National Forest. Due to genetic evidence of low mtDNA sequence divergence (COI = 1.6-3.0%) and lack of sufficient morphologic differences among populations of *P. thermalis*, Hershler and Liu (2010) recommended that populations of this species be treated as “conservation units”.

Threats: Routine monitoring since 2001 indicates that populations of New Mexico springsnail are stable. While no direct threats can be currently identified, possible stressors could include: natural stochastic events (drought, forest fire, sedimentation, flooding), wetland habitat degradation from recreational bathing, poor watershed management, and water contamination from recreational bathing and fire suppressant chemicals (Taylor 1983, 1987; NMDGF 1988; Mehlhop 1993; McDonald and Hamilton 1995; Lang 2002, 2010). Introduction of non-native crayfish and the invasive New Zealand mudsnail can adversely impact springsnails and aquatic habitats (Fernandez and Rosen 1996; NMDGF 2008; <http://www.esg.montana.edu/aim/mollusca/nzms/nzmsbib.html>). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should monitor extant populations and expand surveys to malacologically unexplored reaches within the Gila River Basin. Efforts to control the use of personal hygiene detergents (e.g., soap, shampoo, etc.) by bathers could protect habitat for *P. thermalis* in downstream reaches of Alum Spring. Signage that prohibits use of cleansing agents would still allow for recreational use of the spring.

Literature Cited

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. Oecologia 151:03-103.
- Fernandez, P. J. and P. C. Rosen. 1996. A microcosm study of the effects of an introduced crayfish (*Orconectes virilis*) on aquatic plants, invertebrates, and herpetofauna from Arizona. Final Report, Part II, IIPAM Project No. 19404, Heritage Program, Arizona Game and Fish Department.
- Hershler, R. and H-P. Liu. 2010. Genetic variation of threatened springsnails from the Gila River basin, NM. Final Report to New Mexico Department of Game and Fish under Professional Services Contract No. 10-516-0000-00010. 16pp.

- Lang, B. K. 2002. Status of aquatic mollusks of New Mexico. New Mexico Department of Game and Fish, Completion Report E-20-(5-9) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2010. Macroinvertebrate of Bitter Lake National Wildlife Refuge. NMDGF Performance Report E-56-7 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- McDonald, S. F. and S. J. Hamilton. 1995. Fire retardant and foam suppressant chemicals may be toxic to aquatic invertebrates and algae. National Biological Service. NBS Information Bulletin 35.
- Mehlhop, P. 1992. Establishment of a rare mollusc inventory and monitoring program for New Mexico. Progress Report. NMDGF Professional Services Contract 80-519-52.
- Mehlhop, P. 1993. Establishment of a rare mollusc inventory and monitoring program for New Mexico. Year II Progress Report. NMDGF Professional Services Contract No. 80-519-52-Amendment 1.
- Moritz, C. 1994. Defining 'Evolutionarily Significant Units' for conservation. Trends in Ecology and Evolution 9: 373-375.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-301.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Taylor, D. W. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Service Contract Nos. 519-69-01 and 519-69-01-A.
- Taylor, D. W. 1987. Fresh-water mollusks from New Mexico and vicinity. New Mexico Bureau of Mines & Mineral Resources Bulletin 116.
- United States Fish and Wildlife Service. 2011. Endangered and threatened wildlife and plants; review of native species that are candidates for listing as endangered or threatened; annual notice of findings on resubmitted petitions; annual descriptions of progress on listing actions. Federal Register 76(207):66370-66439.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. Global Change Biology 11:1557-1564.

Star gyro, *Gyraulus crista*

Distribution: This species is widespread throughout northern North America, ranging south into northern New Mexico, where it occurs in emergent wetlands associated with Black Lake and Coyote Creek, Colfax County (Taylor 1983, NMDGF 1988).

Current Status: The star gyro was listed as state threatened in 1983. The status of this species is currently unknown in New Mexico.

Threats: Habitat modification due to any alteration of the wetland complex, pollution, dewatering, or land development within the proximate watershed (Taylor 1983; NMDGF 1988). Aquatic invasive species pose a threat to all native aquatic biota and ecosystems in New Mexico (NMDGF 2008). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should resurvey known site occurrences and conduct statewide surveys to determine the distribution of this species.

Literature Cited

- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. Oecologia 151:03-103.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-281.
- New Mexico Department of Game and Fish. 2008. New Mexico aquatic invasive species management plan. 107 pp.
- Taylor, D. T. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Services Contract Nos. 519-69-01 and 519-69-01A.

Xenopoulos, A., M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P. Van Vuuren. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Shortneck snaggletooth, *Gastrocopta dalliana dalliana*

Distribution: *Gastrocopta dalliana dalliana* is widespread in Arizona (central, southern, and western), and has been documented throughout northern México (Chihuahua and Sonora) south to Baja California (Bequaert and Miller 1973). In New Mexico, shortneck snaggletooth appears restricted to geographically disparate populations in the Upper Sonoran Life Zone of the Animas (Indian Creek Canyon), Big Hatchet, San Luis (Lang Canyon) and Peloncillo mountains (Coronado National Forest lands) of Hidalgo County (Metcalf and Smartt 1997; Lang 2000). Fossil records reported by Branson et al. (1966) near Santa Rosa from drift along the Pecos River are questionable.

Current Status: The shortneck snaggletooth was listed as state endangered in 1990, and was downlisted to threatened during the 2008 Biennial Review. In New Mexico, *G. d. dalliana* is more widespread than previously thought. This species occurs in a diversity of low-elevation plant communities of southwestern Hidalgo County: densely wooded, mesic habitat of Indian Creek Canyon, Animas Mountains (Lang 2000); along the riparian corridor of Guadalupe Canyon (Dr. Artie L. Metcalf, UTEP, unpub. data); and sparse juniper-oak forest (Dr. J. Nekola, UNM, unpub. data). It also occurs sporadically on exposed dry slopes in the Big Hatchet and San Luis mountains (Lang 2000). Habitat vital to *G. d. dalliana* in the Animas and San Luis mountains is under stewardship of the private landowner. The population in the Big Hatchet Mountains occurs on BLM land.

Threats: Habitat modification from logging, mining, and wildland fire represent primary threats to localized populations (NMDGF 1988, Lang 2000).

Recommendations: NMDGF should continue land snail surveys to refine the range of this species in southwestern New Mexico, and work with land managers to ensure that habitat management promotes persistence of the species.

Literature Cited

- Bequaert, J. C. and W. B. Miller. 1973. The mollusks of the Arid Southwest with an Arizona checklist. University of Arizona Press, Tucson. 271 pp.
- Branson, B. A., M. E. Sisk, and C. J. McCoy. 1966. Observations on and distribution of some western and southwestern mollusks. *The Veliger* 9(2):149.
- Lang, B. K. 2000. Status and distribution of terrestrial snails of southern New Mexico. New Mexico Department of Game and Fish, Completion Report E-36 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Pp. 1-69, *In* Land Snails of New Mexico. (A. L. Metcalf and R. A. Smartt, Eds.). New Mexico Museum of Natural History and Science Bulletin 10.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-222.

Ovate vertigo, *Vertigo ovata*

Distribution: The historic range of *Vertigo ovata* included northern North America, ranging south over most of the United States to México. The occurrence of *V. ovata* in the Western Molluscan Province is sporadic, especially in the Rocky Mountain States (Bequaert and Miller 1973). Fossil specimens of *V. ovata* from spring-related Pleistocene and Holocene deposits chronicle the extirpation of localized populations throughout Arizona, New Mexico, and western Texas (Metcalf 1967; Bequaert and Miller 1973; Metcalf and Smartt 1997). In New Mexico, extant populations are known from mesic habitats of Blue Spring, Eddy County, and from the riparian corridor associated with Alamosa Creek immediately upstream of the Monticello Box, Socorro County (Lang 2001a).

Current Status: The ovate vertigo was listed as state threatened in 1991 (NMDGF Regulation 682). Populations at Blue Spring (Eddy County) and Alamosa Creek (Socorro County) appear stable under current land use practices, with evidence of successful reproduction and recruitment of immature snails into the adult population (Lang 2001a). In 2010, this species was found extant in a marsh system located adjacent to the middle Rio Grande south of Cochiti Dam (B. Lang, biologist, NMDGF, pers. obs.).

Threats: In the Desert Southwest, reduction in habitat suitability for this species is attributable to natural stochastic events (e.g., Holocene warming, arroyo entrenchment; Haynes, 1968) exacerbated by human-related land use activities (e.g., wetland [marsh] drainage and development, stream diversion, grazing; Metcalf and Smartt 1997). Beryllium ore exploration and mining within the immediate watershed of Alamosa Creek have posed threats to this species (Lang 2001b, 2003, 2009). Extant populations at Blue Spring are threatened by ground water extraction and oil and gas industry operations which can result in local/regional aquifer depletion (Hennighausen 1969; Quarles 1983), diminution of spring flows (NMDGF 1988), and surface and ground water contamination (Jercinovic 1982, 1984; Longmire 1983; Quarles 1983; Boyer 1986; Eisler 1987; Green and Trett 1989). Poor watershed stewardship and natural stochastic events, such as prolonged drought, could adversely impact habitat conditions at all three known sites by reducing hydrologic discharge through wetland systems, thereby desiccating riparian plant communities and increasing grazing pressure in these areas (Taylor 1983; NMDGF 1988; Mehlhop 1992). Aquatic ecosystems and macroinvertebrates are likely to show strong responses to global climate change (Xenopoulos et al. 2005; Burgmer et al. 2007).

Recommendations: No change in listing status is recommended. NMDGF should continue statewide surveys of marsh habitats while monitoring extant populations. Resource agencies should pursue opportunities to acquire private lands, including mineral and ground water rights, where future beryllium ore exploration or mining may adversely affect aquifers that supply spring-fed wetlands of Alamosa Creek upstream of the Monticello Box.

Literature Cited

- Bequaert, J. C. and W. B. Miller. 1973. The mollusks of the Arid Southwest with an Arizona checklist. University of Arizona Press, Tucson. 271 pp.
- Boyer, D. G. 1986. Differences in produced water contaminants from oil and gas operations in New Mexico – implications for regulatory action. Pp. 291-31, *In* Proceedings of the Conference on Southwestern Groundwater Issues (D. K. Kreamer, Moderator). National Well Water Association, Dublin, Ohio.
- Burgmer, T., H. Hillebrand, and M. Pfenninger. 2007. Effects of climate-driven temperature changes on the diversity of freshwater macroinvertebrates. *Oecologia* 151:03-103.
- Eisler, R. 1987. Polycyclic aromatic hydrocarbon hazards to fish, wildlife, and invertebrates: a syntopic review. U.S. Fish and Wildlife Service. Contaminant Hazard Reviews Report No. 11, Biological Report 85 (1.11).
- Green, J. and M. W. Trett. 1989. The fate and effects of oil in freshwater. Elsevier Science Publishing Co., Inc., New York.
- Haynes, C. V. 1968. Geology of Late-Quaternary alluvium. Pp. 591-631, *In* Means of Correlation of Quaternary Successions (R. B. Morrison and H. E. Wright, Eds.). University of Utah Press, Salt Lake City, UT.
- Hennighausen, F. H. 1969. Meters and their effects in the Roswell Artesian Basin in Chaves and Eddy counties, New Mexico. Pp. 29-33, *In* 14th Annual New Mexico Water Conference (Water Resources Institute).
- Jercinovic, D. E. 1982. Assessment of refined petroleum-product contamination problems in surface and ground waters of New Mexico. Water Pollution Control Bureau, New Mexico Environmental Improvement Division, EID/WPC-82/5.
- Jercinovic, D. E. 1984. Petroleum-product contamination of soil and water in New Mexico. New Mexico Environmental Improvement Division, EID/GWH84/2.
- Lang, B. K. 2001a. Status and distribution of terrestrial snails of southern New Mexico. New Mexico Department of Game and Fish, Completion Report E-36 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2001b. New Mexico endangered invertebrates: monitoring and management. New Mexico Department of Game and Fish, Completion Report E-37 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2003. New Mexico endangered invertebrates: monitoring and management. New Mexico Department of Game and Fish, Performance Report E-37-8 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.

- Lang, B. K. 2009. New Mexico endangered invertebrates: monitoring and management. New Mexico Department of Game and Fish, Performance Report E-37-11 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Longmire, P. A. 1983. Petroleum-product contamination of ground and surface water: a literature review. Ground Water Section, Water Pollution Control Bureau, New Mexico Environmental Improvement Division. EID/WPC-83/7.
- Mehlhop, P. 1992. Establishment of a rare mollusc inventory and monitoring program for New Mexico. Progress Report. NMDGF Professional Services Contract 80-519-52.
- Metcalf, A. L. 1967. Late Quaternary mollusks of the Rio Grande Valley, Caballo Dam, New Mexico to El Paso, Texas. University of Texas at El Paso, Sci. Ser. 1:1-62.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Pp.1-69, *In Land Snails of New Mexico*. (A. L. Metcalf and R. A. Smartt, Eds.). New Mexico Museum of Natural History and Science Bulletin 10.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-242.
- Quarles, J. 1983. Groundwater contamination in the United States. University of Pennsylvania Press, Philadelphia.
- Taylor, D. T. 1983. Endangered species: status investigation of mollusks of New Mexico. Professional Services Contract Nos. 519-69-01 and 519-69-01A.
- Xenopoulos, M. A., D. M. Lodge, J. Alcamo, M. Märker, K. Schulze, and D. P Van Vuurens. 2005. Scenarios of freshwater fish extinctions from climate change and water withdrawal. *Global Change Biology* 11:1557-1564.

Hacheta Grande woodlandsnail, *Ashmunella hebaridi*

Distribution: *Ashmunella hebaridi* is narrowly restricted to dense pine cover along the south wall of Chaney Canyon (6600-7400 ft) on the west-central flank of the Big Hachet Mountains west of Big Hachet Peak, Hidalgo County (Metcalf and Smartt 1997; Lang 2005). The species may occur at higher elevations on vertical limestone faces immediately west-northwest of Big Hachet Peak above 7400 ft.; sampling in this area is limited by access.

Current Status: *Ashmunella hebaridi* was listed as state threatened in 1990, and is considered a federal species of concern (USFWS 1994). The Hacheta Grande woodlandsnail occurs most commonly at the base of limestone outcrops beneath large rock fragments and rubble piles where litter-soil mold collects. The BLM conducted a prescribed burn in the north-central range of the Big Hachet Mountains (Thompson Canyon northward to Zeller Peak) in 2005 that did not impact this species.

Threats: Any form of soil disturbance (e.g., mineral mining) or vegetation removal (e.g. logging, prescribed burn, or grazing) could result in adverse impacts to edaphic conditions and direct habitat loss in areas where this species occurs. Habitat modification from wildland fire, deciduous woody plant diseases, insect pests, and climate change could impact extant populations (Sullivan 1997; Lang 2001, 2005).

Recommendations: No change in listing status is recommended. Population monitoring should continue. NMDGF should consult with the Bureau of Land Management and U. S. fish and Wildlife Service to initiate a conservation plan for this species.

Literature Cited:

- Lang, B. K. 2001. Status and distribution of terrestrial snails of southern New Mexico. New Mexico Department of Game and Fish, Completion Report E-36 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2005. Taxonomic Assessment of *Ashmunella hebaridi* and *Ashmunella mearnsii* of the Big Hachet Mountains, New Mexico. New Mexico Department of Game and Fish, Completion Report E-57-(1-3) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, NM.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Pp. 1-69, *In Land Snails of New Mexico*. (A. L. Metcalf and R. A. Smartt, Eds.). New Mexico Museum of Natural History and Science Bulletin 10.

Sullivan, R. M. 1997. Inventory of some terrestrial snails of southern New Mexico, with emphasis on state listed and federal candidate species of Doña Ana, Otero, and Socorro counties. Final Report submitted to the NMDGF under Professional Services Contract 96-516.64.

U.S. Fish and Wildlife Service. 1994. Endangered and Threatened Wildlife and Plants; Animal Candidate Review for Listing as Endangered or Threatened Species, Proposed Rule. Federal Register 59(219):58982-59028.

Cooke's Peak woodlandsnail, *Ashmunella macromphala*

Distribution: This species was known only from the precipitous north slope of Cooke's Peak, Cooke's Range, Luna County (Vagvolgyi 1974; Metcalf and Smartt 1997). Surveys south of Cooke's Peak documented a single isolated population of *Ashmunella macromphala* on a north-facing, igneous, scree slope in OK Canyon (Lang 2001). While no live snails were observed at this site, recent shell material implies that a viable population may exist there.

Current Status: Cooke's peak woodlandsnail was listed as state threatened in 1990. Both known populations of *A. macromphala* occur on BLM land.

Threats: Land snails occupying high-elevation outcrops and talus sprawls may be at risk from climate change, natural catastrophe (rock slide, wildfire), prescribed burning, and soil disturbance from mining and logging (NMDGF 1988; Sullivan 1997; Lang 2001, 2004). Surveys in May 2000 documented significant sign of cattle grazing throughout the unnamed canyon leading up to the base of the type locality (Lang 2001). While cattle will likely not venture onto or across a talus slope, intense browsing of deciduous woody vegetation around the perimeter of a scree slope can potentially decrease leaf litter available as food for snails, significantly alter seral succession, and affect plant community composition. Vagvolgyi (1974) discussed the importance of deciduous leaf litter for this species.

Recommendations: No change in listing status is recommended. NMDGF should monitor extant populations, and expand malacological surveys for this species to include potentially suitable habitats in southwestern areas of the Cooke's Range. NMDGF should pursue development of a state recovery plan.

Literature Cited:

- Lang, B. K. 2001. Status and distribution of terrestrial snails of southern New Mexico. New Mexico Department of Game and Fish, Completion Report E-36 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Lang, B. K. 2004. Taxonomic Assessment of *Ashmunella hebardei* and *Ashmunella mearnsii* of the Big Hatchet Mountains, New Mexico. New Mexico Department of Game and Fish, Annual Performance Report E-57-(2) submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Pp. 1-69, *In* Land Snails of New Mexico. (A. L. Metcalf and R. A. Smartt, Eds.). New Mexico Museum of Natural History and Science Bulletin 10.
- Sullivan, R. M. 1997. Inventory of some terrestrial snails of southern New Mexico, with emphasis on state listed and federal candidate species of Doña Ana, Otero, and Socorro counties. Final Report submitted to the NMDGF under Professional Services Contract 96-516.64.
- Vagvolgyi, J. 1974. Eight new ashmunellas from the southwestern United States (Pulmonata: Polygyridae). *Proceedings of the Biological Society of Washington* 87:152-53.

Mineral Creek mountainsnail, *Oreohelix pilsbryi*

Distribution: *Oreohelix pilsbryi* is endemic to the Black Range, Sierra County (Pilsbry 1939), where it has been reported from two localities on U. S. Forest Service land near "Oliver's Mine" along Mineral Creek, about 5.5 miles west of Chloride (Metcalf and Smartt 1997). This species was previously known from a 30 m section of limestone outcrop along Mineral Creek (type locality), and from similar habitat located 50 m upslope (NMDGF 1988; Metcalf and Smartt 1997).

Current Status: Mineral Creek mountainsnail was listed as state threatened in 1990. Lang (2001) found *O. pilsbryi* abundant throughout an approximate 0.3 mile reach of stream that constricts Mineral Creek to a narrow, sinuous channel lined by limestone outcrops; several small shells (5-10 mm w) confirmed a reproducing population. No empty shells or fragments were observed downstream from this site.

Threats: Considering this species apparent affinity for moist soils on well-shaded, north- and east-facing slopes, any form of canopy removal, whether by cutting or forest fire, would likely dry the forest floor and potentially render edaphic condition unsuitable to *O. pilsbryi*. This species is vulnerable to any form of soil disturbance or mining activity within the immediate vicinity of occupied habitat. While cattle may not graze regularly at the type locality, cows do travel the narrow stream corridor and rest along shaded canyon walls. Soil disturbance from such foot traffic and trampling could adversely affect *O. pilsbryi* if downstream grazing intensity increases so as to push cattle into marginal habitats upstream in search of forage (NMDGF 1988; Lang 2001).

Recommendations: No change in listing status is recommended. NMDGF should continue to monitor extant populations and survey for new populations. Fencing of the type locality would serve to protect this species' limited habitat. NMDGF should pursue development of a state recovery plan.

Literature Cited:

- Lang, B. K. 2001. Status and distribution of terrestrial snails of southern New Mexico. New Mexico Department of Game and Fish. Completion Report E-36 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Pp. 1-69, *In* Land Snails of New Mexico. (A. L. Metcalf and R. A. Smartt, Eds.). New Mexico Museum of Natural History and Science Bulletin 10.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-115.
- Pilsbry, H. A. 1939. Land mollusca of North America (north of Mexico). Academy of Natural Sciences of Philadelphia Monograph 3(1):418-419, 514-515.

Doña Ana talussnail, Sonorella todseni

Distribution: The Doña Ana talussnail is endemic to Doña Ana Mountains, Doña Ana County (Miller 1976). *Sonorella todseni* can arguably be considered the most geographically restricted of all known species of *Sonorella* in New Mexico (Metcalf and Smartt 1997).

Current Status: *Sonorella todseni* was listed as state threatened in 1990. Lang (2001) reported live *S. todseni* in rivulet-like accumulations of dark, rhyolitic talus on the north and east slope of Doña Ana Peak. The total population size appears very small, probably occupying <1.0 acre, collectively (Sullivan 1997).

Threats: Habitat protection is paramount for the conservation of this species, which is vulnerable due to its restricted range, fragile habitat, and easy public land access (NMDGF 1988; Lang 2001). The extant population is susceptible to any form of soil disturbance or mining activity in the general vicinity of talus slopes. Surveys revealed sign of shrub removal by digging and a plastic tag tie from a local gardening center (Lang 2001). Removal of woody vegetation not only disturbs talus slopes, but also results in loss of food and cover for snails (Vagvolgyi 1974), increases the potential for slope erosion, and effectively reduces water retention capacity of the soil. Cumulative effects of these activities can have irrevocable impacts, exacerbating habitat desiccation and increasing substrate temperatures, which can dry-out developing egg masses deposited in talus just below the ground surface. Climate change, natural perturbations (fire, rock slides), mining, and related substrate disturbance activities represent threats to this species (NMDGF 1988; Sullivan 1997; Lang 2001).

Recommendations: No change in listing status is recommended. NMDGF should continue efforts with the Bureau of Land Management to monitor extant populations and to secure occupied habitat through a state recovery plan.

Literature Cited:

- Lang, B. K. 2001. Status and distribution of terrestrial snails of southern New Mexico. New Mexico Department of Game and Fish, Completion Report E-36 submitted to the Division of Federal Aid, U. S. Fish and Wildlife Service, Albuquerque, New Mexico.
- Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Pp. 1-69, *In* Land Snails of New Mexico. (A. L. Metcalf and R. A. Smartt, Eds.). New Mexico Museum of Natural History and Science Bulletin 10.
- New Mexico Department of Game and Fish. 1988. Handbook of species endangered in New Mexico. Account B-103.
- Miller, W. B. 1976. New species of Sonorella (Pulmonata: Helminthoglyptidae) from New Mexico and Texas. *The Nautilus* 90:70-73.
- Sullivan, R. M. 1997. Inventory of some terrestrial snails of southern New Mexico, with emphasis on state listed and federal candidate species of Doña Ana, Otero, and Socorro counties. Final Report submitted to the NMDGF under Professional Services Contract 96-516.64
- Vagvolgyi, J. 1974. Eight new ashmunellas from the southwestern United States (Pulmonata: Polygyridae). *Proceedings of the Biological Society of Washington* 87:152-53.