DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R2–ES–2013–0071: 4500030113]

RIN 1018–AY23

Endangered and Threatened Wildlife and Plants; Threatened Status for the Northern Mexican Gartersnake and Narrow-Headed Gartersnake

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), determine threatened species status under the Endangered Species Act of 1973 (Act), as amended, for the northern Mexican gartersnake (*Thamnophis eques megalops*) and the narrow-headed gartersnake (*Thamnophis rufipunctatus*), native species from Arizona and New Mexico in the United States. We also finalize a rule under authority of section 4(d) of the Endangered Species Act of 1973, as amended (Act), that provides measures that are necessary and advisable to provide for the conservation of the northern Mexican gartersnake. Both species are listed as threatened throughout their range, which, for the northern Mexican gartersnake, also includes the Mexican states of Sonora, Chihuahua, Durango, Coahuila, Zacatecas, Guanajuato, Nayarit, Hidalgo, Jalisco, San Luis Potosí, Aguascalientes, Tlaxacala, Puebla, México, Veracruz, and Querétaro. The effect of this regulation will be to add these species to the lists of Endangered and Threatened Wildlife and Plants.

DATES: This rule becomes effective August 7, 2014.

ADDRESSES: This final rule is available on the internet at *http://www.regulations.gov* (Docket No. FWS–R2–ES–2013–0071) and *http://www.fws.gov/southwest/es/arizona.* Comments and materials we received, as well as supporting documentation we used in preparing this rule, are available for public inspection at *http://www.regulations.gov.* All of the comments, materials, and documentation that we considered in this rulemaking are available by appointment, during normal business hours at: U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, 2321 West Royal Palm Road, Suite 103, Phoenix, AZ 85021; telephone: 602–242–0210; facsimile: 602–242–2513.

FOR FURTHER INFORMATION CONTACT: Steve Spangle, Field Supervisor, U.S. Fish and Wildlife Service, Arizona Ecological Services Field Office, 2321 West Royal Palm Road, Suite 103, Phoenix, AZ 85021; telephone: 602–242–0210; facsimile: 602–242–2513. Persons who use a telecommunications device for the deaf (TDD) may call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

Why we need to publish a rule. Under the Endangered Species Act, a species may warrant protection through listing if it is endangered or threatened throughout all or a significant portion of its range. Listing a species as an endangered or threatened species requires issuing a rule. This rule will finalize the listing of the northern Mexican gartersnake (*Thamnophis eques megalops*) and narrow-headed gartersnake (*Thamnophis rufipunctatus*) as threatened species, initiated with our proposed listing rule published on July 10, 2013 (78 FR 41500), and finalize a rule under authority of section 4(d) of the Act that provides measures that are necessary and advisable to provide for the conservation of the northern Mexican gartersnake.

The basis for our action. Under the Endangered Species Act, we can determine that a species is an endangered or threatened species based on any of five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence. We have determined that predation from and competition with nonnative species such as bass (*Micropterus* sp.), flathead catfish (*Pylodictis* sp.), channel catfish (*Ictalurus* sp.), Chihuahuan catfish (*Ictalurus chihuahua*), bullheads (*Ameiurus* sp.), sunfish (*Lepomis* sp.), and crappie (*Pomoxis* sp.), brown trout (*Salmo trutta*), American bullfrogs (*Lithobates catesbeiana*), and crayfish (northern (virile) crayfish (*Orconectes virilis*) and red swamp crayfish (*Procambarus clarkia*)) are the most significant threat affecting these gartersnakes across their range. Throughout the remainder of this final rule, the nonnative species identified immediately above will be referred to collectively as ''harmful nonnative species.'' Large-scale wildfires and land uses that divert, dry up, or significantly pollute aquatic habitat have also been found to be significant threats. Collectively, these threats have adversely affected gartersnake populations, and most of their native prey species, such that the gartersnakes' resiliency, redundancy, and representation across their ranges have been significantly compromised.

Peer review and public comment. We sought comments from independent specialists to ensure that our designation is based on scientifically sound data, assumptions, and analyses. We invited these peer reviewers to comment on our listing proposal. We also considered all other comments and information received during the comment period on the proposed listing rule. All comments are available at *http://www.regulations.gov* (Docket No. FWS–R2–ES–2013–0071).

Previous Federal Action

Please refer to the proposed listing rule for the northern Mexican gartersnake and narrow-headed gartersnake (78 FR 41500; July 10, 2013) for a detailed description of previous Federal actions concerning this species.

We will also be finalizing the designation of critical habitat for the northern Mexican gartersnake and narrow-headed gartersnake in a separate rule in the future. Information regarding designation of critical habitat for these species is available at *http://www.regulations.gov* (Docket No. FWS–R2–ES–2013–0022).

Background

Northern Mexican Gartersnake

Subspecies Description

The northern Mexican gartersnake ranges in color from olive to olive-brown or olive-gray with three lighter-colored stripes that run the length of the body, the middle of which darkens toward the tail. This species may inhabit the same area as other native gartersnake species and can be difficult for people without specific expertise to identify. The snake may reach a maximum known length of 44 inches (in) (112 centimeters (cm)). The pale yellow to light-tan lateral (side of body) stripes distinguish the northern Mexican gartersnake from other sympatric (co-occurring) gartersnake species because a portion of the lateral stripe is found on the fourth scale row, while it is confined to lower scale rows for other species. Paired black spots extend along the olive dorsolateral fields (region adjacent to the top of the snake's back) and the olive-gray ventrolateral fields (region adjacent to the area of the snake's body in contact with the ground). The scales are keeled (possessing a ridge down the center of each scale). A more detailed subspecies description can be found in our September 26, 2006 (71 FR 56227), or November 25, 2008 (73 FR 71788) 12-month findings for this subspecies, or by reviewing Rosen and Schwalbe (1988, p. 4), Rossman *et al.* (1996, pp. 171–172), Ernst and Ernst (2003, pp. 391–392), or Manjarrez and Garcia (1993, pp. 1–5).

Taxonomy

The northern Mexican gartersnake (*Thamnophis eques megalops*) is a member of the family Colubridae and subfamily Natricinae (harmless live-bearing snakes) (Lawson *et al.* 2005, p. 596; Pyron *et al.* 2013, p. 31). The taxonomy of the genus *Thamnophis* has a complex history, partly because many of the species are similar in appearance and arrangement of scales and many of the early museum specimens were in such poor and faded condition that it was difficult to study them (Conant 2003, p. 6).

Prior to 2003, *Thamnophis eques* was considered to have three subspecies, *T. e. eques, T. e. megalops,* and *T. e. virgatenuis* (Rossman *et al.* 1996, p. 175). In 2003, an additional seven new subspecies were identified under *T. eques:* (1) *T. e. cuitzeoensis;* (2) *T. e. patzcuaroensis;* (3) *T. e. insperatus;* (4) *T. e. obscurus;* (5) *T. e. diluvialis;* (6) *T. e. carmenensis;* and (7) *T. e. scotti* (Conant 2003, p. 3). Common names were not provided, so in this final rule, we use the scientific name for all subspecies of Mexican gartersnake other than the northern Mexican gartersnake. These seven new subspecies were described based on morphological differences in coloration and pattern, have highly restricted distributions, and occur in isolated wetland habitats within the mountainous Transvolcanic Belt region of southern Mexico, which contains the highest elevations in the country (Conant 2003, pp. 7–8). Additional information regarding this subspecies' taxonomy can be found in de Queiroz *et al.* (2002, p. 323), de Queiroz and Lawson (1994, p. 217), Rossman *et al.* (1996, pp. xvii–xviii, 171–175), Rosen and Schwalbe (1988, pp. 2–3), Liner (1994, p. 107), and Crother *et al.* (2012, p. 70). A description of the taxonomy of the northern Mexican gartersnake is found in our September 26, 2006 (71 FR 56227) and November 25, 2008 (73 FR 71788) 12-month findings for this subspecies.

Habitat and Natural History

Throughout its rangewide distribution, the northern Mexican gartersnake occurs at elevations from 130 to 8,497 feet (ft) (40 to 2,590 meters (m)) (Rossman *et al.* 1996, p. 172) and is considered a ''terrestrial-aquatic generalist'' (Drummond and Marcías-García 1983, pp. 24–26). The northern Mexican gartersnake is a riparian obligate (generally found in riparian areas when not engaged in dispersal, gestation, or hibernation behaviors) and occurs chiefly in the following general habitat types: (1) Small, often isolated wetlands (e.g., cienegas (mid-elevation wetlands with highly organic, reducing (basic or alkaline) soils), or stock tanks (small earthen impoundment)); (2) large-river riparian woodlands and forests; and (3) streamside gallery forests (as defined by well-developed broadleaf deciduous riparian forests with limited, if any, herbaceous ground cover or dense grass) (Hendrickson and Minckley 1984, p. 131; Rosen and Schwalbe 1988, pp. 14–16). Emmons and Nowak (2013, p. 14) found this subspecies most commonly in protected backwaters, braided side channels and beaver ponds, isolated pools near the river mainstem, and edges of dense emergent vegetation that offered cover and foraging opportunities when surveying in the upper and middle Verde River region. Additional information on the habitat requirements of the northern Mexican gartersnake within the United States and Mexico can be found in our 2006 (71 FR 56227) and 2008 (73 FR 71788) 12-month findings for this subspecies and in Rosen and Schwalbe (1988, pp. 14–16), Rossman *et al.* (1996, p. 176), McCranie and Wilson (1987, pp. 11–17), Ernst and Ernst (2003, p. 392), and Cirett-Galan (1996, p. 156).

The northern Mexican gartersnake is surface active at ambient (air) temperatures ranging from 71 degrees Fahrenheit (°F) to 91 °F (22 degrees Celsius (°C) to 33 °C) and forages along the banks of waterbodies (Rosen 1991, p. 305, Table 2). While conducting visual surveys, Rosen (1991, pp. 308–309) found that northern Mexican gartersnakes spent up to 60 percent of their time moving, 13 percent of their time basking on vegetation, 18 percent of their time basking on the ground, and 9 percent of their time under surface cover. However, preliminary telemetry data from a population of northern Mexican gartersnakes at the Bubbling Ponds State Fish Hatchery show individuals were surface active during 16 percent of telemetry observations, not surface active during 64 percent of telemetry observations, and surface activity was undetermined for 20 percent of the telemetry observations (Boyarsky 2013, pers. comm.); at Tavasci Marsh along the upper Verde River, they were inactive 60 percent of the time (Emmons 2013b, pers. comm.). In the northern-most part of its range, the northern Mexican gartersnake appears to be most active during July and August, followed by June and September (Emmons and Nowak 2013, p. 14). Northern Mexican gartersnakes may use different sites as hibernacula during a single cold-season and will bask occasionally (Emmons 2014, pers. comm.).

Although considered a highly aquatic species, the northern Mexican gartersnake uses terrestrial habitat for hibernation (Young and Boyarski 2012b, pp. 25–28), gestation, seeking mates, and dispersal. Along the middle Verde River preliminary telemetry data for the northern Mexican gartersnake found that the species may travel at least 528 feet (161 m) from the nearest water and as much as 0.4 mi (0.6 km) in a single day (total distance traveled) (Emmons 2014, pers. comm.). Terrestrial habitat use in open, grassland-dominated landscapes with scattered livestock tanks, such as in southern Arizona, may reflect that greater distances are traveled as suggested by the observation of a large female northern Mexican gartersnake observed in O'Donnell Canyon, which was far from source populations and may have been dispersing overland (Rosen and Schwalbe 1988, p. 14). Preliminary data from the population at Bubbling Ponds State Fish Hatchery show that home ranges vary from 1.7 acres (0.7 ha) to 10.4 acres (4.2 ha), with a mean home range size of 6.2 acres (2.51 ha) (Young and Boyarski 2012b, p. 23).

The northern Mexican gartersnake is an active predator and depends on smaller animals for its prey base (Rosen and Schwalbe 1988, pp. 18, 20). Northern Mexican gartersnakes forage along vegetated banklines, searching for prey in water and on land, using different strategies (Alfaro 2002, p. 209), or may forage along the edges of open water and thick stands of vegetation such as cattails. Generally, its diet consists of native amphibians and fishes, such as adult and larval (tadpoles) native leopard frogs (e.g., lowland leopard frog (*Lithobates yavapaiensis*) and Chiricahua leopard frog (*Lithobates chiricahuensis*)), as well as juvenile and adult native fish species (e.g., Gila topminnow (*Poeciliopsis occidentalis occidentalis*), desert pupfish (*Cyprinodon macularius*), Gila chub (*Gila intermedia*), and roundtail chub (*Gila robusta*)) (Rosen and

Schwalbe 1988, p. 18). Drummond and Marcías-García (1983, pp. 25, 30) found that as a subspecies, Mexican gartersnakes fed primarily on frogs. The northern Mexican gartersnake may congregate at ephemeral amphibian breeding ponds to exploit high-density prey populations as observed at New Mexican spadefoot toads (*Spea multiplicata*) breeding sites (d'Orgeix *et al.* 2013, pp. 213–215). Auxiliary prey items may also include young Woodhouse's toads (*Anaxyrus woodhousei*), treefrogs (Family Hylidae), earthworms, deermice (*Peromyscus* spp.), lizards of the genera *Aspidoscelis* and *Sceloporus,* larval tiger salamanders (*Ambystoma tigrinum*), and leeches (Rosen and Schwalbe 1988, p. 20; Holm and Lowe 1995, pp. 30–31; Degenhardt *et al.* 1996, p. 318; Rossman *et al.* 1996, p. 176; Manjarrez 1998, p. 465). Salamanders (*Ambystoma* spp.) may be particularly important as prey for northern Mexican gartersnake populations in northern Mexico, both at lower elevations and along the Sierra Madre Occidental (Lemos-Espinal 2013, pers. comm.).

In situations where native prey species are rare or absent, this snake's diet may be almost completely comprised of nonnative species, including larval and juvenile bullfrogs (*Lithobates catesbeianus*), mosquitofish (*Gambusia affinis*) (Holycross *et al.* 2006, p. 23), or subadult green sunfish, bluegill, or largemouth bass (Emmons and Nowak 2013, p. 5; Emmons 2013a, pers. comm.). The most recent observations of northern Mexican gartersnakes attempting to eat predatory fish was discussed in Emmons and Nowak (2013, p. 6) where they found fish inside traps with gartersnakes, and the fish appeared to have been partially consumed and then regurgitated. These observations suggest that, while northern Mexican gartersnakes may attempt to eat predatory fish (at least in the artificial confines of a wire trap), they may often be spontaneously regurtitated, potentially causing harm to the snake (Nowak and Santana-Bendix 2002, p. 24), and may not be compatible prey for northern Mexican gartersnakes. Interestingly, in a 2012 trapping effort along the upper Santa Cruz River, minnow traps that become self-baited with bullfrogs, mosquitofish, or macroinvertebrates captured snakes, but those which contained green sunfish or largemouth bass never caught a single northern Mexican gartersnake (Lashway 2012, p. 6).

Chinese mystery snails (*Cipangopaludina chinensis*) have also been reported as a prey item for northern Mexican gartersnakes at the Page Springs and Bubbling Ponds State Fish Hatcheries in Arizona, but some predation attempts on snails have proven fatal for gartersnakes because of their lower jaw becoming permanently lodged in the snails' shell (Young and Boyarski 2012a, p. 498). Venegas-Barrera and Manjarrez (2001, p. 187) reported the first observation of a snake in the natural diet of any species of *Thamnophis* after documenting the consumption of a Mexican alpine blotched gartersnake (*Thamnophis scalaris*) by a Mexican gartersnake (*T. eques;* subspecies not reported); a behavior termed ophiophagy. Ophiophagy has not been specifically reported in northern Mexican gartersnakes, although they are a subspecies of the Mexican gartersnake.

Marcías-García and Drummond (1988, pp. 129–134) sampled the stomach contents of Mexican gartersnakes and the prey populations at (ephemeral) Lake Tecocomulco, Hidalgo, Mexico. Field observations indicated, with high statistical significance, that larger Mexican gartersnakes fed primarily upon aquatic vertebrates (fishes, frogs, and larval salamanders) and leeches, whereas smaller Mexican gartersnakes fed primarily upon earthworms and leeches (Marcías-García and Drummond 1988, p. 131). Marcías-García and Drummond (1988, p. 130) also found that the birth of newborn *T. eques* tended to coincide with the annual peak density of annelids (earthworms and leeches). There is also preliminary evidence that birth may coincide with a pronounced influx of available prey in a given area, especially with that of explosive breeders, such as toads, but more research is needed to confirm such a relationship (Boyarski 2012, pers. comm.). Positive correlations were also made with respect to capture rates (which are correlated with population size) of *T. eques* to lake levels and to prey scarcity; that is, when lake levels were low and prey species scarce, Mexican gartersnake capture rates declined (Marcías-García and Drummond 1988, p. 132). While prey scarcity could have driven snakes to become active or take shelter underground, their results suggest the importance of available water and an adequate prey base to maintaining viable populations of Mexican gartersnakes. Marcías-García and Drummond (1988, p. 133) found that, while certain prey items were positively associated with size classes of snakes, the largest of specimens consume any prey available.

Native predators of the northern Mexican gartersnake include birds of prey, other snakes (kingsnakes (*Lampropeltis* sp.), whipsnakes (*Coluber* sp.), regal ring-necked snakes (*Diadophis punctatus regalis*), etc.), wading birds, mergansers (*Mergus merganser*), belted kingfishers (*Megaceryle alcyon*), raccoons (*Procyon lotor*), skunks (*Mephitis* sp.), and coyotes (*Canis latrans*) (Rosen and Schwalbe 1988, pp. 18, 39; Brennan *et al.* 2009, p. 123). Historically, large, highly predatory native fish species such as Colorado pikeminnow (*Ptychocheilus lucius*) may have preyed upon northern Mexican gartersnake where the subspecies co-occurred. Native chubs (*Gila* sp.) may also prey on neonatal gartersnakes, but has not been documented in the literature to our knowledge.

Sexual maturity in northern Mexican gartersnakes occurs at 2 years of age in males and at 2 to 3 years of age in females (Rosen and Schwalbe 1988, pp. 16–17). Northern Mexican gartersnakes are viviparous (bringing forth living young rather than eggs). Mating has been documented in April and May followed by the live birth of between 7 and 38 newborns (average is 13.6) in June, July, and August (Rosen and Schwalbe 1988, p. 16; Nowak and Boyarski 2012, pp. 351–352; Boyarski 2013, pers. comm.). However, field observations in Arizona provide preliminary evidence that mating may also occur during the fall, but further research is required to confirm this hypothesis (Boyarski 2012, pers. comm.). Unlike other gartersnake species, which typically breed annually, one study suggests that only half of the sexually mature females within a population of northern Mexican gartersnake might reproduce in any one season (Rosen and Schwalbe 1988, p. 17). We found no information on the longevity of northern Mexican gartersnakes but presume they may live as long as 10 years in the wild.

Historical Distribution

Within the United States, the northern Mexican gartersnake historically occurred predominantly in Arizona at elevations ranging from 130 to 6,150 ft (40 to 1,875 m). It was generally found where water was relatively permanent and supported suitable habitat. The northern Mexican gartersnake has been documented historically in every county and nearly every subbasin within Arizona, but its historical distribution was essentially the southern two-thirds of Arizona. It was known from several perennial or intermittent creeks, streams, and rivers as well as lentic (still, non-flowing water) wetlands such as cienegas, ponds, or stock tanks. Records documenting northern Mexican gartersnake exist within the following subbasins in Arizona: Colorado River, Bill Williams River, Agua Fria River, Salt River, Tonto Creek, Verde River, Santa Cruz River, Cienega Creek, San Pedro River, Babocomari River, and the Rio San Bernardino (Black Draw) (Woodin 1950, p. 40; Nickerson and Mays 1970, p. 503; Bradley 1986, p. 67; Rosen and Schwalbe 1988, Appendix I; 1995, p. 452; 1997, pp. 16–17; Holm and Lowe 1995, pp. 27–35; Sredl *et al.* 1995b, p. 2; 2000, p. 9; Rosen *et al.* 2001, Appendix I; Holycross *et al.* 2006, pp. 1–2, 15–51; Brennan and Holycross 2006, p. 123; Radke 2006, pers. comm.; Rosen 2006, pers. comm.; Holycross 2006, pers. comm.; Cotton *et al.* 2013, p. 111). Numerous records for the northern Mexican gartersnake (through 1996) in Arizona are maintained in the Arizona Game and Fish Department's (AGFD) Heritage Database (1996a).

Historically, the northern Mexican gartersnake had a limited distribution in New Mexico that consisted of scattered locations throughout the Upper Gila River watershed in Grant and western Hidalgo Counties, including the Upper Gila River, Mule Creek in the San Francisco River subbasin, and the Mimbres River (Price 1980, p. 39; Fitzgerald 1986, Table 2; Degenhardt *et al.* 1996, p. 317; Holycross *et al.* 2006, pp. 1–2).

One record for the northern Mexican gartersnake exists for the State of Nevada, opposite Fort Mohave, in Clark County along the shore of the Colorado River that was dated 1911 (De Queiroz and Smith 1996, p. 155). The subspecies may have occurred historically in the lower Colorado River region of California, although we were unable to verify any museum records for California. Any populations of northern Mexican gartersnakes that may have historically occurred in either Nevada or California were likely associated directly with the Colorado River, and we believe the northern Mexican gartersnake to be currently extirpated in Nevada and California.

Within Mexico, northern Mexican gartersnakes historically occurred within the Sierra Madre Occidental and the Mexican Plateau in the Mexican states of Sonora, Chihuahua, Durango, Coahuila, Zacatecas, Guanajuato, Nayarit, Hidalgo, Jalisco, San Luis Potosí, Aguascalientes, Tlaxacala, Puebla, México, Veracruz, and Querétaro, comprising approximately 85 percent of the total rangewide distribution of the subspecies (Conant 1963, p. 473; 1974, pp. 469–470; Van Devender and Lowe 1977, p. 47; McCranie and Wilson 1987, p. 15; Rossman *et al.* 1996, p. 173; Lemos-Espinal *et al.* 2004, p. 83). We are not aware of any systematic, rangewide survey effort for the northern Mexican gartersnake in Mexico. Therefore, we use other related ecological surrogates (such as native freshwater fish) to inform discussion on the status of aquatic communities and aquatic habitat in Mexico, and therefore on the likely status of northern Mexican gartersnake populations. We believe that gartersnakes and native fish are closely ecologically connected because of the high level of dependency of the gartersnakes on the fish as a food source. This discussion is found below in the subheadings pertinent to Mexico.

Current Distribution and Population Status

Data on population status of northern Mexican gartersnakes in the United States are largely summarized in unpublished agency reports. In our literature review we found that reductions in range and population densities have affected the status of the northern Mexican gartersnake significantly in the last 30 years. We found that, in as much as 90 percent of the northern Mexican gartersnakes' historical distribution in the United States, the subspecies occurs at low to very low population densities or may even be extirpated. For example, Holycross *et al.* (2006, p. 66) detected the northern Mexican gartersnake at only 2 of 11 historical localities within the northern-most part of its range in the United States. The degraded status of the northern Mexican gartersnake, in a rangewide context, is primarily the result of predation by and competition with harmful nonnative species, that have been legally released, illegally released, or have naturally dispersed (explained below). However, ecological circumstances and potential threats vary from site to site, and the same threats do not affect every population with the same magnitude across their range. Regardless of how they got into the wild, harmful nonnative species are now widespread and present throughout the range of the northern Mexican gartersnake. Land uses that result in the dewatering of habitat, combined with increasing drought, have destroyed significant amounts of habitat throughout the northern Mexican gartersnake's range and have, therefore, reduced its distribution within several subbasins.

Where northern Mexican gartersnakes are locally abundant, they are usually reliably detected with significantly less effort than populations characterized as having low densities. Northern Mexican gartersnakes are well-camouflaged, secretive, and can be very difficult to detect in structurally complex, dense habitat (Emmons and Nowak 2013, p. 13) or where they occur at very low population densities, which characterizes most occupied sites in lotic habitat. We considered factors such as the date of the last known records for northern Mexican gartersnakes in an area, as well as records of one or more native prey species in making a conclusion on occupancy of the subspecies. We used the year 1980 to qualify occupancy because the 1980s marked the first systematic survey efforts for northern Mexican gartersnakes across their range in the United States (see Rosen and Schwalbe (1988, entire) and Fitzgerald (1986, entire)) and the last, previous records were often dated several decades prior and may not accurately represent the likelihood for current occupation. Several areas where northern Mexican gartersnakes were known to occur have received no, or very little, survey effort in the past several decades. Variability in survey design and effort makes it difficult to compare population sizes or trends among sites and between sampling periods. For each of the sites discussed in Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071), we have attempted to translate and quantify search and capture efforts into comparable units (*i.e.,* person-search hours and trap-hours) and have cautiously interpreted those results. Because the presence of suitable prey species in an area may provide evidence that the northern Mexican gartersnake may still persist in low density where survey data are sparse, a record of a native prey species was considered in our determination of occupancy of this subspecies.

Currently, there are only five northern Mexican gartersnake populations in the United States, where the subspecies remains reliably detected and is considered viable, and all are located in Arizona. The five known populations are: (1) The Page Springs and Bubbling Ponds State Fish Hatcheries along Oak Creek, (2) lower Tonto Creek, (3) the upper Santa Cruz River in the San Rafael Valley, (4) the Bill Williams River, and (5) the upper and middle Verde River. In New Mexico, the northern Mexican gartersnake was last documented in 2013 along the Gila River in the vicinity of the Highway 180 crossing (Hotle 2013, entire) and is considered to occur in extremely low population densities within its historical distribution along the Gila River and Mule Creek. While historically known to occur on tribal lands, the status of the northern Mexican gartersnake on tribal lands, such as those owned by the White Mountain or San Carlos Apache Tribes, is poorly known due to limited survey access. As stated previously, less is known specifically about the current distribution of the northern Mexican gartersnake in Mexico due to limited access to information on survey efforts and field data from Mexico.

In Table 1 below, we summarize the population status of northern Mexican gartersnakes at all known 29 historical localities throughout their United States distribution, as supported by museum records or reliable observations. We categorized each population as either likely viable, likely not viable, or likely extirpated based on the historical survey records, suitable habitat, presence of native prey species, and the presence of harmful nonnative species. For a detailed discussion that explains the rationale for site-by-site conclusions on occupancy, please see Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071). General rationale is provided in the introductory paragraph to this section, ''Current Distribution and Population Status.''

TABLE 1—CURRENT POPULATION STATUS OF THE NORTHERN MEXICAN GARTERSNAKE IN THE UNITED STATES

[References for This Information Are Provided in Appendix A]

Location	Last record	Suitable physical habitat present	Native prey species present	Harmful nonnative species present	Population status
Gila River (NM, AZ)	2013	Yes	Yes	Yes	Likely not viable.
Spring Canyon (NM)	1937	Yes	Possible	Likely	Likely extirpated.
Mule Creek (NM)	1983	Yes	Yes	Yes	Likely not viable.
Mimbres River (NM)	Likely early 1900s.	Yes	Yes	Yes	Likely extirpated.
Lower Colorado River (AZ)	1904	Yes	Yes	Yes	Likely extirpated.
Bill Williams River (AZ)	2012	Yes	Yes	Yes	Likely viable.
Agua Fria River (AZ)	1986	Yes	Yes	Yes	Likely not viable.
Little Ash Creek (AZ)	1992	Yes	Yes	Yes	Likely not viable.
Lower Salt River (AZ)	1964	Yes	Yes	Yes	Likely extirpated.
Black River (AZ)	1982	Yes	Yes	Yes	Likely not viable.
Big Bonito Creek (AZ)	1986	Yes	Yes	Yes	Likely not viable.
Tonto Creek (AZ)	2005	Yes	Yes	Yes	Likely viable.
Upper Verde River (AZ)	2012	Yes	Yes	Yes	Likely viable.
Oak Creek (AZ)	2012	Yes	Yes	Yes	Likely viable.
(Page Springs and Bubbling Ponds State Fish Hatcheries)					
Spring Creek (AZ)	1986	Yes	Yes	Yes	Likely not viable.
Sycamore Creek (Yavapai/Coconino Co., AZ)	1954	Yes	Possible	Yes	Likely extirpated.
Upper Santa Cruz River/San Rafael Valley (AZ)	2013	Yes	Yes	Yes	Likely viable.
Redrock Canyon (AZ)	2008	Yes	Yes	Yes	Likely not viable.
Sonoita Creek (AZ)	2013	Yes	Possible	Yes	Likely not viable.
Scotia Canyon (AZ)	2009	Yes	Yes	No	Likely not viable.
Parker Canyon (AZ)	1986	Yes	Possible	Yes	Likely not viable.
Las Cienegas National Conservation Area and Cienega Creek Natural Preserve (AZ).	2012	Yes	Yes	Possible	Likely not viable.
Lower Santa Cruz River (AZ)	1956	Yes	Yes	Yes	Likely extirpated.
Buenos Aires National Wildlife Refuge (AZ)	2000	Yes	Yes	Yes	Likely not viable.
Bear Creek (AZ)	1987	Yes	Yes	Yes	Likely not viable.
San Pedro River (AZ)	1996	Yes	Yes	Yes	Likely not viable.
Babocomari River and Cienega (AZ)	1986	Yes	Possible	Yes	Likely not viable.
Canelo Hills-Sonoita Grasslands Area (AZ)	2012	Yes	Yes	Yes	Likely not viable.

TABLE 1—CURRENT POPULATION STATUS OF THE NORTHERN MEXICAN GARTERSNAKE IN THE UNITED STATES—Continued

[References for This Information Are Provided in Appendix A]

Location	Last record	Suitable physical habitat present	Native prey species present	Harmful nonnative species present	Population status
San Bernardino National Wildlife Refuge (AZ)	1997	Yes	Yes	Yes	Likely not viable.

Notes: "Possible" means there were no conclusive data found. "Likely extirpated" means the last record for an area pre-dated 1980, and existing threats suggest the species is likely extirpated. "Likely not viable" means there is a post-1980 record for the species, it is not reliably found with minimal to moderate survey effort, and threats exist which suggest the population may be low density or could be extirpated, but there is insufficient evidence to support extirpation. "Likely viable" means that the species is reliably found with minimal to moderate survey effort, and the population is generally considered to be somewhat resilient.

We conclude that as many as 24 of 29 known northern Mexican gartersnake localities in the United States (83 percent) are likely not viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated. In most localities where the species may occur at low population densities, existing survey data are insufficient to support a conclusion of extirpation. Only five populations of northern Mexican gartersnakes in the United States are considered likely viable where the species remains reliably detected. In our November 25, 2008, 12-month finding, we evaluated the total number of stream miles in the United States that historically supported the northern Mexican gartersnake that are now permanently dewatered (except in the case of temporary flows in response to heavy precipitation), and we concluded that the subspecies has been extirpated from or occurs at low densities in as much as 90 percent of its historical range in the United States (73 FR 71788, pp. 71792–71793). As shown in Table 1, harmful nonnative species are present in all but one northern Mexican gartersnake locality in the United States.

The northern Mexican gartersnake is listed as threatened throughout its range in Mexico by the Mexican Government. However, our understanding of the northern Mexican gartersnake's specific population status throughout its range in Mexico is less precise than that known for its United States distribution because survey efforts are less and available records do not exist or are difficult to obtain for many regions. Some specific geographic distribution records for the Mexican states of Sonora, Chihuahua, and San Luis Potosí were presented in Lemos-Espinal (2013, pers. comm.). Lemos-Espinal (2013 pers. comm), a Mexican herpetologist whose work is focused on the states of Sonora, Chihuahua, and Coahuila, commented that the number and magnitude of threats are not equal across the subspecies' range in Mexico. Habitat alteration or removal, as a circumstance of human population growth in Mexico, is reported as a primary concern for populations that occur in the Sierra Madre Occidental (Lemos-Espinal 2013, pers. comm.). In other regions of Mexico, such as the states of Sonora and Chihuahua, Lemos-Espinal (2013, pers. comm.) observed the northern Mexican gartersnake to be quite common. Another gartersnake researcher from Mexico has observed the decline or disappearance of some populations in central Mexico (Manjerrez 2008).

Narrow-Headed Gartersnake

Species Description

The narrow-headed gartersnake is a small to medium-sized gartersnake with a maximum total length of 44 in (112 cm) (Painter and Hibbitts 1996, p. 147). Its eyes are set high on its unusually elongated head, which narrows to the snout, and it lacks striping on the dorsum (top) and sides, which distinguishes its appearance from other gartersnake species with which it could co-occur (Rosen and Schwalbe 1988, p. 7). The base color is usually tan or grey-brown (but may darken) with conspicuous brown, black, or reddish spots that become indistinct towards the tail (Rosen and Schwalbe 1988, p. 7; Boundy 1994, p. 126). The scales are keeled. Degenhardt *et al.* (1996, p. 327), Rossman *et al.* (1996, pp. 242–244), and Ernst and Ernst (2003, p. 416) further describe the species.

Taxonomy

We recognize the narrow-headed gartersnake, *Thamnophis rufipunctatus,* as a monotypic species (no currently recognized subspecies exist). The narrow-headed gartersnake is a member of the family Colubridae and subfamily Natricinae (harmless live-bearing snakes) (Lawson *et al.* 2005, p. 596). The taxonomy of the genus *Thamnophis* has a complex history partly because many of the species are similar in appearance and scutelation (arrangement of scales) and because many of the early museum specimens were in such poor and faded condition that it was difficult to study them (Conant 2003, p. 6). There are approximately 30 species described in the gartersnake genus *Thamnophis* (Rossman *et al.* 1996, pp. xvii–xviii). Two large overlapping clades (related taxonomic groups) of gartersnakes have been identified called the "Mexican" and "widespread" clades, supported by allozyme and mitochondrial DNA genetic analyses (de Queiroz *et al.* 2002, p. 321). The narrow-headed gartersnake (*Thamnophis rufipunctatus*) is a member of the "Mexican" clade and is most closely related taxonomically to the southern Durango spotted gartersnake (*Thamnophis nigronuchalis*) (de Queiroz and Lawson 1994, p. 217; de Queiroz *et al.* 2002; p. 321).

Due to the narrow-headed gartersnake's morphology and feeding habits, there has been considerable deliberation among taxonomists about the correct association of this species within seven various genera over time (Rosen and Schwalbe 1988, pp. 5–6); chiefly, between the genera *Thamnophis* (the "gartersnakes") and *Nerodia* (the "watersnakes") (Pierce 2007, p. 5). Chaisson and Lowe (1989, pp. 110–118) argued that the pattern of ultrastructural (as revealed by an electron microscope) pores in the scales of narrow-headed gartersnakes provided evidence that the species is more appropriately placed within the genus *Nerodia.* However, De Queiroz and Lawson (1994, p. 217) rejected this premise using mitochondrial DNA (mtDNA) genetic analyses to refute the inclusion of the narrow-headed gartersnake in the genus *Nerodia* and maintain the species within the genus *Thamnophis.*

The narrow-headed gartersnake was first described as *Chilopoma rufipunctatum* by E. D. Cope (in Yarrow, 1875). Recently, *Thamnophis* *rufipunctatus nigronuchalis* and *T. r. unilabialis* were recognized as subspecies under *T. rufipunctatus* and comprised what was considered the *T. rufipunctatus* complex (Rossman *et al.* 1996, p. 245). However, Rossman *et al.* (1996, pp. 244–246) elevated *T. r. nigronuchalis* to full species designation and argued that recognition of *T. r. unilabialis* be discontinued due to the diagnostic differences being too difficult to discern. Wood *et al.* (2011, p. 14) used genetic analysis of the *T. rufipunctatus* complex to propose the elevation of these three formerly recognized subspecies as three distinct species, as a result of a combination of interglacial warming, ecological and life-history constraints, and genetic drift, which promoted differentiation of these three species throughout the warming and cooling periods of the Pleistocene epoch (Wood *et al.* 2011, p. 15). We use these most recent and complete data in acknowledging these three entities as unique species: *T. rufipunctatus* (along the Mogollon Rim of Arizona and New Mexico, the narrow-headed gartersnake, which is the subject of this rule), *T. unilabialis* (Chihuahua, eastern Sonora, and northern Durango, Mexico), and *T. nigronuchalis* (southern Durango, Mexico).

Several common names have been used for this species including the red-spotted gartersnake, the brown-spotted gartersnake, and the currently used, narrow-headed gartersnake (Rosen and Schwalbe 1988, p. 5). Further discussion of the taxonomic history of the narrow-headed gartersnake is available in Crother (2012, p. 71), Degenhardt *et al.* (1996, p. 326), Rossman *et al.* (1996, p. 244), De Queiroz and Lawson (1994, pp. 213–229), Rosen and Schwalbe (1988, pp. 5–7), and De Queiroz *et al.* (2002, p. 321).

Habitat and Natural History

The narrow-headed gartersnake, distributed across the Mogollon Rim of Arizona and New Mexico, is widely considered to be one of the most aquatic of the gartersnakes (Drummond and Marcias Garcia 1983, pp. 24, 27; Rossman *et al.* 1996, p. 246). This species is strongly associated with clear, rocky streams, using predominantly pool and riffle habitat that includes cobbles and boulders (Rosen and Schwalbe 1988, pp. 33–34; Degenhardt *et al.* 1996, p. 327; Rossman *et al.* 1996, p. 246; Nowak and Santana-Bendix 2002, pp. 26–37; Ernst and Ernst 2003, p. 417). Rossman *et al.* (1996, p. 246) also note the species has been observed using lake shoreline habitat in New Mexico. Narrow-headed gartersnakes occur at elevations from approximately 2,300 to 8,000 ft (701 to 2,430 m), inhabiting Petran Montane Conifer Forest, Great Basin Conifer Woodland, Interior Chaparral, and the Arizona Upland subdivision of Sonoran Desertscrub communities (Rosen and Schwalbe 1988, p. 33; Brennan and Holycross 2006, p. 122).

An extensive evaluation of habitat use of narrow-headed gartersnakes along Oak Creek in Arizona is provided in Nowak and Santana-Bendix (2002, pp. 26–37). In the upper reaches of Oak Creek, occupied habitat is found in a steep-walled, confined canyon with shallow, braided stream segments, minimal silt, and good canopy coverage, vegetated islands and significant amounts of aquatic vegetation (Nowak and Santana-Bendix 2002, pp. 29–30). In the middle reaches of Oak Creek, occupied habitat is found in a wider canyon with less stream braiding, deeper pools, more silt, and high canopy coverage and stream-side vegetation, but less aquatic vegetation (Nowak and Santana-Bendix 2002, pp. 30–31). In the lower reaches of Oak Creek, historically occupied habitat occurred outside of the canyon proper, with predominant pool-run sequences, rare channel braiding, much silt, significantly less canopy coverage or streamside vegetation and few areas with aquatic vegetation (Nowak and Santana-Bendix 2002, p. 31).

Nowak and Santana-Bendix (2002, pp. 29–31) found the most narrow-headed gartersnakes in the upper reaches of Oak Creek, followed by the middle reaches; no narrow-headed gartersnakes were found in the lower reaches. Nowak and Santana-Bendix (2002, p. 33) found that, in general, narrow-headed gartersnakes in Oak Creek were more likely to be found within reaches without crayfish and without silt. Population densities of warm-water predatory fish increase on a gradient from the upper to the lower reaches of Oak Creek, while the inverse is true for native fish populations, and their presence confounds the analysis of physical habitat preference of narrow-headed gartersnakes. Rosen and Schwalbe (1988, p. 35) found that the relative abundance of narrow-headed gartersnakes may be highest at the conjunction of cascading riffles with pools, where waters were deeper than 20 in (0.5 m) in the riffle and deeper than 40 in (1 m) in the immediately adjoining area of the pool. However, more than twice the number of snakes was found in pools rather than riffles, but this observation may not translate for smaller streams. Despite their highly aquatic behavior, narrow-headed gartersnakes in Oak Creek have been shown to use upland habitat within 328 feet (100 m) during early fall and spring months, strongly associate with boulders in the floodplain during summer months, and use upland habitat up to 656 feet (200 m) out of the floodplain as hibernation sites (Nowak 2006, pp. 20, 26).

Bank-line vegetation is an important component to suitable habitat for this species (Nowak and Santana-Bendix 2002, pp. 26–37). Narrow-headed gartersnakes will usually bask in situations where a quick escape can be made, whether that is into the water or under substrate such as rocks (Fleharty 1967, p. 16). Common plant species associations include Arizona alder (*Alnus oblongifolia*) (highest correlation with occurrence of the narrow-headed gartersnake), velvet ash (*Fraxinus pennsylvanica*), willows (*Salix* ssp.), canyon grape (*Vitis arizonica*), blackberry (*Rubus* ssp.), Arizona sycamore (*Platanus wrightii*), Arizona black walnut (*Juglans major*), Freemont cottonwood (*Populus fremontii*), Gambel oak (*Quercus gambelii*), and ponderosa pine (*Pinus ponderosa*) (Rosen and Schwalbe 1988, pp. 34–35). Rosen and Schwalbe (1988, p. 35) noted that the composition of bank-side plant species and canopy structure may be less important to the species' needs than was the size class of the plant species present; narrow-headed gartersnakes use shrub- and sapling-sized plants for thermoregulating (basking) at the waters' edge (Degenhardt *et al.* 1996, p. 327), as well as islands within the stream channel that are created by sedge (*Carex* spp.) tussocks (Nowak and Santana-Bendix 2002, p. 34).

Narrow-headed gartersnakes may opportunistically forage within dammed reservoirs formed by streams that are occupied habitat, such as at Wall Lake, New Mexico, (located at the confluence of Taylor Creek, Hoyt Creek, and the East Fork Gila River) (Fleharty 1967, p. 207) and most recently at Snow Lake in 2012 (located near the confluence of Snow Creek and the Middle Fork Gila River) (Hellekson 2012b, pers. comm.) in New Mexico, but records from impoundments are rare. The species evolved in the absence of such habitat, and impoundments are generally managed as sport fisheries (Wall Lake and Snow Lake are) and often maintain populations of harmful nonnative species that are incompatible with narrow-headed gartersnakes.

The narrow-headed gartersnake is surface-active generally between March and November (Nowak 2006, p. 16). Little information on suitable temperatures for surface activity of the narrow-headed gartersnake exists;

however, it is presumed to be rather cold-tolerant based on its natural history and foraging behavior that often involves clear, cold streams at higher elevations. Along Oak Creek in Arizona, Nowak (2006, Appendix 1) found the species to be active in air temperatures ranging from 52 to 89 °F (11 to 32 °C) and water temperatures ranging from 54 to 72 °F (12 to 22 °C). Jennings and Christman (2011, pp. 12–14) found body temperatures of narrow-headed gartersnakes along the Tularosa River averaged approximately 68 °F (20 °C) during the mid-morning hours and 81 °F (27 °C) in the late afternoon during the period from late July and August. Variables that affect their body temperature include the temperature of the microhabitat used and water temperature (most predictive), but slope aspect and the surface area of cover used also influenced body temperatures (Jennings and Christman 2011, p. 13). Narrow-headed gartersnakes have a lower preferred temperature for activity as compared to other species of gartersnakes (Fleharty 1967, p. 228), which may facilitate their highly aquatic nature in cold streams.

Narrow-headed gartersnakes specialize on fish as their primary prey item (Rosen and Schwalbe 1988, p. 38; Degenhardt *et al.* 1996, p. 328; Rossman *et al.* 1996, p. 247; Nowak and Santana-Bendix 2002, pp. 24–25; Nowak 2006, p. 22). They are believed to be mainly visual hunters (Hibbitts and Fitzgerald 2005, p. 364) heavily dependent on visual cues when foraging based on comparative analyses among other species of gartersnakes (de Queiroz 2003, p. 381). Unlike many other species of gartersnakes that are active predators (actively crawl about in search of prey), narrow-headed gartersnakes are considered to be ambush predators (sit-and-wait method) (Brennan and Holycross 2006, p. 122; Pierce *et al.* 2007, p. 8). The specific gravity (ratio of the mass of a solid object to the mass of the same volume of water) of the narrow-headed gartersnake was found to be nearly 1, which means that the snake can maintain its desired position in the water column with ease, an adaptation to facilitate foraging on the bottom of streams (Fleharty 1967, pp. 218–219).

Native fish species most often associated as prey items for the narrow-headed gartersnake include Sonora sucker (*Catostomus insignis*), desert sucker (*C. clarki*), speckled dace (*Rhinichthys osculus*), roundtail chub (*Gila robusta*), Gila chub (*Gila intermedia*), and headwater chub (*Gila nigra*) (Rosen and Schwalbe 1988, p. 39; Degenhardt *et al.* 1996, p. 328). Nonnative predatory fish species in their fingerling size classes are also used as prey by narrow-headed gartersnakes, including brown trout (Rosen and Schwalbe 1988, p. 39; Nowak and Santana-Bendix 2002, p. 24; Nowak 2006, pp. 22–23), green sunfish (Fleharty 1967, p. 223), and smallmouth bass (*Micropterus dolomieu*) (M. Lopez, 2010, pers. comm.). Reports suggest that brown trout are consumed more frequently than smallmouth bass. Trout species are commonly stocked in, or near, occupied narrow-headed gartersnake habitat. Fleharty (1967, p. 223) reported narrow-headed gartersnakes eating green sunfish. But nonnative fish with spiny dorsal fins are not generally considered suitable prey items due to the risk of injury to the gartersnake during ingestion and because of where they tend to occur in the water column (see discussion in the subsection ''Fish'' under the subheading ''Decline of the Gartersnake Prey Base'' and Nowak and Santana-Bendix (2002, p. 24)).

Although the narrow-headed gartersnake has been reported to also prey upon amphibians such as frogs, tadpoles, and salamanders (Stebbins 1985, p. 199; Deganhardt *et al.* 1996, p. 328; Ernst and Ernst 2003, p. 418), we believe these are not important items in their diet. Despite several studies focusing on the ecology of narrow-headed gartersnakes in recent times, there are no other records of narrow-headed gartersnakes, under current taxonomic recognition, feeding on prey items other than fish. Fitzgerald (1986, p. 6) referenced the Stebbins (1985) account as the only substantiated account of the species eating something other than fish as prey, apparently as the result of finding a small salamander larvae in the stomach of an individual in Durango, Mexico. Formerly recognized as a subspecies of *Thamnophis rufipunctatus,* that individual is now recognized as *T. unilabialis* (Wood *et al.* 2011, p. 3). We found one account of narrow-headed gartersnakes consuming red-spotted toads in captivity (Woodin 1950, p. 40). Amphibian larvae (i.e. *Hyla* sp., *Anaxyrus* sp., *Ambystoma* sp.) are generally available to narrow-headed gartersnakes as prey, yet observations of narrow-headed gartersnakes using them are rare. Therefore, we do not consider amphibians as ecologically important prey for this species.

Native predators of the narrow-headed gartersnake include birds of prey, such as black-hawks (Etzel *et al.* 2014, p. 56), other snakes such as regal ring-necked snakes (Brennan *et al.* 2009, p. 123), wading birds, mergansers, belted kingfishers, raccoons (Rosen and Schwalbe 1988, p. 39), and possibly other generalist mammalian predators. Historically, large, highly predatory native fish species, such as Colorado pikeminnow, may have preyed upon narrow-headed gartersnakes where the species co-occurred. Native chubs (*Gila* spp.) may also prey on neonatal gartersnakes.

Sexual maturity in narrow-headed gartersnakes occurs at 2.5 years of age in males and at 2 years of age in females (Deganhardt *et al.* 1996, p. 328). Narrow-headed gartersnakes are viviparous. Narrow-headed gartersnakes breed annually, and females give birth to 4 to 17 offspring from late July into early August, perhaps earlier at lower elevations (Rosen and Schwalbe 1988, pp. 35–37). Narrow-headed gartersnakes may live as long as 10 years in the wild (Rosen and Schwalbe 1988, p. 38).

Historical Distribution

The historical distribution of the narrow-headed gartersnake ranged across the Mogollon Rim and along associated perennial stream drainages from central and eastern Arizona, southeast to southwestern New Mexico at elevations ranging from 2,300 to 8,000 ft (700 to 2,430 m) (Rosen and Schwalbe 1988, p. 34; Rossman *et al.* 1996, p. 242; Holycross *et al.* 2006, p. 3). The species was historically distributed in headwater streams of the Gila River subbasin that drain the Mogollon Rim and White Mountains in Arizona, and the Gila Wilderness in New Mexico. Major subbasins in its historical distribution included the Salt and Verde River subbasins in Arizona, and the San Francisco and Gila River subbasins in New Mexico (Holycross *et al.* 2006, p. 3). Holycross *et al.* (2006, p. 3) suspect the species was likely not historically present in the lowest reaches of the Salt, Verde, and Gila Rivers, even where perennial flow persists. Numerous records for the narrow-headed gartersnake (through 1996) in Arizona are maintained in the AGFD's Heritage Database (1996b). The narrow-headed gartersnake as currently recognized does not occur in Mexico.

Current Distribution and Population Status

Population status information suggests that the narrow-headed gartersnake has experienced significant declines in population density and distribution along streams and rivers where it was formerly well-documented and reliably detected. Many areas where the species may occur likely rely on emigration of individuals from occupied habitat into those areas to maintain the species, provided there are no potential barriers to movement, such as extensive stretches of dewatered habitat, or high densities of harmful nonnative species. Holycross *et al.* (2006, entire) represents the most recent, comprehensive survey effort for narrow-headed gartersnakes in Arizona. Narrow-headed gartersnakes were detected in 5 of 16 historical localities in Arizona and New Mexico surveyed by Holycross *et al.* (2006) in 2004 and 2005. Population densities have noticeably declined in many populations, as compared to previous survey efforts (Holycross *et al.* 2006, p. 66). Holycross *et al.* (2006, pp. 66–67) compared narrow-headed gartersnake detections based on results from their effort and that of previous efforts in the same locations and found that significantly more effort is required to detect this species in areas where it was formerly robust, such as along Eagle Creek (AZ), the East Verde River (AZ), the San Francisco River (NM), the Black River (AZ), and the Blue River (AZ).

Where narrow-headed gartersnakes are locally abundant, they can usually be detected reliably and with significantly less effort than populations characterized as having low densities. Narrow-headed gartersnakes are well-camouflaged, secretive, and very difficult to detect in structurally complex, dense habitat where they could occur at very low population densities, which characterizes most occupied sites. We considered factors such as the date of the last known records for narrow-headed gartersnakes in an area, as well as records of one or more native prey species, in making a conclusion on species occupancy. We used all records that were dated 1980 or later because the 1980s marked the first systematic survey efforts for narrow-headed gartersnake species across their range (see Rosen and Schwalbe (1988, entire) and Fitzgerald (1986, entire)), and the last, previous records were often dated several decades prior and may not accurately represent the likelihood for current occupation. Several areas where narrow-headed gartersnakes were known to occur have received no, or very little, survey effort in the past several decades. Variability in survey design and effort makes it difficult to compare population sizes or trends among sites and between sampling periods. Thus, for each of the sites discussed in Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071), we have attempted to translate and quantify search and capture efforts into comparable units (*i.e.,* person-search hours and trap-hours) and have cautiously interpreted those results. Where survey data are sparse, the presence of suitable prey species in an area may provide evidence that narrow-headed gartersnakes may still persist at low densities. Therefore, a record of a native prey species was considered in our determination of occupancy of this species.

As of 2011, the only remaining narrow-headed gartersnake populations where the species could reliably be found were located at: (1) Whitewater Creek (NM), (2) Tularosa River (NM), (3) Diamond Creek (NM), (4) Middle Fork Gila River (NM), and (5) Oak Creek Canyon (AZ). However, populations found in Whitewater Creek and the Middle Fork Gila River were likely significantly affected by the large Whitewater–Baldy Complex Fire, which occurred in June 2012. In addition, salvage efforts were initiated for these two populations, which included the removal of 25 individuals from Whitewater Creek and 14 individuals from the Middle Fork Gila River before the onset of summer rains in 2012. These 39 individuals were transported to the Albuquerque BioPark where 22 remain in captivity. The other 17 of the salvaged individuals were translocated to Saliz Creek, where the resident native prey base appears adequate, and beyond the effects from the Whitewater-Baldy Complex Fire. The status of those populations in Whitewater Creek and the Middle Fork Gila River has likely deteriorated as a result of subsequent declines in resident fish communities due to heavy ash and sediment flows, resulting fish kills, and the removal of snakes, but subsequent survey data have not been collected. If the Whitewater Creek and Middle Fork Gila River populations did decline as a result of these factors, only three remaining populations of this species remain viable today across their entire distribution. While historical records confirm the narrow-headed gartersnake was found on tribal lands, its current status on tribal land is poorly known due to limited survey access.

In Table 2 below, we summarize the population status of the narrow-headed gartersnake at all known localities throughout its distribution, as supported by museum records or reliable observations. For a detailed discussion that explains the rationale for site-by-site conclusions on occupancy and status, please see Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071). General rationale is provided in the introductory paragraph to this section, ''Current Distribution and Population Status.''

TABLE 2—CURRENT POPULATION STATUS OF THE NARROW-HEADED GARTERSNAKE

[References for this information are provided in appendix A]

Location	Last record	Suitable physical habitat present	Native prey species present	Harmful nonnative species present	Population status
West Fork Gila River (NM)	2011	Yes	Yes	Yes	Likely not viable.
Middle Fork Gila River (NM)	2012	Yes	Yes	Yes	Likely not viable.
East Fork Gila River (NM)	2006	Yes	Yes	Yes	Likely not viable.
Gila River (AZ, NM)	2009	Yes	Yes	Yes	Likely not viable.
Snow Creek/Snow Lake (NM)	2012	Yes	No	Yes	Likely not viable.
Gilita Creek (NM)	2009	Yes	Yes	No	Likely not viable.
Iron Creek (NM)	2009	Yes	Yes	No	Likely not viable.
Little Creek (NM)	2010	Yes	Possible	Yes	Likely not viable.
Turkey Creek (NM)	1985	Yes	Yes	Possible	Likely not viable.
Beaver Creek (NM)	1949	Yes	Possible	Yes	Likely extirpated.
Black Canyon (NM)	2010	Yes	Yes	Yes	Likely not viable.
Taylor Creek (NM)	1960	Yes	No	Yes	Likely extirpated.
Diamond Creek (NM)	2011	Yes	Yes	Yes	Likely viable.
Tularosa River (NM)	2012	Yes	Yes	Yes	Likely viable.
Whitewater Creek (NM)	2012	Yes	Yes	Yes	Likely not viable.
San Francisco River (NM)	2011	Yes	Yes	Yes	Likely not viable.
South Fork Negrito Creek (NM)	2011	Yes	Possible	Yes	Likely not viable.
Blue River (AZ)	2007	Yes	Yes	Yes	Likely not viable.

TABLE 2—CURRENT POPULATION STATUS OF THE NARROW-HEADED GARTERSNAKE—Continued

[References for this information are provided in appendix A]

Location	Last record	Suitable physical habitat present	Native prey species present	Harmful nonnative species present	Population status
Dry Blue Creek (AZ, NM)	2010	Yes	Possible	Yes	Likely not viable.
Campbell Blue Creek (AZ, NM)	2010	Yes	Possible	Yes	Likely not viable.
Saliz Creek (NM)	2013	Yes	Possible	Yes	Likely not viable.
Eagle Creek (AZ)	2013	Yes	Possible	Yes	Likely not viable.
Black River (AZ)	2013	Yes	Yes	Yes	Likely not viable.
East Fork Black River (AZ)	2004	Yes	Possible	Yes	Likely not viable.
Fish Creek (Tributary to East Fork Black River; AZ).	2004	Yes	Yes	Possible	Likely viable.
White River (AZ)	1986	Yes	Yes	Possible	Likely not viable.
Diamond Creek (AZ)	1986	Yes	Possible	Possible	Likely not viable.
Tonto Creek (tributary to Big Bonita Creek, AZ).	1915	Yes	Possible	Possible	Likely extirpated.
Canyon Creek (AZ)	1991	Yes	Yes	No	Likely not viable.
Upper Salt River (AZ)	1985	Yes	Yes	Yes	Likely not viable.
Cibeque Creek (AZ)	1991	Yes	Yes	Possible	Likely not viable.
Carrizo Creek (AZ)	1997	Yes	Yes	Possible	Likely not viable.
Big Bonito Creek (AZ)	1957	Yes	Yes	Yes	Likely extirpated.
Haigler Creek (AZ)	2008	Yes	Yes	Yes	Likely not viable.
Houston Creek (AZ)	2005	Yes	Yes	Yes	Likely not viable.
Tonto Creek (tributary to Salt River, AZ).	2005	Yes	Yes	Yes	Likely not viable.
Deer Creek (AZ)	1995	No	No	No	Likely extirpated.
Upper Verde River (AZ)	2012	Yes	Yes	Yes	Likely not viable.
Oak Creek (AZ)	2012	Yes	Yes	Yes	Likely viable.
West Fork Oak Creek (AZ)	2012	Yes	Yes	Yes	Likely viable.
East Verde River (AZ)	1992	Yes	Yes	Yes	Likely not viable.

Notes: ''Possible'' means there were no conclusive data found. ''Likely extirpated'' means the last record for an area pre-dated 1980, and existing threats suggest the species is likely extirpated. ''Likely not viable'' means there is a post-1980 record for the species, it is not reliably found with minimal to moderate survey effort, and threats exist which suggest the population may be low density or could be extirpated, but there is insufficient evidence to support extirpation. ''Likely viable'' means that the species is reliably found with minimal to moderate survey effort, and the population is generally considered to be somewhat resilient.

Table 2 lists the 41 known localities for narrow-headed gartersnakes throughout their range. We have concluded that, in as many as 31 of 41 known localities (76 percent), the narrow-headed gartersnake population is likely not currently viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated, but survey data are lacking in areas where access is restricted. In most localities where the species may occur at low population densities, existing survey data are insufficient to conclude extirpation. As of 2014, narrow-headed gartersnake populations are considered currently likely viable in five localities (12 percent). The remaining five populations (12 percent) are considered currently likely extirpated. As displayed in Table 2, harmful nonnative species are a concern for all but four narrow-headed gartersnake populations. The status of these populations is expected to continue to decline.

Summary of Biological Status and Threats

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on any of the following five factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; and (E) other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination.

In the following threats analysis, we treat both gartersnake species in a combined discussion because of partially overlapping ranges, similar natural histories, similar responses to threats, and the fact that many threats are shared in common throughout their ranges.

Weakened Status of Native Aquatic Communities (Northern Mexican and Narrow-Headed Gartersnakes) (Factors A, C, and E)

The presence of harmful nonnative species constitutes the most significant threat to the two gartersnake species. Harmful nonnative species directly prey upon both species of gartersnake and compete with them for prey. Harmful nonnative species also compete with gartersnake prey species as well as modify habitat for both the gartersnakes and their prey, to the detriment of both gartersnakes. Landscape-level effects from the continued expansion of harmful nonnative species have changed the spatial orientation of these gartersnakes' distributions, creating greater isolation between populations. We expect the viability of extant gartersnake populations to continue to degrade into the foreseeable future as a result of ecological interactions with harmful nonnative species. Riparian and aquatic communities in both the southwestern United States and Mexico have been significantly impacted by a shift in species' composition, from one of primarily native fauna, to one dominated by an expanding assemblage of harmful nonnative animal species. Harmful nonnative species have been introduced or have spread into new areas through a variety of mechanisms, including intentional and accidental releases, sport stocking, aquaculture, aquarium releases, bait-bucket releases, or natural dispersal (Welcomme 1984, entire). The ecological ramifications of the adversarial relationships within southwestern aquatic communities have been discussed and described in a broad body of literature, extending from 1985 to the present (Meffe 1985, pp. 179–185; Propst *et al.* 1986, pp. 14–31, 82; 1988, p. 64; 2009, pp. 5–17; Rosen and Schwalbe 1988, pp. 28, 32; 1997, p. 1; Clarkson and Rorabaugh 1989, pp. 531, 535; Douglas *et al.* 1994, pp. 9–19; Rosen *et al.* 1995, pp. 257–258; 2001, p. 2; Degenhardt *et al.* 1996, p. 319; Fernandez and Rosen 1996, pp. 8, 23–27, 71, 96; Richter *et al.* 1997, pp. 1089, 1092; Inman *et al.* 1998, p. 17; Rinne *et al.* 1998, pp. 4–6; Nowak and Santana-Bendix 2002, Table 3; Propst 2002, pp. 21–25; DFT 2003, pp. 1–3, 5–6, 19; 2004, pp. 1–2, 4–5, 10, Table 1; Bonar *et al.* 2004, pp. 13, 16–21; Rinne 2004, pp. 1–2; Clarkson *et al.* 2005, p. 20; Fagan *et al.* 2005, pp. 34, 34–41; Knapp 2005, pp. 273–275; Olden and Poff 2005, pp. 82–87; Turner 2007, p. 41; Holycross *et al.* 2006, pp. 13–15; Brennan 2007, pp. 5, 7; Caldwell 2008a, 2008b; d'Orgeix 2008; Luja and Rodríguez-Estrella 2008, pp. 17–22; Propst *et al.* 2008, pp. 1242–1243; Rorabaugh 2008a, p. 25; Brennan and Rosen 2009, pp. 8–9; Minckley and Marsh 2009, pp. 50–51; Pilger *et al.* 2010, pp. 311–312; Stefferud *et al.* 2009, pp. 206–207; 2011, pp. 11–12; Young and Boyarski 2013, pp. 159–160).

Decline of the Gartersnake Prey Base (Northern Mexican and Narrow-Headed Gartersnakes) (Factors A and E)

The prey base of these gartersnakes includes native amphibians and fish populations. Declines in their prey base have led to subsequent declines in the distribution and density of gartersnake populations. In most areas across their ranges, prey base declines are largely attributed to the introduction and expansion of harmful nonnative species.

Northern Mexican and narrow-headed gartersnakes may be particularly vulnerable to the loss of native prey species (Rosen and Schwalbe 1988, pp. 20, 44–45). Rosen *et al.* (2001, pp. 10, 13, 19) theorized that the northern Mexican gartersnake: (1) Is unlikely to increase foraging efforts at the risk of increased predation; and (2) needs adequate food on a regular basis to maintain its weight and health. If forced to forage more often for smaller prey items, a reduction in growth and reproductive rates can result (Rosen *et al.* 2001, pp. 10, 13). Rosen *et al.* (2001, p. 22) hypothesized that the presence and expansion of nonnative predators (mainly bullfrogs, crayfish, and green sunfish (*Lepomis cyanellus*)) are the primary causes of decline in northern Mexican gartersnakes and in their prey in southeastern Arizona. In another example, Drummond and Macías Garcia (1989, pp. 25, 30) found that Mexican gartersnakes fed primarily on frogs, and when frogs became unavailable, the species simply ceased major foraging activities. This led the authors to conclude that frog abundance is probably the most important correlate, and main determinant, of foraging behavior in northern Mexican gartersnakes.

With respect to narrow-headed gartersnakes, the relationship between harmful nonnative species, a declining prey base, and gartersnake populations is clearly depicted in one population along Oak Creek. Nowak and Santana-Bendix (2002, Table 3) found a strong correlation in the distribution of fish communities and narrow-headed gartersnake communities in the vicinity of Midgely Bridge. Downstream of that point, nonnative, predatory fish species increase in abundance, and narrow-headed gartersnakes notably decrease in abundance. Upstream of that point, native fish and nonnative, soft-rayed fish species increase in abundance as do narrow-headed gartersnakes (Nowak and Santana-Bendix 2002, p. 23).

Fish (Northern Mexican and Narrow-headed Gartersnakes)—Fish are an important prey item for the northern Mexican gartersnake and are the only prey for the narrow-headed gartersnake. Native fish communities throughout the range of these gartersnake have been on the decline, both in terms of species composition and biomass, for many decades, and largely as a result of predation and competition from and with nonnative, predatory fish species. Stocked for sport, forage, or biological control, nonnative fishes have been shown to become invasive where released and do not require the natural flow regimes that native species do (Kolar *et al.* 2003, p. 9), which has contributed to their expansion in the Gila River basin and elsewhere. Northern Mexican and narrow-headed gartersnakes can successfully use nonnative, soft-rayed fish species as prey, such as mosquitofish, red shiner, and introduced trout species, such as rainbow trout (*Oncorynchus mykiss*), brook trout (*Salvelinus fontinalis*), or brown trout (Nowak and Santana-Bendix 2002, pp. 24–25; Holycross *et al.* 2006, p. 23). However, predatory fish are not generally considered prey species for northern Mexican or narrow-headed gartersnakes and, in addition, are known to prey on neonatal and juvenile gartersnakes (Young and Boyarski 2013, pp. 158–159). Nowak and Santana-Bendix (2002, p. 24) propose two hypotheses regarding the reluctance of narrow-headed gartersnakes to prey on nonnative, predatory fish: (1) The laterally compressed shape and presence of sharp, spiny dorsal spines of many nonnative, predatory fish present a choking hazard to gartersnakes that can be fatal; and (2) nonnative, predatory fish (with the exception of catfish) tend to occupy the middle and upper zones in the water column, while narrow-headed gartersnakes typically hunt along the bottom (where native suckers and minnows often occur). As a result, nonnative, predatory fish may be less ecologically available as prey.

Brown trout are highly predatory in all size classes in a wide range of water temperatures, and they adversely affect native fish communities wherever they are introduced (Taylor *et al.* 1984, pp. 343–344). Predation on gartersnakes by adult brown trout may be a particular problem for narrow-headed gartersnakes due to their overlapping distributions and habitat preferences, both in terms of direct predation on neonatal gartersnakes and through competitive pressures for gartersnakes by preying on their food source. Specifically, the younger age classes of brown trout present competition problems for the narrow-headed gartersnake by eating small fish. As brown trout mature into the medium to larger size classes, they may prey upon neonatal narrow-headed gartersnakes. These issues are confounded by the fact that young brown trout are also eaten by narrow-headed gartersnakes and may represent an important component of their prey base, depending on fish species composition and age classes represented within the resident fish community. However, whatever benefits fingerling brown trout present for narrow-headed gartersnakes are likely off-set by effects of brown trout predation on important native fish species, and possible effects to recruitment of narrow-headed gartersnakes through predation.

Harmful nonnative species invasions can indirectly affect the health, maintenance, and reproduction of northern Mexican and narrow-headed gartersnakes by altering their foraging strategy and compromising foraging success. Rosen *et al.* (2001, p. 19), in addressing the northern Mexican gartersnake, proposed that an increase in energy expended in foraging, coupled by the reduced number of small to medium-sized prey fish available, results in deficiencies in nutrition, affecting growth and reproduction. This occurs because energy is allocated to maintenance and the increased energy costs of intense foraging activity, rather than to growth and reproduction. In contrast, a northern Mexican gartersnake diet that includes both fish and amphibians, such as leopard frogs, reduces the necessity to forage at a higher frequency, allowing metabolic energy gained from larger prey items to be allocated instead to growth and reproductive development. Myer and Kowell (1973, p. 225) experimented with food deprivation in common gartersnakes, and found significant reductions in lengths and weights of juvenile snakes that were deprived of regular feedings versus the control group that were fed regularly at natural frequencies. Reduced foraging success of both northern Mexican and narrow-headed gartersnakes means that individuals are likely to become vulnerable to effects from starvation, which may increase fatality rates of juveniles and, consequently, affect recruitment.

Northern Mexican gartersnakes have a more varied diet than narrow-headed gartersnakes. We are not aware of any studies that have addressed the direct relationship between prey base diversity and northern Mexican gartersnake recruitment and survivorship. However, Krause and Burghardt (2001, pp. 100–123) discuss the benefits and costs that may be associated with diet variability in the common gartersnake (*Thamnophis sirtalis*), an ecologically similar species to the northern Mexican gartersnake. Foraging for mixed-prey species may impede predator learning, as compared to specialization on a certain prey species, but it may also provide long-term benefits such as the ability to capture prey throughout their lifespan (Krause and Burghardt 2001, p. 101).

A wide variety of native fish species (many of which are now listed as endangered, threatened, or candidates for listing under the Act) were historically primary prey species for northern Mexican and narrow-headed gartersnakes (Rosen and Schwalbe 1988, pp. 18, 39). Marsh and Pacey (2005, p. 60) predict that, despite the significant physical alteration of aquatic habitat in the southwestern United States, native fish species could flourish in these altered environments but for the presence of harmful nonnative fish species. Northern Mexican and, in particular, narrow-headed gartersnakes depend largely on native fish as a principal part of their prey base, although nonnative, soft-rayed predatory fish have also been documented as prey where they overlap in distribution with these gartersnakes (Nowak and Santana-Bendix 2002, pp. 24–25; Holycross *et al.* 2006, p. 23; Emmons and Nowak 2013, p. 6). Nonnative, predatory fish compete with northern Mexican and narrow-headed gartersnakes for prey. In their extensive surveys, Rosen and Schwalbe (1988, p. 44) only found narrow-headed gartersnakes in abundance where native fish species predominated but did not find them abundant in the presence of robust nonnative, predatory fish populations. Minckley and Marsh (2009, pp. 50–51) found nonnative fishes to be the single-most significant factor in the decline of native fish species and also their primary obstacle to recovery. Of the 48 conterminous States in the United States, Arizona has the highest proportion of nonnative fish species (66 percent) represented by approximately 68 species (Turner and List 2007, p. 13).

Collier *et al.* (1996, p. 16) note that interactions between native and nonnative fish have significantly contributed to the decline of many native fish species from direct predation and, indirectly, from competition (which has adversely affected the prey base for northern Mexican and narrow-headed gartersnakes). Holycross *et al.* (2006, pp. 52–61) documented depressed or extirpated native fish prey bases for northern Mexican and narrow-headed gartersnakes along the Mogollon Rim in Arizona and New Mexico. Rosen *et al.* (2001, Appendix I) documented the decline of several native fish species in several locations visited in southeastern Arizona, further affecting the prey base of northern Mexican gartersnakes in that area.

Harmful nonnative fish species tend to be nest-builders and actively guard their young, which may provide them another ecological advantage over native species that are broadcast spawners and provide no parental care to their offspring (Marsh and Pacey 2005, p. 60). In fact, nesting smallmouth bass will attack gartersnakes (Winemiller and Taylor 1982, p. 270). It is, therefore, likely that recruitment and survivorship is greater in nonnative species than native species where they overlap, providing nonnative species with an ecological advantage. Table 2–1 in Kolar *et al.* (2003, p. 10) provides a map depicting the high degree of overlap in the distribution of native and nonnative fishes within the Gila River basin of Arizona and New Mexico as well as watersheds thought to be dominated by nonnative fish species.

The widespread decline of native fish species from the arid southwestern United States and Mexico has resulted largely from interactions with nonnative species and has been noted in the listing rules of 11 fishes under the Act, and their historical ranges overlap with the historical distribution of northern Mexican and narrow-headed gartersnakes. Native fish species that were likely prey species for these gartersnakes and are now listed under the Act, include the bonytail chub (*Gila elegans,* 45 FR 27710, April 23, 1980), Yaqui chub (*Gila purpurea,* 49 FR 34490, August 31, 1984), Yaqui topminnow (*Poeciliopsis occidentalis sonoriensis,* 32 FR 4001, March 11, 1967), beautiful shiner (*Cyprinella formosa,* 49 FR 34490, August 31, 1984), Gila chub (*Gila intermedia,* 70 FR 66663, November 2, 2005), Colorado pikeminnow (*Ptychocheilus lucius,* 32 FR 4001, March 11, 1967), spikedace (*Meda fulgida,* 77 FR 10810, February 23, 2012), loach minnow (*Tiaroga cobitis,* 77 FR 10810, February 23, 2012), razorback sucker (*Xyrauchen texanus,* 56 FR 54957, October 23, 1991), desert pupfish (*Cyprinodon macularius,* 51 FR 10842, March 31, 1986), woundfin (*Plagopterus argentissiums,* 35 FR 16047, October 13, 1970), and Gila topminnow (*Poeciliopsis occidentalis,* 32 FR 4001, March 11, 1967). In total within Arizona, 19 of 31 (61 percent) native fish species are listed under the Act. Arizona ranks the highest of all 50 States in the percentage of native fish species with declining trends (85.7 percent), and New Mexico ranks sixth (48.1 percent) (Stein 2002, p. 21; Warren and Burr 1994, p. 14).

The fastest expanding nonnative species are red shiner (*Cyprinella lutrensis*), fathead minnow (*Pimephales promelas*), green sunfish, largemouth bass (*Micropterus salmoides*), western mosquitofish, and channel catfish (*Ictalurus punctatus*). A nonnative species can become invasive if ecological advantages exist for broad physical tolerances, feeding habits and diet, or reproductive behavior (Taylor *et al.* 1984, Table 16–1). These species are considered to be the most invasive in terms of their negative impacts on native fish communities (Olden and Poff 2005, p. 75). Many nonnative fishes, in addition to those listed immediately above, including yellow and black bullheads (*Ameiurus* sp.), flathead catfish (*Pylodictis olivaris*), and smallmouth bass, have been introduced into formerly and currently occupied northern Mexican or narrow-headed gartersnake habitat and are predators on these species (Young and Boyarski 2013, pp. 158–159) and their prey (Bestgen and Propst 1989, pp. 409–410; Marsh and Minckley 1990, p. 265; Sublette *et al.* 1990, pp. 112, 243, 246, 304, 313, 318; Abarca and Weedman 1993, pp. 6–12; Stefferud and Stefferud 1994, p. 364; Weedman and Young 1997, pp. 1, Appendices B, C; Rinne *et al.* 1998, pp. 3–6; Voeltz 2002, p. 88; Bonar *et al.* 2004, pp. 1–108; Fagan *et al.* 2005, pp. 34, 38–39, 41; Propst *et al.* 2008, pp. 1242–1243). Nonnative, predatory fish species, such as flathead catfish, may be especially dangerous to narrow-headed gartersnake populations through competition and direct predation because they are primarily piscivorous (fish-eating) (Pilger *et al.* 2010, pp. 311–312), have large mouths, and have a tendency to occur along the stream bottom, where narrow-headed gartersnakes principally forage.

Rosen *et al.* (2001, Appendix I) and Holycross *et al.* (2006, pp. 15–51) conducted large-scale surveys for northern Mexican gartersnakes in southeastern and central Arizona and narrow-headed gartersnakes in central and east-central Arizona, and documented the presence of nonnative fish at many locations. Holycross *et al.* (2006, pp. 14–15) found nonnative fish species in 64 percent of the sample sites in the Agua Fria subbasin, 85 percent of the sample sites in the Verde River subbasin, 75 percent of the sample sites in the Salt River subbasin, and 56 percent of the sample sites in the Gila River subbasin. In total, nonnative fish were observed at 41 of the 57 sites surveyed (72 percent) across the Mogollon Rim (Holycross *et al.* 2006, p. 14). Entirely native fish communities were presumed in only 8 of 57 sites surveyed (14 percent) (Holycross *et al.* 2006, p. 14). It is well documented that nonnative fish have now infiltrated the majority of aquatic communities in the southwestern United States as depicted in Tables 1 and 2, above, as well as in Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071).

Several authors have identified both the presence of nonnative fish as well as their deleterious effects on native species within Arizona. Many areas have seen a shift from a predominance of native fishes to a predominance of nonnative fishes. On the upper Verde River, native species dominated the total fish community at greater than 80 percent from 1994 to 1996, before dropping to approximately 20 percent in 1997 and 19 percent in 2001. At the same time, three nonnative species increased in abundance between 1994 and 2000 (Rinne *et al.* 2005, pp. 6–7). In an assessment of the Verde River, Bonar *et al.* (2004, p. 57) found that, in the Verde River mainstem, nonnative fishes were approximately 2.6 times more dense per unit volume of river than native fishes, and their populations were approximately 2.8 times that of native fishes per unit volume of river. Similar changes in the dominance of nonnative fishes have occurred on the Middle Fork Gila River, with a 65 percent decline of native fishes between 1988 and 2001 (Propst 2002, pp. 21–25). Abarca and Weedman (1993, pp. 6–12) found that the number of nonnative fish species was twice the number of native fish species in Tonto Creek in the early 1990s, with a stronger nonnative species influence in the lower reaches, where the northern Mexican gartersnake is considered to still occur (Burger 2010, p. 1, Madera-Yagla 2010, p. 6, 2011, p. 6).

Beginning in 2014, the AGFD plans to stock 4.6 million Florida-strain largemouth bass, 3.3 million bluegill, and 4.5 million black crappie annually into Roosevelt Lake in order to control the gizzard shad (*Dorosoma cepedianum*) population, which is currently the most prevalent fish species in the lake and is thought to be depressing sport fish populations in the reservoir (AGFD 2014, p. 3). Roosevelt Lake is not, and will never be, suitable habitat for the northern Mexican gartersnake because of its management as a sport fishery. However, if the goal of this effort is achieved, we expect a higher risk of predation of gartersnakes in lower Tonto Creek when a suitable hydrologic connection is made between Tonto Creek and the lake body (providing the opportunity for predatory nonnative fish to move into lower Tonto Creek). We also expect high risk of predation of individual snakes that may disperse downstream into the lake itself. Fish surveys in the Salt River above Lake Roosevelt already indicate a decline of roundtail chub and other native fishes, with an increase in flathead and channel catfish numbers (Voeltz 2002, p. 49).

In New Mexico, nonnative fish have been identified as the main cause for declines observed in native fish populations (Voeltz 2002, p. 40; Propst *et al.* 2008, pp. 1242–1243). Fish experts from the U.S. Forest Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management (BLM), University of Arizona, Arizona State University, The Nature Conservancy, and others declared the native fish fauna of the Gila River basin to be critically imperiled, and they cite habitat destruction and nonnative species as the primary factors for the declines (DFT 2003, p. 1). They call for the control and removal of nonnative fish as an overriding need to prevent the decline, and possible extinction, of native fish species within the basin (DFT 2003, p. 1). In some areas, nonnative fishes may not dominate the system, but their abundance has increased. This is the case for the Cliff-Gila Valley area of the Gila River where nonnative fishes increased from 1.1 percent to 8.5 percent, while native fishes declined steadily over a 40-year period (Propst *et al.* 1986, pp. 27–32). At the Redrock and Virden Valleys on the Gila River, the relative abundance in nonnative fishes in the same time period increased from 2.4 percent to 17.9 percent (Propst *et al.* 1986, pp. 32–34). Four years later, the relative abundance of nonnative fishes increased to 54.7 percent at these sites (Propst *et al.* 1986, pp. 32–36). The percentage of nonnative fishes increased by almost 12 percent on the Tularosa River between 1988 and 2003, while on the East Fork Gila River, nonnative fishes increased to 80.5 percent relative abundance in 2003 (Propst 2005, pp. 6–7, 23–24).

In addition to harmful nonnative species, various parasites may affect native fish species that are prey for northern Mexican and narrow-headed gartersnakes. Parasites affecting various species of native fishes within the range of these gartersnakes include Asian tapeworm (U.S. Fish and Wildlife Service (USFWS) National Wild Fish Health Survey 2010), *Ichthyophthirius multifiliis* (Ich) (Mpoame 1982, p. 46; Robinson *et al.* 1998, p. 603), anchor worm (*Lernaea cyprinacea*) (Robinson *et al.* 1998, pp. 599, 603–605; Hoffnagle and Cole 1999, p. 24), yellow grub (*Clinostomum marginatum*) (Amin 1969, p. 436; Mpoame and Rinne 1983, pp. 400–401; Bryan and Robinson 2000, p. 19; Maine Department of Inland Fisheries and Wildlife 2002a, p. 1), and black grub (*Neascus spp.*), also called black spot (Robinson *et al.* 1998, p. 603; Bryan and Robinson 2000, p. 21; Lane and Morris 2000, pp. 2–3; Maine Department of Inland Fisheries and Wildlife 2002b, p. 1; Paroz 2011, pers. comm.). However, currently, we have no information on what effect parasite infestation in native fish might have on gartersnake populations.

Decline of Native Fish Communities in Mexico (Northern Mexican Gartersnake)—The first tabulations of freshwater fish species at risk in Mexico occurred in 1961, when 11 species were identified as being at risk (Contreras-Balderas *et al.* 2003, p. 242). As of 2003, of the 506 species of freshwater fish recorded in Mexico, 185 (37 percent) have been listed by the Mexican Federal Government as either endangered, facing extinction, under special protection, or likely extinct (Alvarez-Torres *et al.* 2003, p. 323), almost a 17-fold increase in slightly over four decades; 25 species are believed to have gone extinct (Contreras-Balderas *et al.* 2003, p. 241). In the lower elevations of

Mexico, within the distribution of the northern Mexican gartersnake, there are approximately 200 species of native freshwater fish documented, with 120 native species under some form of threat and an additional 15 that have gone extinct (Contreras-Balderas and Lozano 1994, pp. 383–384). The Fisheries Law in Mexico empowered the country's National Fisheries Institute to compile and publish the National Fisheries Chart in 2000, which found that Mexico's fish fauna has seriously deteriorated as a result of environmental impacts (pollution), water basin degradation (dewatering, siltation), and the introduction of nonnative species (Alvarez-Torres *et al.* 2003, pp. 320, 323). The National Fisheries Chart is regarded as the first time the Mexican Government has openly revealed the status of its freshwater fisheries and described their management policies (Alvarez-Torres *et al.* 2003, pp. 323–324).

Industrial, municipal, and agricultural water pollution, dewatering of aquatic habitat, and the proliferation of nonnative species are widely considered to be the greatest threats to freshwater ecosystems in Mexico (Branson *et al.* 1960, p. 218; Conant 1974, pp. 471, 487–489; Miller *et al.* 1989, pp. 25–26, 28–33; 2005, pp. 60–61; DeGregorio 1992, p. 60; Contreras Balderas and Lozano 1994, pp. 379–381; Lyons *et al.* 1995, p. 572; 1998, pp. 10–12; Landa *et al.* 1997, p. 316; Mercado-Silva *et al.* 2002, p. 180; Contreras-Balderas *et al.* 2003, p. 241; Domínguez-Domínguez *et al.* 2007, Table 3). A shift in land use policies in Mexico to encourage free market principles in rural, small-scale agriculture has been found to promote land use practices that threaten local biodiversity (Ortega-Huerta and Kral 2007, p. 2; Randall 1996, pp. 218–220; Kiernan 2000, pp. 13–23).

These threats have been documented throughout the distribution of the northern Mexican gartersnake in Mexico and are best represented in the scientific literature in the context of fisheries studies. Contreras-Balderas *et al.* (2003, pp. 241, 243) named Chihuahua (46 species), Coahuila (35 species), Sonora (19 species), and Durango (18 species) as Mexican states that had some of the most reports of freshwater fish species at risk. These states are all within the distribution of the northern Mexican gartersnake, indicating an overlapping trend of declining prey bases and threatened ecosystems within the range of the northern Mexican gartersnake in Mexico. Contreras-Balderas *et al.* (2003, Appendix 1) found various threats to be adversely affecting the status of freshwater fish and their habitat in several states in Mexico: (1) Habitat reduction or alteration (Sonora, Chihuahua, Durango, Coahuila, San Luis Potosí, Jalisco, Guanajuato); (2) water depletion (Chihuahua, Durango, Coahuila, Sonora, Guanajuato, Jalisco, San Luis Potosí); (3) harmful nonnative species (Durango, Chihuahua, Coahuila, San Luis Potosí, Sonora, Veracruz); and (4) pollution (México, Jalisco, Chihuahua, Coahuila, Durango). Within the states of Chihuahua, Durango, Coahuila, Sonora, Jalisco, and Guanajuato water depletion is considered serious, with entire basins having been dewatered, or conditions have been characterized as ''highly altered'' (Contreras-Balderas *et al.* 2003, Appendix 1). All of the Mexican states with the highest numbers of fish species at risk are considered arid, a condition hastened by increasing desertification (Contreras-Balderas *et al.* 2003, p. 244).

Aquaculture and Nonnative Fish Proliferation in Mexico (Northern Mexican Gartersnake)—Nonnative fish compete with and prey upon northern Mexican gartersnakes and their native prey species. The proliferation of nonnative fish species throughout Mexico happened mainly by natural dispersal, intentional stockings, and accidental breaches of artificial or constructed barriers by nonnative fish (Welcomme 1984, entire). Lentic water bodies such as lakes, reservoirs, and ponds are often used for flood control, agricultural purposes, and most commonly to support commercial fisheries. The most recent estimates indicate that Mexico has 13,936 of such water bodies, where approximately 96 percent are between 2.47–247 acres (1–100 hectares) and approximately half are artificial (Sugunan 1997, Table 8.3; Alvarez-Torres *et al.* 2003, pp. 318, 322). Areas where these landscape features are most prevalent occur within the distribution of the northern Mexican gartersnake. For example, Jalisco and Zacatecas are listed as two of four states with the highest number of reservoirs, and Chihuahua is one of two states known for a high concentration of lakes (Sugunan 1997, Section 8.4.2).

Based on the data presented in Sugunan (1997, Table 8.5), a total of 422 dammed reservoirs are located within the 16 Mexican states where the northern Mexican gartersnake is thought to occur. Mercado-Silva *et al.* (2006, p. 534) found that, within the state of Guanajuato, ''Practically all streams and rivers in the (Laja) basin are truncated by reservoirs or other water extraction and storage structures.'' On the Laja River alone, there are two major reservoirs and a water diversion dam; 12 more reservoirs are located on its tributaries (Mercado-Silva *et al.* 2006, p. 534). As a consequence of dam operations, the main channel of the Laja remains dry for extensive periods of time (Mercado-Silva *et al.* 2006, p. 541). The damming and modification of the lower Colorado River in Mexico, where the northern Mexican gartersnake occurred, has facilitated the replacement of the entire native fishery with nonnative species (Miller *et al.* 2005, p. 61). Each reservoir created by a dam is either managed as a nonnative commercial fishery or has become a likely source population of nonnative species, which have naturally or artificially colonized the reservoir, dispersed into connected riverine systems, and damaged native aquatic communities.

Mexico depends in large part on freshwater commercial fisheries as a source of protein for both urbanized and rural human populated areas. Commercial and subsistence fisheries rely heavily on introduced, nonnative species in the largest freshwater lakes (Soto-Galera *et al.* 1999, p. 133) down to rural, small ponds (Tapia and Zambrano 2003, p. 252). At least 87 percent of the species captured or cultivated in inland fisheries of Mexico from 1989–1999 included tilapia (*Tilapia* spp.), common carp (*Cyprinus carpio*), channel catfish, trout, and black bass (*Micropterus* sp.), all of which are nonnative (Alvarez-Torres *et al.* 2003, pp. 318, 322). In fact, the northern and central plateau region of Mexico (which comprises most of the distribution of the northern Mexican gartersnake's distribution in Mexico) is considered ideal for the production of harmful, predatory species such as bass and catfish (Sugunan 1997, Section 8.3). Largemouth bass are now produced and stocked in reservoirs and lakes throughout the distribution of the northern Mexican gartersnake (Sugunan 1997, Section 8.8.1).

The Secretariat for Environment, Natural Resources and Fisheries (SEMARNAP), formed in 1995, is the Mexican federal agency responsible for management of the country's environment and natural resources. SEMARNAP dictates the stocking rates of nonnative species into the country's lakes and reservoirs. For example, the permitted stocking rate for largemouth bass in Mexico is one fish per square meter in large reservoirs (Sugunan 1997, Table 8.8); therefore, a 247-acre (100-ha) reservoir could be stocked with 1,000,000 largemouth bass. The common carp, the subject of significant aquaculture investment since the 1960s in Mexico, is known for altering aquatic habitat and consuming the eggs and fry of native fish species, and is now established in 95 percent of Mexico's freshwater systems (Tapia and Zambrano 2003, p. 252).

Basins in northern Mexico, such as the Rio Yaqui, have been found to be significantly compromised by harmful nonnative fish species. Unmack and Fagan (2004, p. 233) compared historical museum collections of nonnative fish species from the Gila River basin in Arizona and the Yaqui River basin in Sonora, Mexico, to gain insight into the trends in distribution, diversity, and abundance of nonnative fishes in each basin over time. They found that nonnative species are slowly, but steadily, increasing in all three parameters in the Yaqui Basin (Unmack and Fagan 2004, p. 233). Unmack and Fagan (2004, p. 233) predicted that, in the absence of aggressive management intervention, significant extirpations or range reductions of native fish species are expected to occur in the Yaqui Basin of Sonora, Mexico, which may have extant populations of the northern Mexican gartersnake, as did much of the Gila Basin before the introduction of nonnative species. Loss of native fishes impacts prey availability for the northern Mexican gartersnake and threatens its persistence in these areas. Black bullheads (*Ameiurus melas*) were reported as abundant, and common carp were detected from the Rio Yaqui in southern Sonora, Mexico (Branson *et al.* 1960, p. 219). Bluegill (*Lepomis macrochirus*) were also reported at this location, representing a significant range expansion that the authors expected was the result of escaping nearby farm ponds or irrigation ditches (Branson *et al.* 1960, p. 220). Largemouth bass, green sunfish, and an undetermined crappie species have also been reported from this area (Branson *et al.* 1960, p. 220).

Documented problems with aquatic habitats in Mexico include water pollution, harmful nonnative species, and physical habitat alteration. All of these factors lead to declines in native fish abundance and, therefore, a decline in the food source for the northern Mexican gartersnake. Domínguez-Domínguez *et al.* (2007, p. 171) sampled 52 localities for a rare freshwater fish, the Picotee goodeid (*Zoogoneticus quitzeoensis*), along the southern portion of the Mesa Central (Mexican Plateau) of Mexico and found 21 localities had significant signs of pollution. Of the 29 localities where the target species was detected, 28 of them also had harmful nonnative species present, such as largemouth bass, cichlids (*Oreochromis* sp.), bluegill, and Pátzcuaro chub (*Algansea lacustris*) (Domínguez-Domínguez *et al.* 2007, pp. 171, Table 3). The first assessment of the impacts of largemouth bass on native fishes in Mexico was in 1941 during the examination of their effect in Lago de Pátzcuaro (Contreras and Escalante 1984, p. 102). Other nonnative fish species reported are soft-rayed and small bodied, and may be prey items for younger age classes of gartersnakes.

Several examples of significant aquatic habitat degradation or destruction were also observed by Domínguez-Domínguez *et al.* (2007, Table 3) in this region of Mexico, including the draining of natural lakes and cienegas for conversion to agricultural purposes, modification of springs for recreational swimming, diversions, and dam construction. It should be noted that approximately 17 percent of the localities sampled by Domínguez-Domínguez *et al.* (2007, entire) are within the likely range of the northern Mexican gartersnake; chiefly sites located within the Rio Grande de Santiago and Laja Basin. However, collectively, observations made by Domínguez-Domínguez *et al.* (2007, entire) provide a regional context to potential threats acting on northern Mexican gartersnakes in their southern-most distribution. As of 2006, native fish species dominated the fish community in both species composition and overall abundance in the Laja Basin; however, the basin is now trending toward a nonnative fishery compared to historical data. For example, nonnative species were most recently collected from 16 of 17 sample sites in the basin, with largemouth bass significantly expanding their distribution within the headwaters of the basin and bluegill being widespread in the Laja River (Mercado-Silva *et al.* 2006, pp. 537, 542, Table 4). The decline of native fishes in this region of Mexico is likely negatively affecting the status of the northern Mexican gartersnakes there.

Harmful nonnative fish species in Mexico (Contraras and Escalante 1984, pp. 102–125) may be posing a significant threat to the native fish prey base of northern Mexican gartersnakes and to the gartersnakes themselves. The ecological risk of nonnative, freshwater fishes is only expected to increase with increases in aquaculture production, most notably in the country's rural, poorest regions (Tapia and Zambrano 2003, p. 252). Amendments to Mexico's existing fishing regulations imposed by other government regulations have been relaxed, and investment in commercial fishing has expanded to promote growth in Mexico's aquaculture sector (Sugunan 1997, Section 8.7.1). Several areas within the range of the northern Mexican gartersnake in Mexico have experienced adverse effects associated with nonnative species.

Amphibian Decline (Northern Mexican Gartersnake)—Amphibians are a principle prey item for the northern Mexican gartersnake, and documented declines in amphibian population densities and distributions have significantly contributed to the decline in northern Mexican gartersnakes. As an example of these effects from another region, Matthews *et al.* (2002, p. 16) examined the relationship of gartersnake distributions, amphibian population declines, and nonnative fish introductions in high-elevation aquatic ecosystems in California. Matthews *et al.* (2002, p. 16) specifically examined the effect of nonnative trout introductions on populations of amphibians and mountain gartersnakes (*Thamnophis elegans elegans*). Their results indicated that the probability of observing gartersnakes was 30 times greater in lakes containing amphibians than in lakes where amphibians have been extirpated by nonnative fish. These results supported a prediction by Jennings *et al.* (1992, p. 503) that native amphibian declines will lead directly to gartersnake declines.

Declines in the native leopard frog populations in Arizona have likely been a significant, contributing factor to declines in many northern Mexican gartersnake populations. Native ranid (of the family Ranidae) frog species, such as lowland leopard frogs, northern leopard frogs, and federally threatened Chiricahua leopard frogs, have experienced declines in various degrees throughout their distribution in the Southwest, largely due to predation and competition with nonnative species (Clarkson and Rorabaugh 1989, pp. 531, 535; Hayes and Jennings 1986, p. 490). Rosen *et al.* (1995, pp. 257–258) found that Chiricahua leopard frog distribution in the Chiricahua Mountain region of Arizona was inversely related to nonnative species distribution. Along the Mogollon Rim, Holycross *et al.* (2006, p. 13) found that only 8 sites of 57 surveyed (15 percent) consisted of an entirely native anuran (of the order Anura) community and that native frog populations in another 19 sites (33 percent) had been completely displaced by invading bullfrogs. However, such declines in native frog populations are not necessarily irreversible. Ranid frog populations have been shown to rebound strongly when nonnative fish are removed (Knapp *et al.* 2007, pp. 15–18).

Scotia Canyon, in the Huachuca Mountains of southeastern Arizona, is a location where corresponding declines of leopard frog and northern Mexican gartersnake populations have been documented through repeated survey efforts over time (Holm and Lowe 1995, p. 33). Surveys of Scotia Canyon occurred during the early 1980s and again during the early 1990s. Leopard frogs in Scotia Canyon were infrequently observed during the early 1980s and were nearly extirpated by the early 1990s (Holm and Lowe 1995, pp. 45–46). Northern Mexican gartersnakes were observed in decline during the early 1980s, with low capture rates continuing through the early 1990s (Holm and Lowe 1995, pp. 27–35). Surveys documented further decline of leopard frogs and northern Mexican gartersnakes in 2000 (Rosen *et al.* 2001, pp. 15–16).

A former large, local population of northern Mexican gartersnakes at the San Bernardino National Wildlife Refuge (SBNWR) in southeastern Arizona has also experienced a correlative decline of leopard frogs, and northern Mexican gartersnakes are now thought to occur at very low population densities or may be extirpated there (Rosen and Schwalbe 1988, p. 28; 1995, p. 452; 1996, pp. 1–3; 1997, p. 1; 2002b, pp. 223–227; 2002c, pp. 31, 70; Rosen *et al.* 1996b, pp. 8–9; 2001, pp. 6–10).

Survey data indicate that declines of leopard frog populations, often correlated with nonnative species introductions, the spread of a chytrid fungus (*Batrachochytrium dendrobatidis,* Bd), and habitat modification and destruction, have occurred throughout much of the northern Mexican gartersnake's U.S. distribution (Nickerson and Mays 1970, p. 495; Vitt and Ohmart 1978, p. 44; Ohmart *et al.* 1988, p. 150; Rosen and Schwalbe 1988, Appendix I; 1995, p. 452; 1996, pp. 1–3; 1997, p. 1; 2002b, pp. 232–238; 2002c, pp. 1, 31; Clarkson and Rorabaugh 1989, pp. 531–538; Sredl *et al.* 1995a, pp. 7–8; 1995b, pp. 8–9, 1995c, pp. 7–8; 2000, p. 10; Holm and Lowe 1995, pp. 45–46; Rosen *et al.* 1996b, p. 2; 2001, pp. 2, 22; Degenhardt *et al.* 1996, p. 319; Fernandez and Rosen 1996, pp. 6–20; Drost and Nowak 1997, p. 11; Turner *et al.* 1999, p. 11; Nowak and Spille 2001, p. 32; Holycross *et al.* 2006, pp. 13–14, 52–61). Holycross *et al.* (2006, pp. 53–57, 59) documented population declines and potential extirpations of lowland leopard frogs (an important prey species of the northern Mexican gartersnake) in most of the Agua Fria subbasin and areas of the Salt and Verde subbasins in the period 1986–2006. Specifically, Holycross *et al.* (2006, pp. 53–57, 59) detected no lowland leopard frogs at several recently, historically, or potentially occupied locations, including the Agua Fria River in the vicinity of Table Mesa Road and Little Grand Canyon Ranch, and at Rock Springs, Dry Creek from Dugas Road to Little Ash Creek, Little Ash Creek from Brown Spring to Dry Creek, Sycamore Creek (Agua Fria subbasin) in the vicinity of the Forest Service Cabin, the Page Springs and Bubbling Ponds fish hatchery along Oak Creek, Sycamore Creek (Verde River subbasin) in the vicinity of the confluence with the Verde River north of Clarkdale, along several reaches of the Verde River mainstem, Cherry Creek on the east side of the Sierra Ancha Mountains, and Tonto Creek from Gisela to ''the Box,'' near its confluence with Rye Creek. Rosen *et al.* (2013, p. 8) suggested that the decline of leopard frogs in the Empire Valley of southern Arizona is likely largely responsible for the decline of the northern Mexican gartersnake there.

A primary factor in the decline of native amphibians as a food source for northern Mexican gartersnakes in southern Arizona is likely the result of impacts from nonnative species, mainly bullfrogs. Rosen *et al.* (1995, pp. 252–253) sampled aquatic herpetofauna at 103 sites in the Chiricahua Mountains region, which included the Chiricahua, Dragoon, and Peloncillo Mountains, and the Sulphur Springs, San Bernardino, and San Simon valleys. They found that 43 percent of all ectothermic (cold-blooded) aquatic and semi-aquatic vertebrate species detected were nonnative. The most commonly encountered nonnative species was the bullfrog (Rosen *et al.* 1995, p. 254). Witte *et al.* (2008, p. 1) found that the disappearance of ranid frog populations in Arizona were 2.6 times more likely in the presence of crayfish. Witte *et al.* (2008, p. 7) emphasized the significant influence of nonnative species on the disappearance of ranid frogs in Arizona. In one area, Rosen *et al.* (2001, p. 22) identified the expansion of bullfrogs into the Sonoita grasslands, which contain occupied northern Mexican gartersnake habitat, and the introduction of crayfish into Lewis Springs as being of particular concern for the northern Mexican gartersnake in that area.

In addition to harmful nonnative species, disease and nonnative parasites have been implicated in the decline of the prey base of the northern Mexican gartersnake. In particular, the outbreak of chytridiomycosis or ''Bd,'' a skin fungus, has been identified as a chief causative agent in the significant declines of many of the native ranid frogs and other amphibian species. As indicated, Bd has been implicated in both large-scale declines and local extirpations of many amphibians, chiefly anuran species, around the world (Johnson 2006, p. 3011). Lips *et al.* (2006, pp. 3166–3169) suggest that the high virulence and large number of potential hosts make Bd a serious threat to amphibian diversity. In Arizona, Bd infections have been reported in several of the native prey species of the northern Mexican gartersnake within the distribution of the snake (Morell 1999, pp. 731–732; Sredl and Caldwell 2000, p. 1; Hale 2001, pp. 32–37; Bradley *et al.* 2002, p. 207; USFWS 2002, pp. 40802–40804; USFWS 2007a, pp. 26, 29–32). Declines of native prey species of the northern Mexican gartersnake from Bd infections have contributed to the decline of this species in the United States (Morell 1999, pp. 731–732; Sredl and Caldwell 2000, p. 1; Hale 2001, pp. 32–37; Bradley *et al.* 2002, p. 207; USFWS 2002, pp. 40802–40804; USFWS 2007a, pp. 26, 29–32).

Evidence of Bd-related amphibian declines has been confirmed in portions of southern Mexico (just outside the range of northern Mexican gartersnakes), and data suggest declines are more prevalent at higher elevations where northern Mexican gartersnakes can occur (Lips *et al.* 2004, pp. 560–562). However, much less is known about the role of Bd in amphibian declines across much of Mexico, in particular the mountainous regions of Mexico (including much of the range of northern Mexican gartersnakes in Mexico) as the region is significantly understudied (Young *et al.* 2000, p. 1218). Because narrow-headed gartersnakes feed on fish, Bd has not affected their prey base. A recent study in Panama by Kilburn *et al.* (2011, p. 132) found that reptiles may act as reservoirs for *Bd* (at least in environments such as Panama) based on the presence of the fungus at non-pathological levels on lizards that occur in areas with significant *Bd* outbreaks in resident amphibians. Their study did not conclude that *Bd* is a virulent reptile pathogen, or that it causes disease-induced population declines in reptiles (Kilburn *et al.* 2011, p. 132).

Effects of Bullfrogs on Native Aquatic Communities (Northern Mexican and Narrow-Headed Gartersnakes) (Factors A, C, and E)

Direct predation by, and competition with, bullfrogs is a serious threat to northern Mexican gartersnakes throughout their range (Conant 1974, pp. 471, 487–489; Rosen and Schwalbe 1988, pp. 28–30; Rosen *et al.* 2001, pp. 21–22). Bullfrogs have and do threaten some populations of narrow-headed gartersnakes, but differing habitat preferences between bullfrogs and narrow-headed gartersnakes lessen their effect on narrow-headed gartersnake populations. Bullfrogs adversely affect northern Mexican and narrow-headed gartersnake populations through direct predation of juveniles and sub-adults. Bullfrogs also compete with northern Mexican gartersnakes for prey species.

Bullfrogs are not native to the southwestern United States or Mexico, and they first appeared in Arizona in 1926 as a result of a systematic introduction effort by the State Game Department (now, the AGFD) for the purposes of sport hunting and as a food source (Tellman 2002, p. 43). The first bullfrog record from New Mexico is dated 1885 (Degenhardt *et al.* 1996, p. 85). Bullfrogs are extremely prolific, are strong colonizers, can reach high densities, are persistent via cannibalism, and may disperse distances of up to 10 mi (16 km) across uplands and likely further within drainages (Bautista 2002, p. 131; Rosen and Schwalbe 2002a, p. 7; Casper and Hendricks 2005, p. 582; Suhre 2008, pers. comm.; Rosen *et al.* 2013, pp. 35–36).

Bullfrogs are large-bodied, voracious, opportunistic, even cannibalistic predators that readily attempt to consume any living thing smaller than them. Bullfrogs have a highly varied diet, which has been documented to include vegetation, invertebrates, fish, birds, mammals, amphibians, and reptiles, including numerous species of snakes (eight genera, including six different species of gartersnakes, two species of rattlesnakes, and Sonoran gophersnakes (*Pituophis catenifer affinis*)) (Bury and Whelan 1984, p. 5; Clarkson and DeVos 1986, p. 45; Holm and Lowe 1995, pp. 37–38; Carpenter *et al.* 2002, p. 130; King *et al.* 2002; Hovey and Bergen 2003, pp. 360–361; Casper and Hendricks 2005, pp. 543–544; Combs *et al.* 2005, p. 439; Wilcox 2005, p. 306; DaSilva *et al.* 2007, p. 443; Neils and Bugbee 2007, p. 443; Rowe and Garcia 2012, pp. 633–634). In one study, three different species of gartersnakes (*Thamnophis sirtalis, T. elegans,* and *T. ordinoides*) totaling 11 snakes were found inside the stomachs of resident bullfrogs from a single region (Jancowski and Orchard 2013, p. 26). Bullfrogs can significantly reduce or eliminate the native amphibian populations (Moyle 1973, pp. 18–22; Conant 1974, pp. 471, 487–489; Hayes and Jennings 1986, pp. 491–492; Rosen and Schwalbe 1988, pp. 28–30; 2002b, pp. 232–238; Rosen *et al.* 1995, pp. 257–258; 2001, pp. 2, Appendix I; Wu *et al.* 2005, p. 668; Pearl *et al.* 2004, p. 18; Kupferberg 1994, p. 95; Kupferburg 1997, pp. 1736–1751; Lawler *et al.* 1999; Bury and Whelan 1986, pp. 9–10; Hayes and Jennings 1986, pp. 500–501; Jones and Timmons 2010, pp. 473–474), which are vital for northern Mexican gartersnakes.

Different age classes of bullfrogs can affect native ranid populations via different mechanisms. Juvenile bullfrogs affect native ranids through competition; male bullfrogs affect native ranids through predation; and female bullfrogs affect native ranids through both mechanisms depending on body size and microhabitat (Wu *et al.* 2005, p. 668). Pearl *et al.* (2004, p. 18) also suggested that the effect of bullfrog introductions on native ranids may be different based on specific habitat conditions but also suggested that an individual ranid frog species' physical ability to escape influences the effect of bullfrogs on each native ranid community. Bullfrogs can also negatively affect native ranid frog populations, both locally and regionally, as carriers or reservoir species for Bd, depending on the strain of Bd (Gervasi *et al.* 2013, p. 169).

Bullfrogs have been documented to occur throughout Arizona. Holycross *et al.* (2006, pp. 13–14, 52–61) found bullfrogs at 55 percent of sample sites in the Agua Fria subbasin, 62 percent of sites in the Verde River subbasin, 25 percent of sites in the Salt River subbasin, and 22 percent of sites in the Gila River subbasin. In total, bullfrogs were observed at 22 of the 57 sites surveyed (39 percent) across the Mogollon Rim (Holycross *et al.* 2006, p. 13). A number of authors have also documented the presence of bullfrogs throughout many subbasins in Arizona and New Mexico adjacent to the historical distribution of the northern Mexican or narrow-headed gartersnake, including northern Arizona (Sredl *et al.* 1995a, p. 7; 1995c, p. 7), central Arizona and along the Mogollon Rim of Arizona and New Mexico (Nickerson and Mays 1970, p. 495; Hulse 1973, p. 278; Sredl *et al.* 1995b, p. 9; Drost and Nowak 1997, p. 11; Nowak and Spille 2001, p. 11; Holycross *et al.* 2006, pp. 15–51; Wallace *et al.* 2008; pp. 243–244; Hellekson 2012a, pers. comm.), southern Arizona (Rosen and Schwalbe 1988, Appendix I; 1995, p. 452; 1996, pp. 1–3; 1997, p. 1; 2002b, pp. 223–227; 2002c, pp. 31, 70; Holm and Lowe 1995, pp. 27–35; Rosen *et al.* 1995, p. 254; 1996a, pp. 16–17; 1996b, pp. 8–9; 2001, Appendix I; Turner *et al.* 1999, p. 11; Sredl *et al.* 2000, p. 10; Turner 2007; p. 41), and along the Colorado River (Vitt and Ohmart 1978, p. 44; Clarkson and DeVos 1986, pp. 42–49; Ohmart *et al.* 1988, p. 143). In one of the more conspicuous examples, bullfrogs were identified as the primary cause for collapse of the northern Mexican gartersnake and its prey base on the SBNWR (Rosen and Schwalbe 1988, p. 28; 1995, p. 452; 1996, pp. 1–3; 1997, p. 1; 2002b, pp. 223–227; 2002c, pp. 31, 70; Rosen *et al.* 1996b, pp. 8–9).

Once established, bullfrogs are persistent in an area and very difficult to eradicate. Rosen and Schwalbe (1995, p. 452) experimented with bullfrog removal at various sites on the SBNWR, in addition to a control site with no bullfrog removal in similar habitat on the Buenos Aires National Wildlife Refuge (BANWR). Removal of adult bullfrogs, without removal of eggs and tadpoles, resulted in a substantial increase in younger age-class bullfrogs where removal efforts were the most intensive (Rosen and Schwalbe 1997, p. 6). Contradictory to the goals of bullfrog eradication, evidence from dissection samples from young adult and subadult bullfrogs indicated these age-classes readily prey upon juvenile bullfrogs (up to the average adult leopard frog size) as well as juvenile gartersnakes, which suggests that the selective removal of only the large adult bullfrogs (presumed to be the most dangerous size class to leopard frogs and gartersnakes), favoring the young adult and sub-adult age classes, could indirectly lead to increased predation of leopard frogs and juvenile gartersnakes (Rosen and Schwalbe 1997, p. 6). These findings illustrate that, in addition to large adults, sub-adult bullfrogs also negatively impact northern Mexican gartersnakes and their prey species. The findings also indicate the importance of including egg mass and tadpole removal during efforts to control bullfrogs and timing removal projects to ensure reproductive bullfrogs are removed prior to breeding. Recent success in regional bullfrog eradication has been found in a few cases described below in the section entitled "*Current Conservation of Northern Mexican and Narrow-headed Gartersnakes.*"

Bullfrogs not only compete with the northern Mexican gartersnake for prey items but directly prey upon juvenile and, occasionally, sub-adult northern Mexican and narrow-headed gartersnakes (Rosen and Schwalbe 1988, pp. 28–31; 1995, p. 452; 2002b, pp. 223–227; Holm and Lowe 1995, pp. 29–29; Rossman *et al.* 1996, p. 177; AGFD *In Prep.,* p. 12; 2001, p. 3; Rosen *et al.* 2001, pp. 10, 21–22; Carpenter *et al.* 2002, p. 130; Wallace 2002, p. 116). A well-circulated photograph of an adult bullfrog in the process of consuming a northern Mexican gartersnake at Parker Canyon Lake, Cochise County, Arizona, taken by John Carr of the AGFD in 1964, provides photographic documentation of bullfrog predation (Rosen and Schwalbe 1988, p. 29; 1995, p. 452). The most recent, physical evidence of bullfrog predation of northern Mexican gartersnakes is provided in photographs of a dissected bullfrog at Pasture 9 Tank in the San Rafael Valley of Arizona that had a freshly eaten neonatal northern Mexican gartersnake in its stomach (Akins 2012, pers. comm.).

A common observation in northern Mexican gartersnake populations that co-occur with bullfrogs is a preponderance of large, mature adult snakes with conspicuously low numbers of individuals in the newborn and juvenile age size classes. This occurs due to bullfrogs preying on young small snakes more effectively, which leads to reduced survival of young and depressed recruitment within populations (Rosen and Schwalbe 1988, p. 18; Holm and Lowe 1995, p. 34). In lotic (flowing water) systems, bullfrogs prefer sites with low or limited flow, such as backwaters, side channels, and pool habitat. These areas are also used frequently by northern Mexican and narrow-headed gartersnakes, which likely results in increased predation rates and likely depressed recruitment of gartersnakes. Potential recruitment problems for northern Mexican gartersnakes due to effects from nonnative species are suspected at Tonto Creek (Wallace *et al.* 2008, pp. 243–244). Rosen and Schwalbe (1988, p. 18) stated that the low recruitment at the SBNWR, a typical characteristic of gartersnake populations affected by harmful nonnative species, is the likely cause of that populations' decline and possibly for declines in populations throughout their range in Arizona. Specific localities within the distribution of northern Mexican and narrow-headed gartersnakes where bullfrogs have been detected are presented in Appendix A (available at *http://www.regulations.gov*, Docket No. FWS–R2–ES–2013–0071).

Effects of Crayfish on Native Aquatic Communities (Northern Mexican and Narrow-Headed Gartersnakes) (Factors A and C)

Crayfish are another nonnative species in Arizona and New Mexico that threaten northern Mexican and narrow-headed gartersnakes through competition by consuming prey species of the gartersnakes and through direct predation on juvenile gartersnakes themselves (Fernandez and Rosen 1996, p. 25; Voeltz 2002, pp. 87–88; USFWS 2007a, p. 22). Rogowski *et al.* (2013, p. 1,280) found Arizona's aquatic communities to be particularly vulnerable to crayfish because many endemic aquatic species never evolved in the presence of crayfish. Fernandez and Rosen (1996, p. 3) studied the effects of crayfish introductions on two stream communities in Arizona, a low-elevation semi-desert stream and a high mountain stream, and concluded that crayfish can noticeably reduce species diversity and destabilize food chains in riparian and aquatic ecosystems through their effect on vegetative structure, stream substrate (stream bottom; *i.e.,* silt, sand, cobble, boulder) composition, and predation on eggs, larval, and adult forms of native invertebrate and vertebrate species. Crayfish fed on embryos, tadpoles, newly metamorphosed frogs, and adult leopard frogs, but they did not feed on egg masses (Fernandez and Rosen 1996, p. 25). However, Gamradt and Kats (1996, p. 1155) found that crayfish readily consumed the egg masses of California newts (*Taricha torosa*). Crayfish are known to also eat fish eggs and larva (Inman *et al.* 1998, p. 17), especially those bound to the substrate (Dorn and Mittlebach 2004, p. 2135). Fernandez and Rosen (1996, pp. 6–19, 52–56) and Rosen (1987, p. 5) discussed observations of inverse relationships between crayfish abundance and native reptile and amphibian populations, including narrow-headed gartersnakes, northern leopard frogs, and Chiricahua leopard frogs. Crayfish may also affect native fish populations. Carpenter (2005, pp. 338–340) documented that crayfish may reduce the growth rates of native fish through competition for food and noted that the significance of this impact may vary between species.

Crayfish alter the abundance and structure of aquatic vegetation by grazing on aquatic and semiaquatic vegetation, which reduces the cover needed by frogs and gartersnakes, as well as the food supply for prey species such as tadpoles (Fernandez and Rosen 1996, pp. 10–12). Fernandez and Rosen (1996, pp. 10–12) found that crayfish frequently burrow into stream banks, leading to increased bank erosion, stream turbidity, and siltation of stream bottoms. Creed (1994, p. 2098) found that filamentous alga (*Cladophora glomerata*) was at least 10-fold greater in aquatic habitats that lacked crayfish. Filamentous algae is an important component of aquatic vegetation that provides cover for foraging gartersnakes, as well as microhabitat for prey species, in situations where predation risk is high.

Crayfish have recently been found to also act as a host for the amphibian disease-causing fungus, Bd (McMahon *et al.* 2013, pp. 210–213). This could have serious implications for northern Mexican gartersnakes because crayfish can now be considered a source of disease in habitat that is devoid of amphibians but otherwise potentially suitable habitat for immigrating amphibians, such as leopard frogs, which could serve as a prey base. Because crayfish are so widespread throughout Arizona, New Mexico, and portions of Mexico, the scope of this threat is significant for native amphibian populations and, therefore, to northern Mexican gartersnake populations.

Inman *et al.* (1998, p. 3) documented crayfish as widely distributed and locally abundant in a broad array of natural and artificial free-flowing and still-water habitats throughout Arizona, many of which overlap the historical and current distribution of northern Mexican and narrow-headed gartersnakes. Hyatt (undated, p. 71) concluded that the majority of waters in Arizona contained at least one species of crayfish. In surveying for northern Mexican and narrow-headed gartersnakes, Holycross *et al.* (2006, p. 14) found crayfish in 64 percent of the sample sites in the Agua Fria subbasin; in 85 percent of the sites in the Verde River subbasin; in 46 percent of the sites in the Salt River subbasin; and in 67 percent of the sites in the Gila River subbasin. In total, crayfish were observed at 35 (61 percent) of the 57 sites surveyed across the Mogollon Rim (Holycross *et al.* 2006, p. 14), most of which were sites historically or currently occupied by northern Mexican or narrow-headed gartersnakes, or sites the investigators believed possessed suitable habitat and may be occupied by these gartersnakes based upon their known historical distributions.

A number of authors have documented the presence of crayfish through their survey efforts throughout Arizona and New Mexico in specific regional areas, drainages, and lentic wetlands within or adjacent to the historical distribution of the northern Mexican or narrow-headed gartersnake, including northern Arizona (Sredl *et al.* 1995a, p. 7; 1995c, p. 7), central Arizona and along the Mogollon Rim of Arizona and New Mexico (Sredl *et al.* 1995b, p. 9; Fernandez and Rosen 1996, pp. 54–55, 71; Inman *et al.* 1998, Appendix B; Nowak and Spille 2001, p. 33; Holycross *et al.* 2006, pp. 15–51; Brennan 2007, p. 7; Burger 2008, p. 4; Wallace *et al.* 2008; pp. 243–244; Brennan and Rosen 2009, p. 9; Karam *et al.* 2009; pp. 2–3; Hellekson 2012a, pers. comm.), southern Arizona (Rosen and Schwalbe 1988, Appendix I; Inman *et al.* 1998,

Appendix B; Sredl *et al.* 2000, p. 10; Rosen *et al.* 2001, Appendix I), and along the Colorado River (Ohmart *et al.* 1988, p. 150; Inman *et al.* 1998, Appendix B). Specific localities within the distribution of northern Mexican and narrow-headed gartersnakes where crayfish have been detected are presented in Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071). Like bullfrogs, crayfish can be very difficult, if not impossible, to eradicate once they have become established in an area, depending on the complexity of the habitat (Rosen and Schwalbe 1996a, pp. 5–8; 2002a, p. 7; Hyatt undated, pp. 63–71).

It is likely that crayfish populations, where they overlap with northern Mexican or narrow-headed gartersnakes, could have a varied influence on gartersnake populations. The size of crayfish can influence their predatory influence on gartersnakes or their prey species; small crayfish are unlikely to pose a significant threat to gartersnakes themselves but may still consume fish eggs or fry, whereas larger crayfish can prey on neonatal gartersnakes directly. The presence of adequate numbers of favorable fish prey for narrow-headed gartersnakes may counter the effects of resident crayfish to some degree. Crayfish densities may also be affected by periodic flooding, which is thought to reduce crayfish population densities temporarily until recolonization occurs from the dispersal of individuals from downstream populations. More field research is needed to fully understand the ecological relationship between crayfish and these gartersnakes, at least at any particular site. However, the best available scientific and commercial information strongly suggests that crayfish in larger size classes or in high densities are a cause for concern for gartersnakes and their prey species, especially with other threats simultaneously affecting gartersnake populations.

Effects of Predation-Related Injuries to Gartersnakes (Northern Mexican and Narrow-Headed Gartersnakes) (Factor C)

The tails of gartersnakes are often broken off during predation attempts by bullfrogs, crayfish, or other predators, and do not regenerate. The incidence of tail breaks in gartersnakes can often be used to assess predation pressure within gartersnake populations. Attempted predation occurs on both sexes and all ages of gartersnakes within a population, although some general trends have been detected. For example, female gartersnakes may be more susceptible to predation as evidenced by the incidence of tail damage (Willis *et al.* 1982, pp. 100–101; Rosen and Schwalbe 1988, p. 22; Mushinsky and Miller 1993, pp. 662–664; Fitch 2003, p. 212). This can be explained by higher basking rates associated with pregnant females that increase their visibility to predators. Fitch (2003, p. 212) found that tail injuries in the common gartersnake occurred more frequently in adults than in juveniles. Predation on juvenile snakes likely results in complete consumption of the animal, which would limit observations of tail injury in their age class.

Tail injuries can have negative effects on the health, longevity, and overall success of individual gartersnakes from infection, slower swimming and crawling speeds, or impeding reproduction. Mushinsky and Miller (1993, pp. 662–664) commented that, while tail breakage in gartersnakes can save the life of an individual snake, it also leads to permanent handicapping of the snake, resulting in slower swimming and crawling speeds, which could leave the snake more vulnerable to predation or affect its foraging ability. Willis *et al.* (1982, p. 98) discussed the incidence of tail injury in three species in the genus *Thamnophis* (common gartersnake, Butler's gartersnake (*T. butleri*), and the eastern ribbon snake (*T. sauritus*)) and concluded that individuals that suffered nonfatal injuries prior to reaching a length of 12 in (30 cm) are not likely to survive and that physiological stress during post-injury hibernation may play an important role in subsequent fatality. While northern Mexican or narrow-headed gartersnakes may survive an individual predation attempt from a bullfrog or crayfish with tail damage, secondary effects from infection of the wound may significantly contribute to fatality of individuals. Perry-Richardson *et al.* (1990, p. 77) described the importance of tail-tip alignment in the successful courtship and mating in Thamnophiine snakes and found that missing or shortened tails adversely affected these activities and, therefore, mating success. In researching the role of tail length in mating success in the red-sided gartersnake (*Thamnophis sirtalis parietalis*), Shine *et al.* (1999, p. 2150) found that males that experienced injuries or the partial or whole loss of the tail experienced a three-fold decrease in mating success.

The frequency of tail injuries can be quite high in a given gartersnake population; for example at the SBNWR (Rosen and Schwalbe 1988, pp. 28–31), 78 percent of northern Mexican gartersnakes had broken tails with a ''soft and club-like'' terminus, which suggests repeated injury from multiple predation attempts by bullfrogs. While medically examining pregnant female northern Mexican gartersnakes, Rosen and Schwalbe (1988, p. 28) noted bleeding from the posterior region, which suggested to the investigators the snakes suffered from ''squeeze-type'' injuries inflicted by adult bullfrogs. In another example, Holm and Lowe (1995, pp. 33–34) observed tail injuries in 89 percent of northern Mexican gartersnakes during the early 1990s in Scotia Canyon in the Huachuca Mountains, as well as a skewed age class ratio that favored adults over sub-adults, which is consistent with data collected by Willis *et al.* (1982, pp. 100–101) on other gartersnake species. Bullfrogs are largely thought to be responsible for the significant decline of northern Mexican gartersnake and its prey base at this locality, although the latter has improved through recovery actions. In the Black River, crayfish are very abundant and have been identified as the likely cause for a high-frequency of tail injuries to narrow-headed gartersnakes (Brennan 2007, p. 7; Brennan and Rosen 2009, p. 9). Brennan (2007, p. 5) found that, in the Black River, 14 of 15 narrow-headed gartersnakes captured showed evidence of damaged or missing tails (Brennan 2007, p. 5). In 2009, 16 of 19 narrow-headed gartersnakes captured in the Black River showed evidence of damaged or missing tails (Brennan and Rosen 2009, p. 8). In the middle Verde River region, Emmons and Nowak (2013, p. 5) reported that 18 of 49 (37 percent) northern Mexican gartersnakes captured had scars (n = 17) and/or missing tails tips (n = 7).

Vegetation or other forms of protective cover may be particularly important for gartersnakes to reduce the effects of harmful nonnative species on populations. For example, the population of northern Mexican gartersnakes at the Page Springs and Bubbling Ponds State Fish Hatcheries occurs with harmful nonnative species (Boyarski 2008b, pp. 3–4, 8). Yet, only 11 percent of northern Mexican gartersnakes captured in 2007 were observed as having some level of tail damage (Boyarski 2008b, pp. 5, 8). The relatively low occurrence of tail damage, as compared to 78 percent of snakes with tail damage found by Rosen and Schwalbe (1988, pp. 28–31), may indicate: (1) Adequate vegetation density was used by gartersnakes to avoid harmful nonnative species predation attempts; (2) a relatively small population of harmful nonnative species may be at a comparatively lower density than sites sampled by previous studies (harmful nonnative species population density data were not collected by Boyarski (2008b)); (3) gartersnakes may not have needed to move significant distances at this locality to achieve foraging success, which might reduce the potential for encounters with harmful nonnative species; or (4) gartersnakes infrequently escaped predation attempts by harmful nonnative species, were removed from the population, and were consequently not detected by surveys.

Expansion of the American Bullfrog and Crayfish in Mexico (Northern Mexican Gartersnake) (Factors A, C, and E)

Bullfrogs are a significant threat to native aquatic and riparian species throughout Mexico. Luja and Rodríguez-Estrella (2008, pp. 17–22) examined the invasion of the bullfrog in Mexico. The earliest records of bullfrogs in Mexico were Nuevo Leon (1853), Tamaulipas (1898), Morelos (1968), and Sinaloa (1969) (Luja and Rodríguez-Estrella 2008, p 20). By 1976, the bullfrog was documented in seven more states: Aguacalientes, Baja California Sur, Chihuahua, Distrito Federal, Puebla, San Luis Potosi, and Sonora (Luja and Rodríguez-Estrella 2008, p. 20). The bullfrog was recently verified from the state of Hidalgo, Mexico, at an elevation of 8,970 feet (2,734 m), which indicates the species continues to spread in that country and can exist even at the uppermost elevations inhabited by northern Mexican gartersnakes (Duifhuis Rivera *et al.* 2008, p. 479). As of 2008, Luja and Rodríguez-Estrella (2008, p. 20) have recorded bullfrogs in 20 of the 31 Mexican States (65 percent of the states in Mexico) and suspect that they have invaded other States, but were unable to find documentation.

Bullfrogs have been commercially produced for food in Mexico in Yucatan, Nayarit, Morelos, Estado de Mexico, Michoacán, Guadalajara, San Luis Potosi, Tamaulipas, and Sonora, and their use for food was endorsed by the Mexican Secretary of Aquaculture Support (Luja and Rodríguez-Estrella 2008, p. 20). However, frog legs ultimately never gained popularity in Mexican culinary culture (Conant 1974, pp. 487–489), and Luja and Rodríguez-Estrella (2008, p. 22) point out that only 10 percent of these farms remain in production. Luja and Rodríguez-Estrella (2008, pp. 20, 22) document instances where bullfrogs have escaped production farms and suspect the majority of the frogs that were produced commercially in farms that have since ceased operation have assimilated into surrounding habitat.

Luja and Rodríguez-Estrella (2008, p. 20) also state that Mexican people deliberately introduce bullfrogs for ornamental purposes, or ''for the simple pleasure of having them in ponds.'' The act of deliberately releasing bullfrogs into the wild in Mexico was cited by Luja and Rodríguez-Estrella (2008, p. 21) as being ''more common than we can imagine.'' Bullfrogs are available for purchase at some Mexican pet stores (Luja and Rodríguez-Estrella 2008, p. 22). Luja and Rodríguez-Estrella (2008, p. 21) state that bullfrog eradication efforts in Mexico are often thwarted by their popularity in rural communities (presumably as a food source). Currently, no regulation exists in Mexico to address the threat of bullfrog invasions or prevent their release into the wild (Luja and Rodríguez-Estrella 2008, p. 22). As a result, the bullfrogs' distribution continues to increase in Mexico, beyond what it would through natural dispersal mechanisms.

Rosen and Melendez (2006, p. 54) report bullfrog invasions to be prevalent in northwestern Chihuahua and northwestern Sonora, where the northern Mexican gartersnake is thought to occur. In many areas, native leopard frogs were completely displaced where bullfrogs were observed. Rosen and Melendez (2006, p. 54) also demonstrated the relationship between fish and amphibian communities in Sonora and western Chihuahua. Native leopard frogs, a primary prey item for the northern Mexican gartersnake, only occurred in the absence of nonnative fish, and were absent from waters containing nonnative species, which included several major waters. In Sonora, Rorabaugh (2008a, p. 25) also considers the bullfrog to be a significant threat to the northern Mexican gartersnake and its prey base, substantiated by field observations made during surveys conducted in Chihuahua and Sonora in 2006 (Rorabaugh 2008b, p. 1).

Few data were found on the presence or distribution of nonnative crayfish species in Mexico. However, in a 2-week gartersnake survey effort in 2006 in northern Mexico, crayfish were observed as ''widely distributed'' in the valleys of western Chihuahua (Rorabaugh 2008b, p. 1). Based on the invasive nature of crayfish ecology and their distribution in the United States along the Border region, it is reasonable to assume that, at a minimum, crayfish are likely distributed along the entire Border region of northern Mexico, adjacent to where they occur in the United States, and act in a similar fashion on affected northern Mexican gartersnake populations.

Risks to Gartersnakes From Fisheries Management Activities (Northern Mexican and Narrow-Headed Gartersnakes) (Factors A and E)

The decline in native fish communities from the effects of harmful nonnative fish species has spurred resource managers to take action to help recover native fish species. While we fully support activities designed to help recover native fish, recovery actions for native fish, in the absence of thorough planning, can have negative effects on resident gartersnake populations.

Piscicides—Piscicide is a term that refers to a ''fish poison.'' The use of piscicides, such as rotenone or antimycin A, for the removal of harmful nonnative fish species has widely been considered invaluable for the conservation and recovery of imperiled native fish species throughout the United States, and in particular the Gila River basin of Arizona and New Mexico (Dawson and Kolar 2003, entire). Antimycin A is rarely used anymore due to limited production and has been largely replaced by rotenone in field applications. Experimentation with ammonia as a piscicide has shown promising results and may ultimately replace rotenone in the future as a desired control method if legally registered for such use (Ward *et al.* 2013, pp. 402–404). Currently, rotenone is the most commonly used piscicide. The active ingredient in rotenone is a natural chemical compound extracted from the stems and roots of tropical plants in the family Leguminosae that interrupts oxygen absorption in gill-breathing animals (Fontenot *et al.* 1994, pp. 150–151). In the greater Gila River subbasin alone, 57 streams or water bodies have been treated with piscicide, some on several occasions spanning many years (Carpenter and Terrell 2005; Table 6). However, this practice has been the source of recent controversy due to a perceived link between rotenone and Parkinson's disease in humans, as well as potential effects to livestock.

Speculation of the potential role of rotenone in Parkinson's disease was fueled by Tanner *et al.* (2011, entire), which correlated the incidence of the disease with lifetime exposure to certain pesticides, including rotenone. As a result, in 2012, the Arizona State Legislature proposed two bills that called for the development of an environmental impact statement prior to the application of rotenone or antimycin A (S.B. 1453, see State of Arizona Senate (2012b)) and urged the U.S. Environmental Protection Agency to deregister rotenone from use in the

United States (S.B. 1009, see State of Arizona Senate (2012b)). Public safety considerations were fully evaluated by a multidisciplined technical team of specialists that found no correlation between rotenone applications performed, according to product label instructions, and Parkinson's disease (Rotenone Review Advisory Committee 2012, pp. 24–25). Nonetheless, continued anxiety regarding the use of piscicides for conservation and management of fish communities leaves an uncertain future for this important management tool. Should circumstances result in the discontinued practice of using piscicides for fish recovery and management, the likelihood of recovery for listed or sensitive aquatic vertebrates in Arizona, such as northern Mexican and narrow-headed gartersnakes, would be substantially reduced, if not eliminated outright.

The use of piscicides is a vital and scientifically sound tool, the only tool, in most circumstances, for reestablishing native fish communities and removing threats related to nonnative aquatic species in occupied northern Mexican and narrow-headed gartersnake habitat. By extension, the use of piscicides is also invaluable in the recovery and conservation of northern Mexican and narrow-headed gartersnakes. However, without proper planning the amount of time a treated water body remains fishless post-treatment can affect gartersnakes by removing fish, their primary food source. The time period between rotenone applications and the subsequent restocking of native fish is contingent on two basic variables, the time it takes for piscicide levels to reach nontoxic levels and the level of certainty required to ensure that renovation goals and objectives have been met prior to restocking. Implementation of the latter consideration may vary from to a year or longer, depending on the level of certainty required by project proponents. Carpenter and Terrell (2005, p. 14) reported that standard protocols used by the AGFD for Apache trout renovations at that time required two applications of piscicide before repatriating native fish to a stream, waiting a season to see if the renovation was successful, and then continuing to renovate if necessary. Past protocols have included goals for the renovated water body to remain fishless for extended periods, sometimes up to an entire year before restocking (Carpenter and Terrell 2005, p. 14). At a minimum and according to our files, reaches of Big Bonito Creek, the West Fork Black River, West Fork Gila River, Little Creek, and O'Donnell Creek have all been subject to fish renovations using these or similarly accepted protocols (Carpenter and Terrell 2005; Table 6; Paroz and Propst 2009, p. 4; Hellekson 2012a, pers. comm.). Therefore, northern Mexican or narrow-headed gartersnake populations in these streams have likely been negatively affected, due to the eradication of a portion of, or their entire, prey base in these systems for varying periods of time. Big Bonito Creek was restocked with salvaged native fish shortly after renovation occurred. However, we are uncertain how long other stream reaches remained fishless post-treatment, but it was likely to be a minimum of weeks in each instance, and possibly a year or longer in some instances.

Although significant efforts are generally made to salvage as many native fish as possible prior to treatment, logistics of holding fish for several weeks prior to restocking limit the number of individuals that can be held safely. Therefore, not every individual fish is salvaged, and native fish remaining in the stream are subsequently lost during the treatment. The number of fish subsequently restocked is, therefore, smaller than the number of fish that were present prior to the treatment. The full restoration of native fish populations to pre-treatment levels may take several years, depending on the size of the treated area and the size and maturity of the founding populations. Restocking salvaged fish in the fall may allow natural spawning and recruitment to begin in the spring, which would provide a more immediate benefit to resident gartersnake populations.

Several streams within the distribution of narrow-headed gartersnakes in New Mexico have been identified for potential future fish barrier construction, for which piscicide applications are likely necessary. These streams include Little Creek, West Fork Gila River, Middle Fork Gila River, Turkey Creek, Saliz Creek, Dry Blue Creek, Iron Creek, and the San Francisco River (Riley and Clarkson 2005, pp. 4–5, 7, 9, 12; Clarkson and Marsh 2012, p. 8; 2013, pp. 1, 4, 6; Hellekson 2013, pers. comm.). Of these, the Middle Fork Gila River and Turkey Creek appear to the most likely chosen for renovation (Clarkson and Marsh 2013, p. 8). Mule Creek and Cienega Creek, both occupied by northern Mexican gartersnakes, as well as Whitewater Creek (occupied by narrow-headed gartersnakes), are under consideration but ultimately may not be chosen (Clarkson and Marsh 2013, pp. 8–9). Haigler Creek (occupied by narrow-headed gartersnakes) is planned for renovation in 2015 (Burger and Jeager 2013, p. 2) and barrier development.

The current standard operating procedures for piscicide application, as adopted nationally and provided in Finlayson *et al.* (2010, p. 23), provide guidance for assuring that nontarget, baseline environmental conditions (the biotic community) are accounted for in assessing whether mitigation measures are necessary. This procedural protocol states, ''Survival and recovery of the aquatic community may be demonstrated by sampling plankton, macroinvertebrates (aquatic insects, crustacea, leeches, and mollusks), and amphibians (frogs, tadpoles, and larval and adult salamanders)'' (Finlayson *et al.* 2010, p. 23). This protocol, adopted by the AGFD (see AGFD 2012a), does not in itself consider the effects of leaving a treated water body without a prey base for a sensitive species much less for a fish-specialist, such as the narrow-headed gartersnake, for extended periods of time. However, the AGFDs' internal Environmental Assessment Checklist (EAC) addresses considerations for nontarget aquatic reptiles. Thus, we believe that concerns for potential effects of piscicide treatments on these gartersnake species within Arizona should not be substantial in the future.

As of 2012, a new policy was finalized by the AGFD that includes an early and widespread public notification and planning process that involves the approval of several decision-makers within four major stages: (1) Piscicide project internal review and approval; (2) preliminary planning and public involvement; (3) intermediate planning and public involvement; and (4) project implementation and evaluation (AGFD 2012a, p. 3). Within the Internal Review and Approval stage of the process, sensitive, endemic, and listed species potentially impacted by the project must be identified (AGFD 2012a, p. 13), such as northern Mexican or narrow-headed gartersnakes. This change ensures that an analysis of potential effects to nontarget wildlife by fisheries management activities occurs within the same planning document, versus a separate process. In addition, the AGFD's Conservation and Mitigation Program has specifically committed to quickly restocking renovated streams that are occupied by either northern Mexican or narrow-headed gartersnakes (USFWS 2011, Appendix C).

Piscicide application protocols used by the New Mexico Department of Game and Fish are provided in Pierce (2014, entire) and specify that effects to amphibian species are reviewed prior to application; however, the protocol does not provide for an assessment of potential gartersnake effects from treatment. No specific timeframe, post-treatment, was recommended by the protocol for when native fish are recommended for stocking into treated waters (Pierce 2014, pers. comm.). We intend to coordinate with the New Mexico Department of Game and Fish as active partners in wildlife conservation to ensure potential effects, from piscicide treatments, to either gartersnake are avoided or minimized. However, if proper protocols are not incorporated into future fish restoration projects, these activities will continue to threaten local gartersnake populations.

Mechanical Methods—In addition to chemical renovation techniques, mechanical methods using electroshocking equipment are often used in fisheries management, both for nonnative aquatic species removal and fisheries survey and monitoring activities that often occur in conjunction with piscicide treatments. Northern Mexican and narrow-headed gartersnakes often flee into the water as a first line of defense when startled. In occupied habitat, gartersnakes present in the water and within the affected radius of electroshockers are often temporarily paralyzed from electrical impulses intended for fish, and are, therefore, readily detected by surveyors (Hellekson 2012a, pers. comm.). We are not aware of any research that has investigated potential short- or long-term consequences to gartersnakes from these events, and so we do not consider electroshock surveys as a substantial threat to either gartersnake.

Trapping methods are also used in fisheries surveys, for other applications in aquatic species management, and for the collection of live baitfish in recreational fishing. One such common method to study aquatic or semi-aquatic wildlife (including populations of aquatic snakes such as gartersnakes) is through the use of wire minnow traps. When used to monitor gartersnake populations, wire minnow traps are anchored to vegetation, logs, etc., along the shoreline (in most applications) and positioned so that half to one-third of the trap, along its lateral line, is above the water surface to allow snakes to surface for air. These traps often attract prey species, such as small fishes and amphibian larvae (when present), and, therefore, become self-baiting. They are then checked according to a predetermined schedule. Because the wire, twine, etc., used to anchor these traps is fixed in length, these traps may become fully submerged if there is a sudden, unanticipated rise in water levels (e.g., storm event). During the monsoon in Arizona and New Mexico, these types of storm events are common, and river hydrographs respond accordingly with rapid and dynamic increases in flow.

We are aware of examples where northern Mexican gartersnakes, intentionally captured in minnow traps, have drowned as a direct result of a rapid, unexpected rise in water levels. Some examples include an adult female northern Mexican gartersnake along lower Tonto Creek in 2004, an adult and two neonates at the Bubbling Ponds State Fish Hatchery in 2009 and 2010, respectively, and an individual of undisclosed age in the upper Santa Cruz River (Holycross *et al.* 2006, p. 41, Boyarski 2011, pp. 2–3; Lashway 2012, p. 5). In another example, involving an underwater funnel trap used to survey for lowland leopard frogs (but which are not used for fishery surveys), a large adult female northern Mexican gartersnake was discovered deceased in the trap (Jones 2012a, pers. comm.). Death of that individual was likely due to drowning or predation by numerous crayfish that were also confined in the funnel trap with the gartersnake (Jones 2012a, pers. comm.). Depending on the mesh size of traps, neonatal gartersnakes can become stuck in the mesh of traps (Lashway 2012, p. 5), which could result in injury or death of the individual. There are likely additional cases where northern Mexican or narrow-headed gartersnake fatality from trapping has not been reported, particularly where trapping has occurred in occupied habitat prone to flash flooding.

Minnow traps are often deployed for monitoring fully aquatic species, such as fish, and are, therefore, intentionally positioned in the water column where they are fully under water. Traps used for this purpose may be checked less frequently, because risks to gill-breathing aquatic species are less if held in the trap for longer periods of time. As fish collectively become trapped, the trap becomes incidentally self-baited for gartersnakes and, if deployed in habitat occupied by either northern Mexican or narrow-headed gartersnakes, these traps may accidentally attract, capture, and drown gartersnakes that are actively foraging under water and are lured to the traps because of captured prey species. Neonatal northern Mexican and narrow-headed gartersnakes can also wriggle through the mesh of some wire minnow traps and become lodged halfway through, depending on the pore size of the wire mesh (Jaeger 2012, pers. comm.). If not found in time, this situation would likely result in their death from drowning, predation, or exposure.

The use of minnow traps is also allowed in recreational fishing in Arizona and New Mexico (AGFD 2013a, p. 57; New Mexico Department of Game and Fish (NMDGF) 2013, p. 17). In Arizona and New Mexico, it is lawful to set minnow traps for the collection of live baitfish (AGFD 2013a, pp. 56–57; NMDGF 2013, p. 17). In Arizona, minnow traps used for collecting live baitfish must be checked once daily and the trapping activity must occur where captured bait will be used (AGFD 2013a, pp. 56–57); in New Mexico, there is no stipulation on time intervals in the regulations to check minnow traps (NMDGF 2013, p. 17). In either scenario in either state, these minnow traps are likely to be fully submerged when in use and pose a drowning hazard to resident gartersnakes while foraging underwater, as they can be lured into the traps by fish already caught.

We do not have adequate information to assess the frequency and geographical extent to which accidental drownings of gartersnakes in minnow traps may be occurring. This is mainly because it happens incidentally as a result of trapping efforts for other species, and so it historically did not get reported by researchers. Without additional information, we cannot conclude at this time that deaths from accidental minnow trapping are likely having population-level effects on either gartersnake. However, if even a few adult females are lost from populations that already have low densities and low rates of recruitment, these losses would contribute to population extirpations and the continued decline in the status of the gartersnakes. Working with researchers in the future to minimize the chances of snake drownings and to report any incidental collections of gartersnakes will be important for future conservation of both species.

Intentional Dewatering—Lastly, dewatering or water fluctuation techniques are sometimes considered for eliminating undesirable fish species from water bodies (Finlayson *et al.* 2010, p. 4). Dewatering of occupied northern Mexican or narrow-headed gartersnake habitat would have deleterious effects to affected populations by removing a primary habitat feature and eliminating the prey base. Because northern Mexican gartersnakes often occupy lentic water bodies or intermittently watered canyon bottoms, where this practice is most feasible, effects of dewatering activities may disproportionately affect that species. This technique is being considered by the AGFD for pools within Redrock Canyon where northern Mexican gartersnakes could be adversely affected. We have been made aware that northern Mexican gartersnakes are being considered by the AGFD in their implementation planning process. Depending on the availability of suitable habitat regionally and the length of time water is absent, these activities may ultimately cause local extirpations of gartersnake populations.

Summary

In our review of the scientific and commercial literature, we have found that over time, native aquatic communities, specifically the native prey bases for northern Mexican and narrow-headed gartersnakes, have been substantially weakened as a result of the cumulative effects of disease and harmful nonnative species. Harmful nonnative species have been intentionally introduced or have naturally dispersed into virtually every subbasin throughout the distribution of northern Mexican and narrow-headed gartersnakes in the United States and Mexico. According to Geographic Information System (GIS) analyses, nonnative, predatory fish are known to occur in 90 percent of the historical distribution of the northern Mexican gartersnake and 85 percent of the historical distribution of the narrow-headed gartersnake in the United States. Bullfrogs are known to occur in 85 percent of the historical distribution of the northern Mexican gartersnake and 53 percent of the historical distribution of the narrow-headed gartersnake in the United States. Crayfish are known to occur in 77 percent of the historical distribution of the northern Mexican gartersnake and 75 percent of the historical distribution of the narrow-headed gartersnake in the United States. Nonnative, predatory fish, bullfrogs, and crayfish are known to occur simultaneously in 65 percent of the historical distribution of the northern Mexican gartersnake and 44 percent of the historical distribution of the narrow-headed gartersnake in the United States.

Native fish are important prey for northern Mexican gartersnakes but much more so for narrow-headed gartersnakes. Predation by and competition with primarily nonnative, predatory fish species, and secondarily with brown trout and crayfish, are widely considered to be the primary reason for major declines in native fish communities throughout the range of both gartersnakes. In Arizona, 19 of 31 (61 percent) of all native fish species are listed under the Act. Consequently, Arizona ranks the highest of all 50 States in the percentage of native fish species with declining trends (85.7 percent). Similar trends in the loss of native fish biodiversity have been described in New Mexico and Mexico. Native amphibians such as the Chiricahua leopard frog, an important component of the northern Mexican gartersnake prey base, have declined significantly and may face future declines as a result of Bd and harmful nonnative species. Historical native frog populations have been wholly replaced by harmful nonnative species, both on local and regional scales. These declines have directly contributed to subsequent northern Mexican gartersnake population declines or extirpations in these areas. An adequate native prey base is essential to the conservation and recovery of northern Mexican gartersnakes, and this native ranid frog prey base faces an uncertain future if harmful nonnative species continue to persist and expand their distributions in occupied habitat.

The best available commercial and scientific information confirms that harmful nonnative species are the most important threat to northern Mexican and narrow-headed gartersnakes and their prey bases, and they have had a profound role in their decline. A large body of literature documents that northern Mexican and narrow-headed gartersnakes are uniquely susceptible to the influence of harmful nonnative species in their biotic communities. This sensitivity is largely the result of complex ecological interactions that result in direct predation on gartersnakes; shifts in biotic community structure from largely native to largely nonnative; and competition for a diminished prey base that can ultimately result in the injury, starvation, or death of northern Mexican or narrow-headed gartersnakes followed by reduced recruitment, population declines, and extirpations.

Lastly, fisheries management activities can have negative effects on gartersnake populations when gartersnakes are not considered in project planning and implementation. The use of rotenone and other fisheries management techniques are important in the conservation and recovery of native fish. However, significant threats can occur if streams are left without an intact fish community for extended periods of time. New policies and mitigation measures have been developed in Arizona that will reduce the likelihood of these activities having negative effects on either northern Mexican or narrow-headed gartersnake populations in the future. However, some level of effect is still expected based on logistical complications and complexities of restoring fish populations to pre-treatment levels. We expect to coordinate with resource managers in New Mexico as we do in Arizona, to ensure gartersnake populations are not significantly affected by these activities. However, if proper protocols are not incorporated into future fish restoration projects, these activities will continue to threaten local gartersnake populations. Other mechanisms or activities used in fisheries management, such as electroshocking, trapping, or dewatering, can result in the injury or death of northern Mexican or narrow-headed gartersnakes, where these activities coincide with extant populations, and if they have not been considered in the planning or implementation processes. The significance of these losses depends on the status of the gartersnake population affected and whether or not either gartersnake, as appropriate, was considered in project planning. If similar fisheries management techniques are used in Mexico, we conclude that the northern Mexican gartersnake populations in Mexico are threatened by the same mechanisms described above.

The presence of harmful nonnative species ultimately affects where northern Mexican and narrow-headed gartersnakes can live as viable populations. Collectively, the ubiquitous presence of harmful nonnative species across the landscape has appreciably reduced the quantity of suitable gartersnake habitat and changed its spatial orientation on the landscape. Most northern Mexican and narrow-headed gartersnake populations, even some considered viable today, live in the presence of harmful nonnative species. While they continue to persist, they do so under constant threat from unnatural levels of predation and competition associated with harmful nonnative species. This weakens their resistance to other threats, including those that affect the physical suitability of their habitat (discussed below). This ultimately renders populations much less resilient to stochastic, natural, or anthropogenic stressors that could otherwise be withstood. Over time and space, subsequent population declines have threatened the genetic representation of each species because many populations have become disconnected and isolated from neighboring populations. Expanding distances between extant populations coupled with increasing populations of harmful nonnative species prevents normal colonizing mechanisms that would otherwise reestablish populations where they have become extirpated. This subsequently leads to a reduction in species redundancy when isolated, small populations are at increased vulnerability to the effects of stochastic events, without a means for natural recolonization. Ultimately, the effect of scattered, small, and disjunct populations, without the means to naturally recolonize, is weakened species resiliency as a whole, which ultimately enhances the risk of either or both species becoming endangered.

Therefore, based on the best available scientific and commercial information, we conclude that harmful nonnative species are the most significant threat to both the northern Mexican and narrow-headed gartersnake, rangewide. We expect the impacts from harmful nonnative species to only increase in the foreseeable future. The effects of these threats on both gartersnakes have resulted in the extirpation of a few populations already and the decline in abundance in the vast majority of populations, so we expect the results of continuing decline of the gartersnakes, in terms of additional population losses and increased risk of extinction in the foreseeable future, which we consider as the next several decades.

Main Factors That Destroy or Modify the Physical Habitat of Northern Mexican and Narrow-Headed Gartersnakes (Factor A)

Relationship Between Harmful Nonnative Species and Adverse Effects to Physical Habitat (Northern Mexican and Narrow-headed Gartersnakes)

The presence or absence of harmful nonnative species in occupied gartersnake habitat affects the tolerance, or sensitivity, of gartersnake populations to factors or activities that threaten to modify or destroy components of their physical habitat. When we use the term ''physical habitat,'' we refer to the structural integrity of aquatic and terrestrial components to habitat, such as plant species richness and density, available water, stream banks and substrates, and any habitat feature that does not pertain to the animal community, which we also define as a habitat component. The animal community (the prey and predator species that co-occur within habitat) is not considered in our usage of ''physical habitat,'' for reasons described immediately below. In the presence of harmful nonnative species, gartersnake populations are more sensitive to alterations in their physical habitat. In the absence of harmful nonnative species, gartersnake populations have shown resiliency, or tolerance, to changes in their physical habitat.

As discussed above, we found harmful nonnative species to be a significant and widespread factor that continues to drive further declines in and extirpations of gartersnake populations. Furthermore, we found various activities have affected, and continue to affect, primary components of the physical habitat required by northern Mexican and narrow-headed gartersnakes, even when the potential impact of harmful nonnatives is absent. These activities, such as dams, water diversions, groundwater pumping, and residential and commercial development, result in the loss of stream flow. The period from 1850 to 1940 marked the greatest loss and degradation of riparian and aquatic communities in Arizona, many of which were caused by anthropogenic (human-caused) land uses (Stromberg *et al.* 1996, p. 114; Webb and Leake 2005, pp. 305–310). An estimated one-third of Arizona's wetlands has dried or is no longer suitable (Yuhas 1996, entire). However, not all aquatic and riparian habitats in the United States that support northern Mexican or narrow-headed gartersnakes have been degraded or lost. Despite the loss or modification of aquatic and riparian habitat, large reaches of the Verde, Salt, San Pedro, and Gila Rivers, as well as several of their tributaries, remain functionally suitable as physical habitat for either gartersnake species.

Our treatment of how the loss or modification of physical habitat may affect the northern Mexican or narrow-headed gartersnake is based, in part, on recent observations made in Mexico that illustrate the relationship of gartersnakes' physical habitat suitability to the presence of native prey species and the lack of harmful nonnative species, and the presence, or lack thereof, of attributes associated with these gartersnakes' physical habitat. In 2007, two groups consisting of agency biologists (including U.S. Fish and Wildlife Service staff), species experts, and field technicians conducted numerous gartersnake surveys in Durango and Chihuahua, Mexico (Burger 2007, p. 1; Burger *et al.* 2010, entire).

While considerable gartersnake habitat in Mexico is affected by the presence of harmful nonnative species (Conant 1974, pp. 471, 487–489; Contreras Balderas and Lozano 1994, pp. 383–384; Unmack and Fagan 2004, p. 233; Miller *et al.* 2005, pp. 60–61; Rosen and Melendez 2006, p. 54; Luja and Rodríguez-Estrella 2008, pp. 17–22), Burger (2007, pp. 1–72) surveyed several sites in remote areas that appeared to be free of nonnative species. In some sites, the physical habitat for northern Mexican gartersnakes and similar species of gartersnakes appeared to be in largely good condition, but few or no gartersnakes were detected. At other sites, the physical habitat was drastically affected by overgrazing, rural development, or road crossings; however, gartersnakes were relatively easily detected, indicating seemingly adequate population densities, but we do not have the necessary data to calculate population trends at sampled localities. Inversely, gartersnake habitat in Arizona and New Mexico is in relatively better physical condition compared to observations of these habitats made in Durango and Chihuahua, Mexico. However, harmful nonnative species are essentially ubiquitous in the southwestern United States, based on our literature review and GIS modeling. Several sites visited by Burger (2007, pp. 1–72) in Durango and Chihuahua, Mexico, had physical habitat in poor to very poor condition, but were largely free of nonnative species. These situations are rarely encountered in Arizona and New Mexico and, therefore, provided Burger (2007, entire) a unique opportunity to examine differences in gartersnake population densities based on condition of the physical habitat, without the confounding effect of harmful nonnative species on resident gartersnake populations.

Our observations of gartersnake populations in Mexico provide evidence for the relative importance of native prey species and the lack of nonnative species in comparison to the physical attributes of gartersnake habitat. For example, Burger (2007, pp. 6, 12, 36, 41, 58, 63) detected moderate to high densities of gartersnakes at six sites where their physical habitat was moderately to highly impacted by land uses but were largely free of nonnatives. Burger (2007, pp. 18, 26, 32, 61, 64, 66, 67, 69, 72) also detected either low densities or no gartersnakes at nine sites where the physical habitat was in moderate to good condition but where nonnative species were detected. Eight streams surveyed by Burger (2007, pp. 15, 22, 46, 49, 51–52, 54, 62) had little to no surface flow, were without fish detections and had few to no gartersnake observations. As a result, we have formulated three general hypotheses: (1) Northern Mexican and narrow-headed gartersnakes may be more resilient to adverse effects to physical habitat in the absence of harmful nonnative species and, therefore, more sensitive to negative effects to physical habitat in the presence of harmful nonnative species; (2) the presence of an adequate prey base is important for persistence of gartersnake populations regardless of whether or not harmful nonnative species are present; and (3) detections and effects from harmful nonnative species appear to decrease from north to south in the Mexican states of Chihuahua and Durango (from the United States–Mexico International Border), as discussed in Unmack and Fagan (2004, pp. 233–243).

Based on field data collected by Burger (2007, entire), Burger *et al.* (2010, entire), and on the above hypotheses, we evaluated effects to physical habitat in the context of the presence or absence of nonnative species. Effects to the physical habitat of gartersnakes can have varying effects on the gartersnakes themselves depending on the composition of their biotic community. In the presence of harmful nonnative species, effects to physical habitat, especially those that diminish or weaken the gartersnake prey base, are believed to be comparatively more significant than those that do not. As previously discussed, harmful nonnative species are essentially ubiquitous in Arizona and New Mexico where the northern Mexican and narrow-headed gartersnakes occur and, therefore, exacerbate the effects from activities or factors that modify or destroy their physical habitat.

Altering or Dewatering Aquatic Habitat (Northern Mexican and Narrow-headed Gartersnakes)

Dams and Diversions (Northern Mexican and Narrow-headed Gartersnakes)—The presence of water is critical for northern Mexican and narrow-headed gartersnakes, as well as their prey base. Activities that reduce flows or dewater habitat, such as dams, diversions, flood-control projects, and groundwater pumping, seriously threaten the physical habitat of the gartersnakes, because both fish and amphibians must have water to survive and reproduce and without this prey base, gartersnakes cannot persist. Such activities are widespread in Arizona. For example, municipal water use in central Arizona increased by 39 percent from 1998 to 2006 (American Rivers 2006), and at least 35 percent of Arizona's perennial rivers have been dewatered, assisted by approximately 95 dams that are in operation in Arizona today (Turner and List 2007, pp. 3, 9). Larger dams may prevent movement of fish between populations (which affects prey availability for northern Mexican and narrow-headed gartersnakes) and dramatically alter the flow regime of streams through the impoundment of water (Ligon *et al.* 1995, pp. 184–189). These diversions also require periodic maintenance and reconstruction, resulting in potential habitat damages and inputs of sediment into the active stream.

Flow regimes within stream systems are a primary factor that shape fish community assemblages. The timing, duration, intensity, and frequency of flood events has been altered to varying degrees by the presence of dams, which has an effect on fish communities (Rinne *et al.* 1998, pp. 8–10; 2005, p. 2). Specifically, Haney *et al.* (2008, p. 61) suggested that flood pulses may help to reduce populations of nonnative species, and efforts to increase the baseflows may assist in sustaining native prey species for northern Mexican and narrow-headed gartersnakes. However, the investigators in this study also suggest that, because the northern Mexican gartersnake preys on both fish and frogs, it may be less affected by reductions in baseflow of streams (Haney *et al.* 2008, pp. 82, 93). The effect of regulated flow regimes on the fish community in the Bill Williams River was studied by Pool and Olden (2014 *In press,* p. 5), who found the presence of Alamo Dam having a negative effect on native fish, while benefitting harmful nonnative species, which now account for the majority of the fish fauna, in terms of species composition and relative biomass, in the Bill Williams River.

Other streams that are not dammed in the same watershed still reflect a largely native fish community due to the presence of a natural flow regime (Pool and Olden 2014 *In press,* pp. 5–6). Collier *et al.* (1996, p. 16) mentions that water development projects are one of two main causes for the decline of native fish in the Salt and Gila rivers of Arizona. Unregulated flows with elevated discharge events favor native species, and regulated flows, absent significant discharge events, favor nonnative species (Propst *et al.* 2008, p. 1246). Interactions among native fish, nonnative fish, and flow regimes were observed in the upper reaches of the East Fork of the Gila River. Prior to the 1983 and 1984 floods in the Gila River system, native fish occurrence was limited, while nonnative fish were moderately common. Following the 1983 flood event, adult nonnative predators were generally absent, and native fish were subsequently collected in moderate numbers in 1985 (Propst *et al.* 1986, p. 83). These relationships are most readily observed in canyon-bound streams, where shelter sought by nonnative species during large-scale floods is minimal (Propst *et al.* 2008, p. 1249). Propst *et al.* (2008, p. 1246) also suggested the effect of nonnative fish species on native fish communities may be most significant during periods of natural drought (simulated by artificial dewatering).

Effects from flood control projects threaten riparian and aquatic habitat, as well as threaten the northern Mexican gartersnake directly in lower Tonto Creek. Kimmell (2008, pers. comm.), Gila County Board of Supervisors (2008, pers. comm.), Trammell (2008, pers. comm.), and Sanchez (2008, pers. comm.) all discuss a growing concern of residents that live within or adjacent to the floodplain of Tonto Creek in Gila County, Arizona, both upstream and downstream of the town of Gisela, Arizona. Specifically, there is growing concern to address threats to private property and associated infrastructure posed by flooding of Tonto Creek (Sanchez 2008, pers. comm.). An important remaining population of northern Mexican gartersnakes within the Salt River subbasin occurs on Tonto Creek. In Resolution No. 08–06–02, the Gila County Board of Supervisors proactively declared a state of emergency within Gila County as a result of the expectation for heavy rain and snowfall causing repetitive flooding conditions (Gila County Board of Supervisors 2008, pers. comm.). In response, the Arizona Division of Emergency Management called meetings and initiated discussions among stakeholders in an attempt to mitigate these flooding concerns (Kimmell 2008, pers. comm., Trammell 2008, pers. comm.).

Mitigation measures that have been discussed include removal of riparian vegetation, removal of debris piles, potential channelization of Tonto Creek, improvements to existing flood control structures or addition of new structures, and the construction of new bridges. Adverse effects from these types of activities to aquatic and riparian habitat, and to the northern Mexican gartersnake or its prey species, will result from the physical alteration or destruction of habitat, significant increases to flow velocity, and removal of key foraging habitat and areas to hibernate, such as debris jams. Specifically, flood control projects permanently alter stream flow characteristics and have the potential to make the stream unsuitable as habitat for the northern Mexican gartersnake by reducing or eliminating stream sinuosity and associated pool and backwater habitats that are critical to northern Mexican gartersnakes and their prey species. Threats presented by these flood control planning efforts are considered imminent within the next decade because high flows associated with the monsoon are expected to increase in both intensity and frequency according to climate change predictions, as discussed below in the section ''Climate Change and Drought.''

Many streams in New Mexico, currently or formerly occupied by northern Mexican or narrow-headed gartersnakes, have been or could be affected by water withdrawals. Approximately 9.5 river mi (15.3 km) of the Gila River mainstem in New Mexico, from Little Creek to the Gila Bird Area, are in private ownership and have been channelized, and the water is largely used for agricultural purposes (Hellekson 2012a, pers. comm.). Below the Highway 180 crossing of the mainstem Gila River, several water diversions have reduced stream flow (Hellekson 2012a, pers. comm.). Channelization has also affected a privately owned reach of Whitewater Creek from the Catwalk downstream to Glenwood, New Mexico (Hellekson 2012a, pers. comm.). The Gila River downstream of the town of Cliff, New Mexico, flows through a broad valley where irrigated agriculture and livestock grazing are the predominant uses. Human settlement has increased since 1988 (Propst *et al.* 2008, pp. 1237–1238). Agricultural practices have led to dewatering of the river in the Cliff-Gila valley at times during the dry season (Soles 2003, p. 71). For those portions of the Gila River downstream of the Arizona–New Mexico border, agricultural diversions and groundwater pumping have caused declines in the water table, and surface flows in the central portion of the river basin are diverted for agriculture (Leopold 1997, pp. 63–64; Tellman *et al.* 1997, pp. 101–104).

The San Francisco River in New Mexico has undergone sedimentation, riparian habitat degradation, and extensive water diversion, and at present has an undependable water supply throughout portions of its length (Hellekson 2012a, pers. comm.; 2013, pers. comm.). The San Francisco River is seasonally dry in the Alma Valley, and two diversion structures fragment habitat in the upper Alma Valley and at Pleasanton (NMDGF 2006, p. 302). An approximate 2-stream-mi (3.2-km) reach of the lower San Francisco River between the Glenwood Diversion and Alma Bridge, which would otherwise be good narrow-headed gartersnake habitat, has been completely dewatered by upstream diversions (Hellekson 2012a, pers. comm.).

Additional withdrawals of water from the Gila and San Francisco Rivers may occur in the next several decades as the effects of drought and human population levels increase. Implementation of Title II of the Arizona Water Settlements Act (AWSA) (Public Law 108–451) would facilitate the exchange of Central Arizona Project water within and between southwestern river basins in Arizona and New Mexico, and may result in the construction of new water development projects. Section 212 of the AWSA pertains to the New Mexico Unit of the Central Arizona Project. The AWSA provides for New Mexico water users to deplete 14,000 acre-feet of additional water from the Gila Basin in any 10-year period. The settlement also provides the ability to divert that water without complaint from downstream pre-1968 water rights in Arizona. New Mexico will receive $66 million to $128 million in non-reimbursable Federal funding. The Interstate Stream Commission (ISC) funds may be used to cover costs of an actual water supply project, planning, environmental mitigation, or restoration activities associated with or necessary for the project, and may be used on one or more of 15 alternative projects ranging from Gila National Forest San Francisco River Diversion/Ditch improvements to a regional water supply project (the Deming Diversion Project). Currently, 3 of the 15 projects under consideration include elements of diversion or storage. At this time, it is not known how the funds will be spent or which potential alternatives may be chosen. While multiple potential project proposals have been accepted by the New Mexico Office of the State Engineer (NMOSE) (NMOSE 2011a, p. 1), implementation of the AWSA is still in the planning stages on these streams, and final notice is expected by the end of 2014. Should water be diverted from the Gila or San Francisco Rivers, flows would be diminished and direct and indirect losses and degradation of habitat for the narrow-headed gartersnake and its prey species would result.

In addition to affecting the natural behavior of streams and rivers through changes in timing, intensity, and duration of flood events, dams create reservoirs that alter resident fish communities (Paradzick *et al.* 2006, entire). Water level fluctuation can affect the degree of benefit to harmful nonnative fish species. Reservoirs that experience limited or slow fluctuations in water levels are especially beneficial to harmful nonnative species whereas reservoirs that experience greater fluctuations in water levels provide less benefit for harmful nonnative species (Paradzick *et al.* 2006, entire). The timing of fluctuating water levels contributes to their effect; a precipitous drop in water levels during harmful nonnative fish reproduction is most deleterious to their recruitment (Paradzick *et al.* 2006, entire). A drop in water levels outside of the reproductive season of harmful nonnative species has less effect on overall population dynamics (Paradzick *et al.* 2006, entire). Large dams can also act as fish barriers, which prevent upstream migration of harmful nonnative fish that occur downstream of these structures.

The cross-sectional profile of any given reservoir also contributes to its benefit for harmful nonnative fish species (Paradzick *et al.* 2006, entire). Shallow reservoir profiles generally provide maximum space and elevated water temperatures favorable to reproduction of harmful nonnative species, while deep reservoir profiles, with limited shallow areas, provide commensurately less benefit (Paradzick *et al.* 2006, entire). Examples of reservoirs that benefit harmful nonnative species, and therefore adversely affect northern Mexican and narrow-headed gartersnakes (presently or historically), include Horseshoe and Bartlett Reservoirs on the Verde River, and Roosevelt, Saguaro, Canyon, and Apache Lakes on the Salt River. The Salt River Project (SRP) operates the previously mentioned reservoirs on the Verde and Salt Rivers and, in the case of Horseshoe and Bartlett Reservoirs, received section 10(a)(1)(B) take authorization under the Act for adverse effects to several avian and aquatic species (including northern Mexican and narrow-headed gartersnakes) through a comprehensive threat minimization and mitigation program found in SRP's habitat conservation plan (SRP 2008, entire). There is no such minimization and mitigation program developed for the operation of Lake Roosevelt, where comparatively limited fluctuation in reservoir levels benefit harmful nonnative species and negatively affect northern Mexican or narrow-headed gartersnakes and their prey bases in Tonto Creek. A detailed analysis of the effects of reservoir operations on aquatic communities is provided in our intra-Service biological and conference opinion provided in USFWS (2008, pp. 112–131).

The Effect of Human Population Growth and Development on Water Demands and Gartersnake Habitat (Northern Mexican and Narrow-headed

Gartersnakes)—Arizona's population is expected to double from 5 million to 10 million people by the year 2030, which will put increasing pressure on water demands (Overpeck 2008, entire). Arizona increased its population by 474 percent from 1960 to 2006 (Gammage 2008, p. 15) and is second only to Nevada as the fastest growing State in terms of human population (Social Science Data Analysis Network (SSDAR) (2000, p. 1). Over approximately the same time period, population growth rates in Arizona counties where northern Mexican or narrow-headed gartersnake habitat exists have varied by county but are no less remarkable, and all are increasing: Maricopa (463 percent); Pima (318 percent); Santa Cruz (355 percent); Cochise (214 percent); Yavapai (579 percent); Gila (199 percent); Graham (238 percent); Apache (228 percent); Navajo (257 percent); Yuma (346 percent); LaPaz (142 percent); and Mohave (2,004 percent) (SSDAR 2000, entire). From 1960 to 2006, the Phoenix metropolitan area alone grew by 608 percent, and the Tucson metropolitan area grew by 356 percent (Gammage 2008, p. 15). Population growth in Arizona is expected to be focused along wide swaths of land from the international border in Nogales, through Tucson, Phoenix, and north into Yavapai County (called the Sun Corridor ''Megapolitan'') and is predicted to have 8 million people by 2030, an 82.5 percent increase from 2000 (Gammage et al. 2008, pp. 15, 22–23). If build-out occurs as expected, it could indirectly affect (through increased recreation pressure and demand for water) currently occupied habitat for the northern Mexican or narrow-headed gartersnake, particularly regional populations in lower Cienega Creek near Vail, Arizona, and the Verde Valley, and, to a lesser extent, Red Rock Canyon in extreme south-central Arizona.

The effect of the increased water withdrawals may be exacerbated by the current, long-term drought facing the arid southwestern United States, which is predicted to continue. The effect of long-term drought has already been observed in the Southwest. Philips and Thomas (2005, pp. 1–4) provided stream flow records that indicate that the drought Arizona experienced between 1999 and 2004 was the worst drought since the early 1940s and possibly earlier. The Arizona Drought Preparedness Plan Monitoring Technical Committee (ADPPMTC) (2012) determined the drought status within the Arizona distributions of northern Mexican and narrow-headed gartersnakes, through June 2012, to be in ''severe drought.'' Ongoing drought conditions have depleted recharge of aquifers and decreased base flows in the region. While drought periods have been relatively numerous in the arid Southwest from the mid-1800s to the present, the effects of human-caused impacts on riparian and aquatic communities have compromised the ability of these communities to function under the additional stress of prolonged drought conditions. Below we further discuss the effect of climate change-induced drought in the future.

The Arizona Department of Water Resources (ADWR) manages water supplies in Arizona and has established five Active Management Areas (AMAs) across the State (ADWR 2006, entire). An AMA is established by ADWR when an area's water demand has exceeded the groundwater supply and an overdraft has occurred. In these areas, groundwater use has exceeded the rate where precipitation can recharge the aquifer, and these areas are subject to regulation pursuant to Arizona's Groundwater Code with a goal of balancing groundwater use with recharge (reaching safe yield) by the year 2025. Geographically, these five AMAs overlap the historical distribution of the northern Mexican or narrow-headed gartersnake, or both, in Arizona. The establishment of these AMAs further illustrates the condition of limited water availability for riparian habitat in these areas both currently and into the future, and they indicate a cause of concern for the long-term maintenance of northern Mexican and narrow-headed gartersnake habitat. These areas are already vulnerable to declines in surface and groundwater availability, and surface water may not be sustainable to support the gartersnakes' prey base. An overdraft of groundwater withdrawal creates what is referred to as a cone of depression within the groundwater. Reduced or eliminated surface flow can result in areas where these cones of depression intersect with stream alluvium (deposits in a valley a stream flows through).

The presence of surface water is a primary habitat component for northern Mexican and narrow-headed gartersnakes. Existing water laws in Arizona and New Mexico may not be fully adequate to protect gartersnake habitat from the dewatering effects of groundwater withdrawals. New Mexico water law now includes provisions for instream water rights to protect fish and wildlife and their habitats. Arizona water law also recognizes such provisions; however, because this change is relatively recent, instream water rights have low priority, and are often never fulfilled because more senior diversion rights have priority. Existing water laws are considered outdated and reflect a legislative interpretation of water resources that is not consistent with current scientific understanding of the hydrologic connection between groundwater and surface water (Gelt 2008, pp. 1–12).

Water for development and urbanization is often supplied by groundwater pumping and surface water diversions from sources that include reservoirs and Central Arizona Project's allocations from the Colorado River. As stated previously, groundwater pumping creates a cone of depression within the affected aquifer that slowly radiates outward from the well site. When the cone of depression intersects the hyporheic zone of a stream (the active transition zone between two adjacent ecological communities under or beside a stream channel or floodplain between the surface water and groundwater that contributes water to the stream itself), the surface water flow may decrease, and the subsequent drying of riparian and wetland vegetative communities can follow. Continued groundwater pumping at such levels draws down the aquifer sufficiently to create a water-level gradient away from the stream and floodplain (Webb and Leake 2005, p. 309). Complete disconnection of the aquifer and the stream results in strong negative effects to riparian vegetation (Webb and Leake 2005, p. 309) that result in a reduction or loss in surface water and riparian vegetation that can reduce or eliminate the local prey base that gartersnakes depend on for survival.

The arid southwestern United States is characterized by limited annual precipitation, which means limited annual recharge of groundwater aquifers; even modest changes in groundwater levels from groundwater pumping can affect above-ground stream flow as evidenced by depleted flows in the Santa Cruz, Verde, San Pedro, Blue, and lower Gila rivers as a result of regional groundwater demands (Stromberg *et al.* 1996, pp. 113, 124–128; Rinne *et al.* 1998, p. 9; Voeltz 2002, pp. 45–47, 69–71; Haney *et al.* 2009 p. 1). Groundwater demands are expected to reduce surface water flow in Arivaca Creek, Babocomari River, lower Cienega Creek, San Pedro River, upper Verde River, and Agua Fria River over the next several decades (Haney *et al.* 2009 p. 3, Table 2), which historically or currently support northern Mexican or narrow-headed gartersnake populations. If surface flow is lost entirely from additional stress caused by drought induced by projected climate change in the Southwest, local or regional extirpations of both gartersnake species are likely to occur.

Water depletion is a concern for the Verde River (Garner *et al.* 2013, entire). For example, the City of Prescott, Arizona, experienced a 22 percent increase in population between 2000 and 2005 (U.S. Census Bureau 2010, p. 1), averaging around 4 percent growth per year (City of Prescott 2010, p. 1). In addition, the towns of Prescott Valley and Chino Valley experienced growth rates of 66 and 67 percent, respectively (Arizona Department of Commerce 2009a, p. 1; 2009b, p. 1). This growth is facilitated by groundwater pumping in the Verde River basin. In 2004, the cities of Prescott and Prescott Valley purchased a ranch in the Big Chino basin in the headwaters of the Verde River, with the intent of drilling new wells to supply up to approximately 5 million cubic meters (4,000 acre-feet (AF)) of groundwater per year. Barnett and Hawkins (2002, Table 4) reported population census data from 1970, as well as projections for 2030, for communities situated along the middle Verde River or within the Verde River subbasin as a whole, such as Clarkdale, Cottonwood, Jerome, and Sedona. From 1970–2000, population growth was recorded as Clarkdale (384 percent), Cottonwood (352 percent), Jerome (113 percent), and Sedona (504 percent) (Barnett and Hawkins 2002, Table 4). Projected growth in these same communities from 1970–2030 was tabulated at Clarkdale (620 percent), Cottonwood (730 percent), Jerome (292 percent), and Sedona (818 percent) (Barnett and Hawkins 2002, Table 4).

Garner *et al.* (2013, p. 5) found that the Verde Valley population grew 13 percent in 10 years from 63,000 in 2000 to 71,000 in 2010. These examples of documented and projected population growth within the Verde River subbasin indicate ever-increasing water demands that have impacted base flow in the Verde River and are expected to continue. The middle and lower Verde River has limited or no flow during portions of the year due to agricultural diversion and upstream impoundments, and it has several impoundments in its middle reaches, which could expand the area of impacted northern Mexican and narrow-headed gartersnake habitat. Blasch *et al.* (2006, p. 2) suggests that groundwater storage in the Verde River subbasin has already declined due to groundwater pumping and reductions in natural channel recharge resulting from stream flow diversions.

Scientific studies have shown a link between the Big Chino aquifer and spring flows that form the headwaters of the Verde River. It is estimated that 80 to 86 percent of baseflow in the upper Verde River comes from the Big Chino aquifer (Wirt 2005, p. G8). An in-depth discussion of the potential effects to the Verde River from pumping of the Big Chino Aquifer is available in Marder (2009, pp. 183–189). However, while these withdrawals could potentially dewater the upper 26 mi (42 km) of the Verde River (Wirt and Hjalmarson 2000, p. 4; Marder 2009, pp. 188–189), it is uncertain that this project will occur given the cost and administrative challenges it faces. An agreement in principle was signed among the Salt River Project, the City of Prescott, and Town of Prescott Valley to work toward resolution of water rights in the Verde watershed, and, in 2012, Comprehensive Agreement No. 1, which established monitoring and modeling plans, was entered into. Within the Verde River subbasin, and particularly within the Verde Valley, where the northern Mexican and narrow-headed gartersnakes could occur, several other activities continue to threaten surface flows (Rinne *et al.* 1998, p. 9; Paradzick *et al.* 2006, pp. 104–110).

Portions of the Verde River or its tributaries are permanently or seasonally dewatered by water diversions for agriculture (Paradzick *et al.* 2006, pp. 104–110). The demands for surface water allocations from rapidly growing communities and agricultural and mining interests have altered flows or dewatered significant reaches during the spring and summer months in some of the Verde River's larger, formerly perennial tributaries such as Wet Beaver Creek, West Clear Creek, and the East Verde River (Girmendonk and Young 1993, pp. 45–47; Sullivan and Richardson 1993, pp. 38–39; Paradzick *et al.* 2006, pp. 104–110), which may have supported either the northern Mexican or narrow-headed gartersnake, or both. Groundwater pumping in the Tonto Creek drainage regularly eliminates surface flows during parts of the year (Abarca and Weedman 1993, p. 2).

Further south in Arizona, portions of the once-perennial San Pedro River are now ephemeral, and water withdrawals are a concern for the San Pedro River (USGS 2013, p. 3). The Cananea Mine in Sonora, Mexico, owns the land surrounding the headwaters of the San Pedro. There is disagreement on the exact amount of water withdrawn by the mine, Mexicana de Cananea, which is one of the largest open-pit copper mines in the world. However, there is agreement that it is the largest water user in the basin (Harris *et al.* 2001, p. 213; Varady *et al.* 2000, p. 232). Along the upper San Pedro River, Stromberg *et al.* (1996, pp. 124–127) found that wetland herbaceous species, important as cover for northern Mexican gartersnakes, are the most sensitive to the effects of a declining groundwater level. Webb and Leake (2005, pp. 302, 318–320) described a correlative trend regarding vegetation along southwestern streams from historically being dominated by marshy grasslands preferable to northern Mexican gartersnakes, to currently being dominated by woody species that are more tolerant of declining water tables due to their deeper rooting depths. The cone of depression associated with regional groundwater pumping is expected to continue expanding its influence on surface flow in the San Pedro River over the next several decades, which is expected to further reduce surface flow in the river and negatively affect riparian vegetation (Stromberg *et al.* 1996, pp. 124–128).

Another primary groundwater user in the San Pedro subbasin is Fort Huachuca. Fort Huachuca is a U.S. Army installation located near Sierra Vista, Arizona. Initially established in 1877 as a camp for the military, the Fort has some of the earliest priority dates for water rights in the state (Varady *et al.* 2000, p. 230). Fort Huachuca has pursued a rigorous water use reduction plan, working over the past decade to reduce groundwater consumption in the Sierra Vista subbasin. Their efforts have focused primarily on reductions in groundwater demand both on-post and off-post and increased artificial and enhanced recharge of the groundwater system. Annual pumping from Fort Huachuca production wells has decreased from a high of approximately 3,200 AF in 1989, to a low of approximately 1,400 AF in 2005. In addition, Fort Huachuca and the City of Sierra Vista have increased the amount of water recharged to the regional aquifer through construction of effluent recharge facilities and detention basins that not only increase stormwater recharge but mitigate the negative effects of increased runoff from urbanization. The amount of effluent that was recharged by Fort Huachuca and the City of Sierra Vista in 2005 was 426 AF and 1,868 AF, respectively. During this same year, enhanced stormwater recharge at detention basins was estimated to be 129 AF. The total net effect of all the combined efforts initiated by Fort Huachuca has been to reduce the net groundwater consumption by approximately 2,272 AF (71 percent) since 1989 (USFWS 2007b, pp. 41–42). Additional water conservation and recharge efforts have since been implemented by Fort Huachuca and have reduced the Fort's effect on baseflow in the upper San Pedro River to near zero, as analyzed in a recent section 7 consultation (see *http://www.fws.gov/southwest/es/arizona/Documents/Biol_Opin/120173_Fort%20HuachucaFINALBO_3.31.2014.pdf*).

Groundwater withdrawal in Eagle Creek, primarily for water supplying the large open-pit copper mine at Morenci, Arizona, dries portions of the stream (Sublette *et al.* 1990, p. 19; USFWS 2005; Propst *et al.* 1986, p. 7) that otherwise supports habitat for narrow-headed gartersnakes. Mining is the largest industrial water user in southeastern Arizona (ADWR Undated (accessed 2014), p. 62). The Morenci mine on Chase Creek is North America's largest producer of copper, covering approximately 24,281 hectares (ha) (60,000 acres (ac)). Water for the Morenci mine is pumped from the Black River as an inter-basin transfer via pipeline and open channel to Willow Creek, an east-flowing tributary to Eagle Creek, then downstream more than 30 stream miles (50 km) to a facility where water is withdrawn and pumped uphill to the mine in the adjacent Chase Creek drainage (Arizona Department of Water Resources 2009, p. 1; Marsh 2013, pers. comm.). We are not aware of plans for the closure of the Morenci Mine over the next several years, and as the price for copper increases, the demand for copper mining will increase into the future.

The Rosemont Copper Mine proposed to be constructed in the northeastern area of the Santa Rita Mountains in Santa Cruz County, Arizona, will include a mine pit that will be excavated to a depth greater than that of the regional aquifer. Water will thus drain from storage in the aquifer into the pit. The need to dewater the pit during mining operations will thus result in ongoing removal of aquifer water storage. Upon cessation of mining, a pit lake will form, and evaporation from this water body will continue to remove water from storage in the regional aquifer. This aquifer also supplies baseflow to Cienega Creek, immediately east of the proposed project site. Several groundwater models have been developed to analyze potential effects of expected groundwater withdrawals. The latest independent models indicate that a potentially significant reduction to baseflows in Cienega Creek and Emprire Gulch are expected within 50 years post-closure of the Rosemont Copper Mine, should it be permitted for development (see *http://www.rosemonteis.us/final-eis*).

The best available scientific and commercial information indicates that any reduction in the presence or availability of water is a significant threat to northern Mexican and narrow-headed gartersnakes, their prey base, and their habitat. This is because water is a fundamental need that supports the necessary aquatic and riparian habitats and prey species needed by both species of gartersnake. Through GIS analyses, we found that approximately 32 percent of formerly perennial streams have been dewatered within the historical distribution of the northern Mexican gartersnake. Within the historical distribution of the narrow-headed gartersnake, approximately 13 percent of formerly perennial streams have been dewatered. With continued human population growth and corresponding water use throughout the range of both gartersnakes, we expect the loss of habitat due to reduction in stream flows to increase in the foreseeable future and result in additional declines and extirpations of gartersnake populations.

Climate Change and Drought (Northern Mexican and Narrow-headed gartersnake)—Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms ''climate'' and ''climate change'' are defined by the Intergovernmental Panel on Climate Change (IPCC). ''Climate'' refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term ''climate change'' thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007, pp. 8–14, 18–19). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change and their predicted effects on northern Mexican and narrow-headed gartersnakes.

The ecology and natural histories of northern Mexican and narrow-headed gartersnakes are strongly linked to water. As discussed above, the northern Mexican gartersnake is a highly aquatic species and relies largely upon other aquatic species, such as ranid frogs and native and nonnative, soft-rayed fish as prey. The narrow-headed gartersnake is the most aquatic of the southwestern gartersnakes and is a specialized predator on native and nonnative, soft-rayed fish found primarily in clear, rocky, higher elevation streams. Because of their aquatic nature, they may be uniquely susceptible to environmental change, especially factors associated with climate change (Wood *et al.* 2011, p. 3). Together, these factors are likely to make northern Mexican and narrow-headed gartersnakes vulnerable to effects of climate change and drought discussed below.

Several climate-related trends have been detected since the 1970s in the southwestern United States, including increases in surface temperatures, rainfall intensity, drought, heat waves, extreme high temperatures, and average low temperatures (Overpeck 2008, entire). Annual precipitation amounts in the southwestern United States may decrease by 10 percent by the year 2100 (Overpeck 2008, entire). Seager *et al.* (2007, pp. 1181–1184) analyzed 19 different computer models of differing variables to estimate the future climatology of the southwestern United States and northern Mexico in response to predictions of changing climatic patterns. All but 1 of the 19 models predicted a drying trend within the Southwest; one predicted a trend toward a wetter climate (Seager *et al.* 2007, p. 1181). A total of 49 projections were created using the 19 models, and all but 3 predicted a shift to increasing aridity (dryness) in the Southwest as early as 2021–2040 (Seager *et al.* 2007, p. 1181). Northern Mexican and particularly narrow-headed gartersnakes, and their prey bases, depend on permanent or nearly permanent water for survival. A large percentage of habitats within the current distribution of northern Mexican and narrow-headed gartersnakes are predicted to be at risk of becoming more arid with reductions in snow pack levels by 2021–2040 (Seager *et al.* 2007, pp. 1183–1184). This has severe implications for the integrity of aquatic and riparian ecosystems and the water that supports them.

In assessing potential effects of predicted climate change to river systems in New Mexico, Molles (2007, entire) found that: (1) Variation in stream flow will likely be higher than variation in precipitation; (2) predicted effects such as warming and drying are expected to result in higher variability in stream flows; and (3) high-elevation fish and non-flying invertebrates (which are prey for gartersnake prey species) are at greatest risk from effects of predicted climate change. Enquist and Gori (2008, p. iii) found that most of New Mexico's mid- to high-elevation forests and woodlands have experienced either consistently warmer and drier conditions or greater variability in temperature and precipitation from 1991 to 2005. However, Enquist *et al.* (2008, p. v) found the upper Gila and San Francisco subbasins, which support narrow-headed gartersnake populations, have experienced very little change in moisture stress during the same period.

Cavazos and Arriaga (2010, entire) found that average temperatures along the Mexican Plateau in Mexico could rise in the range of 1.8 °F (1 °C) to 9 °F (5 °C) in the next 20 years, according to their models. Cavazos and Arriaga (2010, entire) also found that precipitation may decrease up to 12 percent over the next 20 years in the same region, with pronounced decreases in winter and spring precipitation.

Potential drought associated with changing climatic patterns may adversely affect the amphibian prey base for the northern Mexican gartersnake. Amphibians may be among the first vertebrates to exhibit broad-scale changes in response to changes in global climatic patterns due to their sensitivity to changes in moisture and temperature (Reaser and Blaustein 2005, p. 61). Changes in temperature and moisture, combined with the ongoing threat to amphibians from the persistence of disease-causing bacteria such as *Batrachochytrium dendrobatidis* (Bd) may cause prey species to experience increased physiological stress and decreased immune system function, possibly leading to disease outbreaks (Carey and Alexander 2003, pp. 111–121; Pounds *et al.* 2006, pp. 161–167). Of the 30 different vertebrate species in the Sky Island region of southeastern Arizona, the northern Mexican gartersnake was found to be the fifth most vulnerable (total combined score) to predicted climate change; one of its primary prey species, the Chiricahua leopard frog, was determined to be the fourth most vulnerable (Coe *et al.* 2012, p. 16). Both the northern Mexican gartersnake and the Chiricahua leopard frog ranked the highest of all species assessed for vulnerability of their habitat to predicted climate change, and the Chiricahua leopard frog was also found to be the most vulnerable in terms of its physiology (Coe *et al.* 2012, p. 18). Relative uncertainty for the vulnerability assessment provided by Coe *et al.* (2012, Table 2.2) ranged from 0 to 8 (higher score means greater uncertainty), and the northern Mexican gartersnake score was 3, meaning that the vulnerability assessment was more certain than not. Coe *et al.* (2012, entire) focused their assessment of species vulnerability to climate change on those occurring on the Coronado National Forest in southeastern Arizona. However, it is not unreasonable to hypothesize that results might be applicable in a larger, regional context as applied in most climate models.

The bullfrog, also assessed by Coe *et al.* (2012, pp. 16, 18, Table 2.2), was shown to be significantly less vulnerable to predicted climate change than either northern Mexican gartersnakes or Chiricahua leopard frogs with an uncertainty score of 1 (very certain). We suspect bullfrogs were found to be less vulnerable by Coe *et al.* (2012) to predicted climate change in southeastern Arizona due to their dispersal and colonization capabilities, capacity for self-sustaining cannibalistic populations, and ecological dominance where they occur. Based upon climate change models, nonnative species biology, and ecological observations, Rahel *et al.* (2008, p. 551) concluded that climate change could foster the expansion of nonnative aquatic species into new areas, magnify the effects of existing aquatic nonnative species where they currently occur, increase nonnative predation rates, and heighten the virulence of disease outbreaks in North America.

Rahel and Olden (2008, p. 526) expect that increases in water temperatures in drier climates such as the southwestern United States will result in periods of prolonged low flows and stream drying. These effects from changing climatic conditions may have profound effects on the amount, permanency, and quality of habitat for northern Mexican and narrow-headed gartersnakes as well as their prey base. Changes in amount or type of winter precipitation may affect snowpack levels as well as the timing of their discharge into high-elevation streams. Low or no snowpack levels would jeopardize the amount and reliability of stream flow during the arid spring and early summer months, which would increase water temperatures to unsuitable levels or eliminate flow altogether. Harmful nonnative species such as largemouth bass are expected to benefit from prolonged periods of low flow (Rahel and Olden 2008, p. 527). These nonnative predatory species evolved in river systems with hydrographs that were largely stable, not punctuated by flood pulses in which native species evolved and benefit from. Propst *et al.* (2008, p. 1246) also suggested that nonnative fish species may benefit from drought.

Changes to climatic patterns may warm water temperatures, alter stream flow events, and increase demand for water storage and conveyance systems (Rahel and Olden 2008, pp. 521–522). Warmer water temperatures across temperate regions are predicted to expand the distribution of existing harmful nonnative species, which evolved in warmer water temperatures, by providing 31 percent more suitable habitat. This conclusion is based upon studies that compared the thermal tolerances of 57 fish species with predictions made from climate change temperature models (Mohseni *et al.* 2003, p. 389). Eaton and Scheller (1996, p. 1,111) reported that, while several cold-water fish species (such as trout, a prey species for narrow-headed gartersnakes) in North America are expected to have reductions in their distribution from effects of climate change, several harmful nonnative species are expected to increase their distribution. In the southwestern United States, this situation may occur where the quantity of water is sufficient to sustain effects of potential prolonged drought conditions but where water temperature may warm to a level found suitable to harmful nonnative species that were previously physiologically precluded from occupation of these areas. Species that are particularly harmful to northern Mexican and narrow-headed gartersnake populations, such as the green sunfish, channel catfish, largemouth bass, and bluegill, are expected to increase their distribution by 7.4 percent, 25.2 percent, 30.4 percent, and 33.3 percent, respectively (Eaton and Scheller 1996, p. 1,111).

Vanishing Cienegas (Northern Mexican Gartersnake)—Cienegas are particularly important habitat for the northern Mexican gartersnake because these areas present ideal habitat characteristics for the species and its prey base and have been shown to support robust populations of both (Rosen and Schwalbe 1988, p. 14). Hendrickson and Minckley (1984, p. 131) defined cienegas as ''mid-elevation (3,281–6,562 ft (1,000–2000 m)) wetlands characterized by permanently saturated, highly organic, reducing (lowering of oxygen level) soils.'' Many of these unique communities of the southwestern United States, Arizona in particular, and Mexico have been lost in the past century to streambed modification, intensive livestock grazing, woodcutting, artificial drainage structures, stream flow stabilization by upstream dams, channelization, and stream flow reduction from groundwater pumping and water diversions (Hendrickson and Minckley 1984, p. 161). Stromberg *et al.* (1996, p. 114) state that cienegas were formerly extensive along streams of the Southwest; however, most were destroyed during the late 1800s, when groundwater tables declined several meters and stream channels became incised. Drying trends are expected to continue into the next several decades and likely beyond.

Development and Recreation Within Riparian Corridors (Northern Mexican and Narrow-headed Gartersnake)—Development within and adjacent to riparian areas has proven to be a significant threat to riparian biological communities and their suitability for native species (Medina 1990, p. 351; Nowak and Santana-Bendix 2002, p. 37). Riparian communities are sensitive to even low levels (less than 10 percent) of urban development within a subbasin (Wheeler *et al.* 2005, p. 142). Development along or within proximity to riparian zones can alter the nature of stream flow dramatically, changing once-perennial streams into ephemeral streams, which has direct consequences on the riparian community (Medina 1990, pp. 358–359). Medina (1990, pp. 358–359) correlated tree density and age class representation to stream flow in a high-elevation system with a narrow alluvium basin, finding that decreased flow reduced tree densities and generally resulted in few to no small-diameter trees. Small-diameter trees assist northern Mexican and narrow-headed gartersnakes by providing additional habitat complexity, thermoregulatory opportunities, and cover needed to reduce predation risk and enhance the usefulness of areas for maintaining optimal body temperature. Development along lower elevation streams with broad alluvial basins may have different effects on stream flow and riparian vegetation, as compared to high-elevation streams. The presence of small shrubs and trees may be particularly important for the narrow-headed gartersnake (Deganhardt *et al.* 1996, p. 327). Development within occupied riparian habitat also likely increases the number of human-gartersnake encounters and, therefore, the frequency of adverse human interaction, described below.

Obvious examples of the influence of urbanization and development can be observed within the areas of greater Tucson and Phoenix, Arizona, where impacts have modified riparian vegetation, structurally altered stream channels, facilitated nonnative species introductions, and dewatered large reaches of formerly perennial rivers where the northern Mexican gartersnake historically occurred (Santa Cruz, lower Gila, and lower Salt Rivers, respectively). Urbanization and development of these areas, along with the introduction of nonnative species, are largely responsible for the likely extirpation of the northern Mexican gartersnake from these regions.

Development near riparian areas usually leads to increased recreation. Riparian areas located near urban areas are vulnerable to the effects of increased recreation. An example of such an area within the existing distribution of both the northern Mexican and narrow-headed gartersnake is the Verde Valley. The reach of the Verde River that winds through the Verde Valley receives a high amount of recreational use from people living in central Arizona (Paradzick *et al.* 2006, pp. 107–108). Increased human use results in the trampling of near-shore vegetation, which reduces cover for gartersnakes, especially newborns. Increased human visitation in occupied habitat also increases the potential for adverse human interactions with gartersnakes, which frequently leads to the capture, injury, or death of the snake (Rosen and Schwalbe 1988, p. 43; Ernst and Zug 1996, p. 75; Green 1997, pp. 285–286; Nowak and Santana-Bendix 2002, pp. 37–39).

Oak Creek Canyon, which represents an important source population for narrow-headed gartersnakes, is also a well-known example of an area with very high recreation levels (Nowak and Santana-Bendix 2002, p. 37). In 1995, 1.3 million people visited the Red Rock Ranger District, which includes Oak Creek Canyon and the Sedona, Arizona area; that figure climbed to six million visitors by 1999 (Nowak and Santana-Bendix 2002, p. 37). Recreational activities in the Southwest are often heavily tied to water bodies and riparian areas, due to the general lack of surface water on the landscape. Increased recreational impacts on the quantity and quality of water, as well as the adjacent vegetation, negatively affect northern Mexican and narrow-headed gartersnakes. The impacts to riparian habitat from recreation can include movement of people or livestock, such as horses or mules, along stream banks, trampling, loss of vegetation, and increased danger of fire starts (Northern Arizona University 2005, p. 136; Monz *et al.* 2010, pp. 553–554).

High stream-side recreation levels can result in increased siltation of streams, which can result in lower recruitment rates of native fish and, therefore, negatively affect the prey base for narrow-headed gartersnakes (Nowak and Santana-Bendix 2002, pp. 37–38). In the arid Gila River Basin, recreational impacts are disproportionately distributed along streams as a primary focus for recreation (Briggs 1996, p. 36). Within the range of the northern Mexican and narrow-headed gartersnakes in the United States, the majority of the occupied areas occur on Federal lands, which are managed for recreation and other purposes. On the Gila National Forest, and associated private, state, or non-Forest Service inholdings in the area, heavy recreation use can affect gartersnakes within occupied narrow-headed gartersnake habitat along the Middle Fork Gila River, the West Fork Gila River between Cliff Dwellings and Little Creek, and Whitewater Creek from the Catwalk to Glenwood (Hellekson 2012a, pers. comm.). Much of the recreation use in these areas is related to hiking and backpacking, which are not a threat to gartersnakes except when increased human visitation leads to more gartersnake encounters and potentially more killing of gartersnakes where the foot trail is near the canyon bottom (see ‘‘Adverse Human Interactions with Gartersnakes’’ below).

Urbanization on smaller scales can also impact habitat suitability and the prey base for the northern Mexican or narrow-headed gartersnakes, such as along Tonto Creek, within the Verde Valley, and the vicinity of Rock Springs along the Agua Fria River (Girmendonk and Young 1997, pp. 45–52; Voeltz 2002, pp. 58–59, 69–71; Holycross *et al.* 2006, pp. 53, 56; Paradzick *et al.* 2006, pp. 89–90). One of the more stable populations of the northern Mexican gartersnake in the United States, at the Page Springs and Bubbling Ponds fish hatcheries along Oak Creek, is likely to be affected by future small-scale development over the next decade. As mitigation for effects to species covered under their habitat conservation plan for the operation of Horseshoe and Bartlett Reservoirs on the Verde River, the Salt River Project will be funding development improvements and capacity expansion at these State-owned and operated hatcheries for the purpose of creating a native fish hatchery. Construction is likely to include the replacement of earthen ponds currently used by the gartersnakes, with modernized non-earthen units. However, the AGFD is committed to maintaining the healthy population of northern Mexican gartersnakes at these hatcheries, and is investigating land use options to improve gartersnake habitat. A variety of activities associated with ongoing and future operation of the hatchery is likely to contribute to some level of fatality in resident gartersnakes, but that level might be offset by a mitigation strategy when adopted.

Diminishing Water Quantity and Quality in Mexico (Northern Mexican Gartersnake)—While effects to riparian and aquatic communities affect both the northern Mexican gartersnake and the narrow-headed gartersnake in the United States, Mexico provides habitat only for the northern Mexican gartersnake. Threats to northern Mexican gartersnake habitat in Mexico include intensive livestock grazing, urbanization and development, water diversions and groundwater pumping, loss of vegetation cover and deforestation, and erosion, as well as impoundments and dams that have modified or destroyed riparian and aquatic communities in areas of Mexico where the species occurred historically. Rorabaugh (2008, pp. 25–26) noted threats to northern Mexican gartersnakes and their native amphibian prey base in Sonora, which included disease, pollution, intensive livestock grazing, conversion of land for agriculture, nonnative plant invasions, and logging.

Illegal or under-regulated logging in the Sierra Madre of Mexico, and particularly within Chihuahua (Sierra Tarahumara), has been identified as a significant environmental concern (Gingrich 1993, entire). Gingrich (1993, p. 6) described the risk to streams from excessive logging in the Sierra Madre as including increased flooding, increased sedimentation, and lower baseflows. In an attempt to reverse disturbing trends in logging practices, the World Wildlife Fund-Mexico (2004, entire) has begun implementing a conservation plan for the Sierra Tarahumara region. Ramirez Bautista and Arizmendi (2004, p. 3) stated that the principal threats to northern Mexican gartersnake habitat in Mexico include the drying of temporary ponds, livestock grazing, deforestation, wildfires, and human settlements. In addition, nonnative species, such as bullfrogs and nonnative, predatory fish, have been introduced throughout Mexico and continue to disperse naturally, broadening their distributions (Conant 1974, pp. 487–489; Miller *et al.* 2005, pp. 60–61; Luja and Rodríguez-Estrella 2008, pp. 17–22).

Mexico's water needs for urban and agricultural development, as well as impacts to aquatic habitat from these uses, are linked to significant human population growth over the past century in Mexico. Mexico's human population grew 700 percent from 1910 to 2000 (Miller *et al.* 2005, p. 60). Mexico's population increased by 245 percent from 1950 to 2002 and is projected to grow by another 28 percent by 2025 (EarthTrends 2005, p. 1). Growth is concentrated in Mexico's northern states (Stoleson *et al.* 2005, Table 3.1) and is now skewed towards urban areas (Miller *et al.* 2005, p. 60). The human population of Sonora, Mexico, doubled in size from 1970 (1.1 million) to 2000 (2.2 million) (Stoleson *et al.* 2005, p. 54). The population of Sonora is expected to increase by 23 percent, to 2.7 million people, in 2020 (Stoleson *et al.* 2005, p. 54). Increasing trends in Mexico's human population will continue to place additional stress on the country's freshwater resources and continue to be the catalyst for the elimination of northern Mexican gartersnake habitat and prey species.

Much knowledge of the status of aquatic ecosystems in Mexico has come from fisheries research, which is particularly applicable to assessing the status of northern Mexican gartersnakes because of the gartersnakes' ecology and relationship to other aquatic and riparian vertebrates. Fisheries research is particularly applicable because of the role fishes serve as indicators of the status of the aquatic community as a whole. Miller *et al.* (2005) reported information on threats to freshwater fishes and riparian and aquatic communities in specific water bodies from several regions throughout Mexico within the range of the northern Mexican gartersnake: headwaters of the Río Lerma (extirpation of freshwater fish species, nonnative species, pollution, dewatering, pp. 60, 105, 197); medium-sized streams throughout the Sierra Madre Occidental (localized extirpations, logging, dewatering, pp. 109, 177, 247); the Río Conchos (extirpations of freshwater fish species, p. 112); the ríos Casas Grandes, Santa María, del Carmen, and Laguna Bustillos (water diversions, groundwater pumping, channelization, flood control practices, pollution, and introduction of nonnative species, pp. 124, 197); the Río Santa Cruz (extirpations, p. 140); the Río Yaqui (dewatering, nonnative species, p. 148, Plate 61, p. 247); the Río Colorado (nonnative species, p. 153); the ríos Fuerte and Culiacán (logging, p. 177); canals, ponds, lakes in the Valle de México (nonnative species, extirpations, pollution, pp. 197, 281); the Río Verde Basin (dewatering, nonnative species, extirpations, Plate 88); the Río Mayo (dewatering, nonnative species, p. 247); the Río Papaloapan (pollution, p. 252); and the Río Pánuco Basin (nonnative species, p. 295). These examples should not be construed as to suggest that all native fishes are threatened and all aquatic habitat or ecosystems are in peril. Rather, these examples suggest that threats may be localized in some examples and wider-ranging in others, but collectively several types of threats are acting in various degrees across numerous drainages in Mexico, throughout the range of the northern Mexican gartersnake. This provides some level of insight into the status of native aquatic ecosystems within its range.

Excessive sedimentation also appears to be a significant problem for aquatic habitat in Mexico. Recent estimates indicate that 80 percent of Mexico is affected by soil erosion caused by vegetation removal related to grazing, fires, agriculture, deforestation, etc. The most serious erosion is occurring in the states of Guanajuato (43 percent of the state's land area), Jalisco (25 percent of the state's land area), and México (25 percent of the state's land area) (Landa *et al.* 1997, p. 317), all of which occur within the distribution of the northern Mexican gartersnake. Miller *et al.* (2005, p. 60) stated that ''During the time we have collectively studied fishes in México and southwestern United States, the entire biotas of long reaches of major streams such as the Río Grande de Santiago below Guadalajara (Jalisco) and Río Colorado (lower Colorado River in Mexico) downstream of Hoover (Boulder) Dam (in the United States), have simply been destroyed by pollution and river alteration.'' These streams are within the distribution of the northern Mexican gartersnake. The geographic extent of threats reported by Miller *et al.* (2005) across the distribution of the northern Mexican gartersnake in Mexico is evidence that they are widespread through the country, and encompass a large proportion of the distribution of the northern Mexican gartersnake in Mexico.

In northern Mexico, effects of development, which is expected to continue at similar rates, if not increase, over the next several decades, such as agriculture and irrigation practices on streams and rivers in Sonora have been documented at least as far back as the 1960s. Branson *et al.* (1960, p. 218) found that the perennial rivers that drain the ''mountains'' (Sierra Madre) are ''silt-laden and extremely turbid, mainly because of irrigation practices.'' Specific rivers were not identified where Branson *et al.* (1960, p. 218) describes the effects of irrigation practices, but the Sierra Madre in Sonora is within the known distribution of the northern Mexican gartersnake in Mexico and, therefore, suggests that at least some portion of occupied habitat has been adversely impacted by these practices. Smaller mountain streams, such as the Rio Nacozari in Sonora were found to be ''biological deserts'' from the effects of numerous local mining practices (Branson *et al.* 1960, p. 218). The perennial rivers and their mountain tributaries that may have been historically occupied by northern Mexican gartersnakes (as well as their prey species) have since been adversely affected, which likely contributed to declines in these areas.

Minckley *et al.* (2002, pp. 687–705) provided a summary of threats (p. 696) to two newly described (at the time) species of pupfish and their habitat in Chihuahua, Mexico, which occur with the northern Mexican gartersnake and comprise part of its prey base. Initial settlement and agricultural development of the area resulted in significant channel cutting through soil layers protecting the alluvial plain above them, which resulted in reductions in the base level of each basin in succession (Minckley *et al.* 2002, p. 696). Related to these activities, the building of dams and diversion structures dried entire reaches of some regional streams and altered flow patterns of others (Minckley *et al.* 2002, p. 696). This was followed by groundwater pumping (enhanced by the invention of the electric pump), which lowered groundwater levels and dried up springs and small channels and reduced the reliability of baseflow in ''essentially all systems'' (Minckley *et al.* 2002, p. 696). Subsequently, the introduction and expansion of nonnative species in the area successfully displaced or extirpated many native species (Minckley *et al.* 2002, p. 696). Conant (1974, pp. 486–489) described significant threats to northern Mexican gartersnake habitat within its distribution in western Chihuahua, Mexico, and within the Rio Concho system where it occurs. These threats included impoundments, water diversions, and purposeful introductions of largemouth bass, common carp, and bullfrogs.

In the central portions of the northern Mexican gartersnakes' range in Mexico, such as in Durango, Mexico, population growth since the 1960s has led to regional effects such as reduced stream flow, increased water pollution, and largemouth bass introductions, which ''have seriously affected native biota'' (Miller *et al.* 1989, p. 26). McCranie and Wilson (1987, p. 2) discuss threats to the pine–oak communities of higher elevation habitats (within the distribution of the northern Mexican gartersnake) in the Sierra Madre Occidental in Mexico, specifically noting that ''. . . the relative pristine character of the pine–oak woodlands is threatened . . . every time a new road is bulldozed up the slopes in search of new madera or pasturage. Once the road is built, further development follows; pueblos begin to pop up along its length. . . .'' Several drainages that possess suitable habitat for the northern Mexican gartersnake occur in the area referenced above by McCranie and Wilson (1987, p. 2), including the Rio de la Cuidad, Rio Quebrada El Salto, Rio Chico, Rio Las Bayas, Rio El Cigarrero, Rio Galindo, Rio Santa Barbara, and the Rio Chavaria.

In the southern portion of the northern Mexican gartersnake's range in Mexico, growth and development around Mexico City resulted in agricultural practices and groundwater demands that dewatered aquatic habitat and led to declines, and in some cases, extinctions of local native fish species (Miller *et al.* 1989, p. 25). Considerable research has been focused in the central and west-central regions of Mexico, within the southern portion of the northern Mexican gartersnake's range, where native fish endemism (unique, narrowly distributed suite of species) is high, as are threats to their populations and habitat. Since the 1970s in central Mexico, significant human population growth has resulted in the overexploitation of local fisheries and water pollution; these factors have accelerated the degradation of stream and riverine habitats and led to fish communities becoming reduced or undergoing significant changes in structure and composition (Mercado-Silva *et al.* 2002, p. 180).

These shifts in fish community composition, population density, and shrinking distributions have adversely affected the northern Mexican gartersnake prey base in the southern portion of its range in Mexico. The Lerma River basin is the largest in west-central Mexico and is within the distribution of the northern Mexican gartersnake in the states of Jalisco, Guanajuato, and Querétaro in the southern portion of its range. Lyons *et al.* (1995, p. 572) reported that many fish communities in large perennial rivers, isolated spring-fed streams, or spring sources themselves of this region have been ''radically restructured'' and are now dominated by a few nonnative, generalist species. Lowland streams and rivers in this region are used heavily for irrigation and are polluted by industrial, municipal, and agricultural discharges (Lyons and Navarro-Perez 1990, p. 37; Lyons *et al.* 1995, p. 572).

Native fish communities of west-central Mexico have been found to be in serious decline as a result of habitat degradation at an ''unprecedented'' rate due to water withdrawals (diversions for irrigation), as well as untreated municipal, industrial, and agricultural discharges (Lyons *et al.* 1998, pp. 10–11). Numerous dams have been built along the Lerma River and along its major tributaries to support one of Mexico's most densely populated regions during the annual dry period; the water is used for irrigation, industry, and human consumption (Lyons *et al.* 1998, p. 11). From 1985 to 1993, Lyons *et al.* (1998, p. 12) found that 29 of 116 (25 percent) fish sampling locations visited within the Lerma River watershed were completely dry and another 30 were too polluted to support a fish community. These figures indicate that over half of the localities visited by Lyons *et al.* (1998, p. 12) that maintained fish populations prior to 1985 no longer support fish, which has likely adversely affected local northern Mexican gartersnake populations, and perhaps led to population declines or extirpations.

Soto-Galera *et al.* (1999, p. 137) reported fish and water quality sampling results from within the Rio Grande de Morelia-Lago de Cuitzeo Basin of Michoacán and Guanajuato, Mexico. The easternmost portion of this basin occurs at the periphery of the known northern Mexican gartersnake range in Mexico. Soto-Galera *et al.* (1999, p. 137) found that over the past several decades, diminishing water quantity and worsening water quality have resulted in the elimination of 26 percent of native fish species from the basin, the extinction of two species of native fish, and declining distributions of the remaining 14 species. These figures suggest significant concern for aquatic ecosystems of this region. Some conservation value, however, is realized when headwaters, springs, and small streams are protected as parks or municipal water supplies (Lyons *et al.* 1998, p. 15), but these efforts do little to protect larger perennial rivers that represent valuable habitat for northern Mexican gartersnakes.

Mercado-Silva *et al.* (2002, Appendix 2) reported results from fish community sampling and habitat assessments along 63 sites across central Mexico; the easternmost of these sites include most of the northern Mexican gartersnake's southern range. Specifically, sampling locations in the Balsas, Lerma, Morelia, Pánuco Moctezuma, and Pánuco

Tampaón basins each occurred within the range of the northern Mexican gartersnake in the states of Guanajuato, Queretaro, Mexico, and Puebla; approximately 30 locations in total. The purpose of this sampling effort was to score each site in terms of its index of biotic integrity (IBI) and environmental quality (EQ), with a score of 100 representing the optimum score for each category. The IBI scoring method has been verified as a valid means to quantitatively assess ecosystem integrity at each site (Lyons *et al.* 1995, pp. 576–581; Mercado-Silva *et al.* 2002, p. 184). The range in IBI scores in these sampling locations was 85 to 35, and the range in EQ scores was 90 to 50 (Mercado-Silva *et al.* 2002, Appendix 2). The average IBI score was 57, and the average EQ score was 74, across all 30 sites and all 4 basins (Mercado-Silva *et al.* 2002, Appendix 2). According to the qualitative equivalencies assigned to scores (Mercado-Silva *et al.* 2002, p. 184), these values indicate that the environmental quality score averaged across all 30 sites was ''good'' and the biotic integrity scores were ''fair.'' It should be noted that 14 of the 30 sites sampled had IBI scores equal to or less than 50, and 5 of those ranked as ''poor.'' Of all the basins throughout central Mexico that were scored in this exercise, the two Pánuco basins represented 20 of the 30 sites sampled and scored the worst of all basins (Mercado-Silva *et al.* 2002, p. 186). This indicates that threats to the northern Mexican gartersnake, its prey base, and its habitat pose the greatest risk in this portion of its range in Mexico.

Near Torreón, Coahuila, where the northern Mexican gartersnake occurs, groundwater pumping has resulted in flow reversal, which has dried up many local springs, drawn arsenic-laden water to the surface, and resulted in adverse human health effects in that area (Miller *et al.* 2005, p. 61). Severe water pollution from untreated domestic waste is evident downstream of large Mexican cities, such as Mexico City, and inorganic pollution from nearby industrialized areas and agricultural irrigation return flow has dramatically affected aquatic communities through contamination (Miller *et al.* 2005, p. 60). Miller *et al.* (2005, p. 61) provide an excerpt from Soto Galera *et al.* (1999) addressing the threats to the Río Lerma, Mexico's longest river, which is occupied by the northern Mexican gartersnake: ''The basin has experienced a staggering amount of degradation during the 20th Century. By 1985–1993, over half of our study sites had disappeared or become so polluted that they could no longer support fishes. Only 15 percent of the sites were still capable of supporting sensitive species. Forty percent (17 different species) of the native fishes of the basin had suffered major declines in distribution, and three species may be extinct. The extent and magnitude of degradation in the Río Lerma basin matches or exceeds the worst cases reported for comparably sized basins elsewhere in the world.''

In the Transvolcanic Belt Region of the states of Jalisco, Mexico, and Veracruz in southern Mexico, Conant (2003, p. 4) noted that water diversions, pollution (e.g., discharge of raw sewage), sedimentation of aquatic habitats, and increased dissolved nutrients were resulting in decreased dissolved oxygen in suitable northern Mexican gartersnake habitat. Conant (2003, p. 4) stated that many of these threats were evident during his field work in the 1960s, and that they are ''continuing with increased velocity.''

High-Intensity Wildfires and Sedimentation of Aquatic Habitat (Narrow-Headed Gartersnake)

High-intensity wildfires lead to excessive sedimentation and ash flows in streams, which can, in turn, result in sharp declines, and even complete elimination, in fish communities downstream. According to the Apache-Sitgreaves National Forest forested vegetation types, historic fire-return intervals varied from frequent, low-intensity surface fires in ponderosa pine types (every 2–17 years), to mixed-severity fires in wet mixed-conifer forests (every 35–50 years), to high-severity, stand-replacement fires of the spruce-fir ecosystems (every 150–400 years) (U.S. Forest Service (USFS) 2013). Low-intensity fire has been a common, natural disturbance factor in forested landscapes for centuries prior to European settlement (Rinne and Neary 1996, pp. 135–136). Rinne and Neary (1996, p. 143) concluded that existing wildfire suppression policies intended to protect the expanding number of human structures on forested public lands have altered the fuel loads in these ecosystems and increased the probability of high-intensity wildfires.

Climate change-driven drought cycles are also likely contributing to a changing fire regime in the west (Westerling *et al.* (2006, pp. 941–943). Westerling *et al.* (2006, p. 940) showed that ''large wildfire activity (in the western United States) increased suddenly and markedly in the mid-1980s, with higher large-wildfire frequency, longer wildfire durations, and longer wildfire seasons.'' The effects of these high-intensity wildfires include the removal of vegetation, the degradation of subbasin condition, altered stream behavior, and increased sedimentation of streams. These effects can harm fish communities, as observed in the 1990 Dude Fire, when corresponding ash flows resulted in fish kills in Dude Creek and the East Verde River (Voeltz 2002, p. 77). Fish kills, also discussed below, can drastically affect the suitability of habitat for northern Mexican and narrow-headed gartersnakes due to the removal of a portion or the entire prey base. The Chiricahua leopard frog recovery plan cites altered fire regimes as a serious threat to Chiricahua leopard frogs, a prey species for northern Mexican gartersnakes (USFWS 2007a, pp. 38–39).

The nature and occurrence of wildfires in the Southwest is expected to also be affected by climate change and ongoing and predicted future drought. Current predictions of drought and/or higher winter low temperatures may stress ponderosa pine forests in which the narrow-headed gartersnake principally occurs, and may increase the frequency and magnitude of wildfire. Ganey and Vojta (2010, entire) studied tree mortality in mixed-conifer and ponderosa pine forests in Arizona from 1997–2007, a period of extreme drought. They found the mortality of trees to be severe; the number of trees dying over a 5-year period increased by more than 200 percent in mixed-conifer forest and by 74 percent in ponderosa pine forest during this timeframe. Ganey and Vojta (2010) attributed drought and subsequent insect (bark beetle) infestation to the die-offs in trees. Drought stress and a subsequent high degree of tree mortality from bark beetles make high-elevation forests more susceptible to high-intensity wildfires.

Climate is a top-down factor that synchronizes with fuel loads, a bottom-up factor. Combined with a predicted reduction in snowpack and an earlier snowmelt, these factors suggest wildfires will be larger, more frequent, and more severe in the southwestern United States (Fulé 2010, entire). Wildfires are expected to reduce vegetative cover and result in greater soil erosion, subsequently resulting in increased sediment flows in streams (Fulé 2010, entire). Increased sedimentation in streams reduces the visibility of gartersnakes in the water column, hampering their hunting ability as well as resulting in fish kills (which is also caused by the disruption in the nitrogen cycle post-wildfire), which reduce the amount of prey available to gartersnake populations. Additionally, unnaturally high amounts of sediment fill in pools in intermittent streams, which reduces the amount and availability of habitat for fish and amphibian prey.

In 2011 and 2012, both Arizona (2011 Wallow Fire) and New Mexico (2012 Whitewater-Baldy Complex Fire) experienced the largest wildfires in their respective State histories; indicative of the last decade that has been punctuated by wildfires of massive proportion. The 2011 Wallow Fire affected (to various degrees) approximately 540,000 acres (218,530 ha) of Apache-Sitgreaves National Forest, White Mountain Apache Indian Tribe, and San Carlos Apache Indian Reservation lands in Apache, Navajo, Graham, and Greenlee counties in Arizona as well as Catron County, New Mexico (InciWeb 2011). The 2011 Wallow Fire impacted 97 percent of perennial streams in the Black River subbasin, 70 percent of perennial streams in the Gila River subbasin, and 78 percent of the San Francisco River subbasin and resulted in confirmed fish kills in each subbasin (Meyer 2011, p. 3, Table 1); each of these streams is known to support populations of either northern Mexican or narrow-headed gartersnakes.

Although the Black River drainage received no moderate or high-severity burns as a result of the 2011 Wallow Fire, the Fish and Snake Creek subbasins (tributaries to the Black River) were severely burned (Coleman 2011, p. 2). Post-fire fisheries surveys above Wildcat Point in the Black River found no fish in a reach extending up to the confluence with the West Fork of the Black River. This was likely due to subsequent ash and sediment flows that had occurred there (Coleman 2011, p. 2). Fisheries surveys of the Black River in 2012 also reflected a largely absent prey base for narrow-headed gartersnakes (narrow-headed gartersnakes observed appeared to be in starving condition), but young-of-the-year native fish were detected, which may signal the beginning of fish recruitment (Lopez *et al.* 2012, entire). Post-fire fisheries surveys at ''the Box,'' in the Blue River, detected only a single native fish. This was also likely due to ash and sediment flows and the associated subsequent fish kills that had occurred there, extending down to the Gila River Box in Safford, Arizona (Coleman 2011, pp. 2–3). The East Fork Black River subbasin experienced moderate to high-severity burns in 23 percent of its total acreage that resulted in declines in Apache trout and native sucker populations, but speckled dace and brown trout remained prevalent as of 2011 (Coleman 2011, p. 3). These fire data suggest that the persistence of the prey base for northern Mexican and narrow-headed gartersnakes in the Black River, and narrow-headed gartersnakes in the lower Blue River, will be precarious into the near- to mid-term future, as will likely be the stability of gartersnake populations there. Immediate post-fire fish sampling in Eagle Creek confirmed that fish populations had been severely depleted, but that some level of population rebound had occurred by 2 years post-fire (Marsh 2013, pers. comm.).

Several large wildfires have occurred historically on the Gila National Forest. These fires have resulted in excessive sedimentation of streams and affected resident fish populations that serve as prey for narrow-headed gartersnakes. From 1989–2004, numerous wildfires cumulatively burned much of the uplands within the Gila National Forest, which resulted in most perennial streams in the area experiencing ash flows and elevated sedimentation (Paroz *et al.* 2006, p. 55). More recently, the 2012 Whitewater-Baldy Complex Fire in the Gila National Forest in New Mexico is the largest wildfire in that State's history. This wildfire was active for more than 5 weeks and consumed approximately 300,000 acres (121,406 ha) of ponderosa, mixed-conifer, pinyon-juniper, and grassland habitat (InciWeb 2012). Over 25 percent of the burn area experienced high-moderate burn severity (InciWeb 2012) and included several subbasins occupied by narrow-headed gartersnakes such as the Middle Fork Gila River, West Fork Gila River, Iron Creek, the San Francisco River, Whitewater Creek, Turkey Creek, and Mineral Creek (Brooks 2012, Table 1; Hellekson 2013, pers. comm.). Other extant populations of the narrow-headed gartersnake in Gilita and South Fork Negrito Creeks are also expected to be impacted from the 2012 Whitewater-Baldy Complex Fire. Narrow-headed gartersnake populations in the Middle Fork Gila River and Whitewater Creek formerly represented two of the four most robust populations known from New Mexico, and two of the five known rangewide, and are expected to have been severely jeopardized by post-fire effects to their prey base. Thus, we now consider them currently as likely not viable, at least until the watershed stabilizes and again supports a fish community, or perhaps the next 5–10 years. In reference to Gila trout populations, Brooks (2012, p. 3) stated that fish populations are expected to be severely impacted in the West Fork Gila River and Whitewater Creek. The loss of fish communities in affected streams is likely to lead to associated declines, or potential extirpations, in affected narrow-headed gartersnake populations as a result of the collapse in their prey base.

Since 2000, several wildfires have affected occupied narrow-headed gartersnake habitat on the Gila National Forest. The West Fork Gila subbasin was affected by the 2002 Cub Fire, the 2003 Dry Lakes Fire, and the 2011 Miller Fire; each resulted in post-fire ash and sediment flows, which adversely affected fish populations used by narrow-headed gartersnakes (Hellekson 2012a, pers. comm.). In 2011, the Miller Fire significantly affected the Little Creek subbasin and has resulted in substantive declines in abundance of the fish community (Hellekson 2012a, pers. comm.). Dry Blue and Campbell Blue creeks were affected by the 2011 Wallow Fire (Hellekson 2012a, pers. comm.). Saliz Creek was highly affected by the 2006 Martinez Fire (Hellekson 2012a, pers. comm.). Turkey Creek was heavily impacted by the Dry Lakes Fire in 2003, which resulted in an extensive fish kill, but the fish community has since rebounded (Hellekson 2012a, pers. comm.). It is not certain how long the fish community was depleted or absent from Turkey Creek, but it is suspected that the narrow-headed gartersnake population there may have suffered declines from the loss of their prey base, as evidenced by the current low population numbers. Black Canyon was affected by large ash and debris flows from the 2013 Silver Fire (USFS 2013, entire). Prior to the 2002 Dry Lakes Fire, Turkey Creek was largely populated by nonnative, predatory fish species, in its lower reaches. Upper reaches were largely dominated by native fish species, which have since rebounded in numbers (Hellekson 2012a, pers. comm.), and may provide high-quality habitat for narrow-headed gartersnakes, once the subbasin has adequately stabilized.

Effects to northern Mexican and narrow-headed gartersnake habitat from wildfire should be considered in light of effects to the structural habitat and effects to the prey base. Post-fire effects vary with burn severity, percent of area burned within each severity category, and the intensity and duration of precipitation events that follow (Coleman 2011, p. 4). Low-severity burns within riparian habitat can actually have a rejuvenating effect by removing decadent ground cover and providing nutrients to remaining vegetation. As a result, riparian vegetative communities may be more resilient to wildfire, given that water is present (Coleman 2011, p. 4). Willows, an important component to narrow-headed gartersnake habitat, can be positively affected by low-severity burns, as long as the root crowns are not damaged (Coleman 2011, p. 4). High-severity burns that occur within the floodplain of occupied habitat are expected to have some level of shorter term effect on resident gartersnake populations through effects to the vegetative structure and abundance, which may include a reduction of basking sites and a loss of cover, which could increase the risk of predation. These potential effects need further study. Post-fire ash flows, flooding, and impacts to native prey populations are longer term effects and can occur for many years after a large wildfire (Coleman 2011, p. 2).

Post-fire flooding with significant ash and sediment loads can result in significant declines, or even the collapse, of resident fish communities, which poses significant concern for the persistence of resident gartersnake populations in affected areas. Sedimentation can adversely affect fish populations used as prey by northern Mexican or narrow-headed gartersnakes by: (1) Interfering with respiration; (2) reducing the effectiveness of fish's visually based hunting behaviors; and (3) filling in interstitial spaces (spaces between cobbles, etc., on the stream floor) of the substrate, which reduces reproduction and foraging success of fish (Wheeler *et al.* 2005, p. 145). Excessive sediment also fills in intermittent pools required for amphibian prey reproduction and foraging. Siltation of the rocky interstitial spaces along stream bottoms decreases the dissolved oxygen content where fish lay their eggs, resulting in depressed recruitment of fish and a subsequent reduction in prey abundance for northern Mexican and narrow-headed gartersnakes through the loss of prey microhabitat (Nowak and Santana-Bendix 2002, pp. 37–38). As stated above, sediment can lead to several effects in resident fish species used by northern Mexican or narrow-headed gartersnakes as prey, which can ultimately cause increased direct fatalities, reduced reproductive success, lower overall abundance, and reductions in prey species composition as documented by Wheeler *et al.* (2005, p. 145). The underwater foraging ability of narrow-headed gartersnakes (de Queiroz 2003, p. 381) and likely northern Mexican gartersnakes is largely based on vision and is also directly compromised by excessive turbidity caused by sedimentation of water bodies. Suspended sediment in the water column may reduce the narrow-headed gartersnake's visual hunting efficiency from effects to water clarity, based on research conducted by de Queiroz (2003, p. 381) that concluded the species relied heavily on visual cues during underwater striking behaviors.

The presence of adequate interstitial spaces along stream floors may be particularly important for narrow-headed gartersnakes. Hibbitts *et al.* (2009, p. 464) reported the precipitous decline of narrow-headed gartersnakes in a formerly robust population in the San Francisco River at San Francisco Hot Springs from 1996 to 2004. The exact cause for this decline is uncertain, but the investigators suspected that a reduction in interstitial spaces along the stream floor from an apparent conglomerate, cementation process may have affected the narrow-headed gartersnake's ability to successfully anchor themselves to the stream bottom when seeking refuge or foraging for fish (Hibbitts *et al.* 2009, p. 464). These circumstances would likely result in low predation success and eventually starvation. Other areas where sedimentation has affected either northern Mexican or narrow-headed gartersnake habitat are Cibecue Creek in Arizona, and the San Francisco River and South Fork Negrito Creek in New Mexico (Rosen and Schwalbe 1988, p. 46; Arizona Department of Water Resources 2011, p. 1; Hellekson 2012a, pers. comm.). The San Francisco River in Arizona was classified as impaired due to excessive sediment from its headwaters downstream to the Arizona–New Mexico border (Arizona Department of Water Resources 2011, p. 1). South Fork Negrito Creek is also listed as impaired due to excessive turbidity (Hellekson 2012a, pers. comm.).

Potential mechanisms exist that can ameliorate the effects of wildfires, such as prescribed fire, use of wildland fire, fuels management, and timber harvest, and can sustain desired conditions for fire-adapted ecosystems and provide habitat for threatened and endangered species, but will only be effective at a landscape scale. The Guidance for Implementation of Federal Wildland Fire Management Policy is the Department of Agriculture's single cohesive Federal fire policy, and it was updated in February 2009. The intent of this policy is to solidify that the full range of strategic and tactical options are available and considered in the response to every wildland fire (USFS 2013, entire). Benefits are considered to include the movement of vegetation toward desired conditions, a greater contribution to landscape restoration, control of invasive species, a reduction in uncharacteristic wildfire across the broader landscape, and the resiliency of potential natural vegetation types to adapt to climate change (USFS 2013, entire). We are uncertain whether such projects can be completed with the scope and urgency required to reverse the current trend of massive, high-intensity wildfires in the southwest but intend to facilitate their implementation as project cooperators. We conclude that effects of high-intensity wildfires are threatening narrow-headed gartersnakes with increasing likelihood of future impacts as a result of climate change.

Summary

The presence of water is critical to both northern Mexican and narrow-headed gartersnakes and their primary prey species because their ecology and natural histories are strongly linked to water. Several factors, both natural and manmade, contribute to the continued degradation and dewatering of aquatic habitat throughout the range of northern Mexican and narrow-headed gartersnakes. Increasing human population growth is driving higher and higher demands for water in both the United States and Mexico. Water is subsequently secured through dams, diversions, flood-control projects, and groundwater pumping, which affects gartersnake habitat through reductions in flow and complete dewatering of stream reaches. Entire reaches of the Gila, Salt, Santa Cruz, and San Francisco Rivers, as well as numerous other rivers throughout the Mexican Plateau in Mexico that were historically occupied by either or both northern Mexican or narrow-headed gartersnakes, are now completely dry due to diversions, dams, and groundwater pumping. Several groundwater basins within the range of northern Mexican and narrow-headed gartersnakes in the United States are considered active management areas where pumping exceeds recharge, which is a constant threat to surface flow in streams and rivers connected to these aquifers. Reduced flows concentrate northern Mexican and narrow-headed gartersnakes and their prey with harmful nonnative species, which accelerate and amplify adverse effects of native–nonnative community interactions. Where surface water persists, increasing land development and recreation use adjacent to and within riparian habitat has led to further reductions in stream flow, removal or alteration of vegetation, and increased frequency of adverse human interactions with gartersnakes.

Exacerbating the effects of increasing human populations and higher water demands, climate change predictions include increased aridity, lower annual precipitation totals, lower snow pack levels, higher variability in flows (lower low-flows and higher high-flows), and enhanced stress on ponderosa pine communities in the southwestern United States and northern Mexico. Increased stress to ponderosa pine forests places them at higher risk of high-intensity wildfires, the effects of which are discussed below. Climate change has also been predicted to enhance the abundance and distribution of harmful nonnative species, which adversely affect northern Mexican and narrow-headed gartersnakes.

Cienegas, a unique and important habitat for northern Mexican gartersnakes, have been adversely affected or eliminated by a variety of historical and current land uses in the United States and Mexico, including streambed modification, intensive livestock grazing, woodcutting, artificial drainage structures, stream flow stabilization by upstream dams, channelization, and stream flow reduction from groundwater pumping and water diversions. The historical loss of the cienega habitat of the northern Mexican gartersnake has resulted in local population declines or extirpations, negatively affecting its status and contributing to its decline rangewide.

Wildfire has historically been a natural and important disturbance factor within the range of northern Mexican and narrow-headed gartersnakes. However, in recent decades, forest management policies in the United States have favored fire suppression, the result of which has led to wildfires of unusual proportions, particularly along the Mogollon Rim of Arizona and New Mexico. These policies are generally not in place in Mexico, and consequently, wildfire is not viewed as a significant threat to the northern Mexican gartersnake in Mexico. However, in the last 2 years, both Arizona (2011 Wallow Fire) and New Mexico (2012 Whitewater-Baldy Complex Fire) have experienced the largest wildfires in their respective State histories, which is indicative of the last decade having been punctuated by wildfires of significant magnitude. High-intensity wildfire has been shown to result in significant ash and sediment flows into habitat occupied by northern Mexican or narrow-headed gartersnakes, resulting in significant reductions of their fish prey base and, in some instances, total fish kills. The interstitial spaces between rocks located along the stream floor are important habitat for the narrow-headed gartersnake because of its specialized foraging strategy and specialized diet. These spaces are also important spawning and egg deposition habitat for native fish species used as prey by narrow-headed gartersnakes. When these spaces fill in with sediment, the narrow-headed gartersnake may be unable to forage successfully and may succumb to stress created by a depressed prey base.

A significant reduction or absence of a prey base results in stress of resident gartersnake populations and can result in local population extirpations. Also, narrow-headed gartersnakes are believed to rely heavily on visual cues while foraging underwater; increased turbidity from suspended fine sediment in the water column is likely to impede their ability to use visual cues at some level. Factors that result in depressed foraging ability from excessive sedimentation are likely to be enhanced when effects from harmful nonnative species are also acting on resident northern Mexican and narrow-headed gartersnake populations. We consider the narrow-headed gartersnake to be particularly threatened by the effects of wildfires as described because they occur throughout its range, the species is a fish-eating specialist that is unusually vulnerable to localized fish kills, and wildfire has already significantly affected two of the last remaining five populations that were formerly considered viable, pre-fire. We have demonstrated that high-intensity wildfires have the potential to eliminate gartersnake populations through a reduction or loss of their prey base. Since 1970, wildfires have adversely impacted the native fish prey base in 6 percent of the historical distribution of northern Mexican gartersnakes in the United States and 21 percent of that for narrow-headed gartersnakes rangewide, according to GIS analysis. These percentages represent only stream miles within fire perimeters, not downstream effects of ash flows within drainages, which would undoubtedly increase the percentage of habitat impacted, at least for narrow-headed gartersnakes, whose distribution overlaps more concisely with more and larger wildfires over recent decades.

All of these conditions affect the primary drivers of gartersnake habitat suitability (the presence of water and prey) and exist in various degrees throughout the range of both gartersnake species. Collectively, they reduce the amount and arrangement of physically suitable habitat for northern Mexican and narrow-headed gartersnakes over their regional landscapes. The genetic representation of each species is threatened when populations become disconnected and isolated from neighboring populations because the length or area of dewatered zones is too great for dispersing individuals to overcome. Therefore, normal colonizing mechanisms that would otherwise reestablish populations where they have become extirpated are no longer viable. This subsequently leads to a reduction in species redundancy when isolated, small populations are at increased vulnerability to the effects of stochastic events, without a means for natural recolonization. Ultimately, the effects of scattered, small, and disjunct populations, without the means to naturally recolonize, is weakened species resiliency as a whole, which ultimately enhances the risk of either or both species becoming endangered or going extinct. Therefore, based on the best available scientific and commercial information, we conclude that land uses or conditions described above that alter or dewater northern Mexican and narrow-headed gartersnake habitat are threats rangewide, now and in the foreseeable future.

Other Cumulative and Synergistic Effect of Threats on Low-Density Populations (Northern Mexican and Narrow-Headed Gartersnakes)

In most locations where northern Mexican or narrow-headed gartersnakes historically occurred or still occur currently, two or more threats are likely acting in combination with regard to their influence on the suitability of those habitats or on the species themselves. Many threats could be considered minor in isolation, but when they affect gartersnake populations in combination with other threats, become more serious. We have concluded that in as many as 24 of 29 known localities in the United States (83 percent), the northern Mexican gartersnake population is likely not viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated. We also determined that in as many as 29 of 38 known localities (76 percent), the narrow-headed gartersnake population is likely not viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated, but survey data are lacking in areas where access is restricted. We have also discussed how harmful nonnative species have affected recruitment of gartersnakes across their range. In viable populations, gartersnakes are resilient to the loss of individuals through ongoing recruitment into the reproductive age class. However, when northern Mexican or narrow-headed gartersnakes occur at low population densities in the absence of appropriate recruitment, the loss of even a few adults could substantially increase the risk of extirpation of local populations. Below, we discuss threats that, when considered in combination, can appreciably threaten low-density populations of these species with extirpation.

Historical and Unmanaged Livestock Grazing and Agricultural Land Uses (Northern Mexican and Narrow-Headed Gartersnake) (Factor A)

Currently in the United States, livestock grazing is a largely managed activity, but in Mexico, livestock grazing is much less managed or unmanaged altogether. Several examples of extant gartersnake populations (in some cases, apparently robust populations) in Mexico were found in habitat that was heavily grazed with no riparian vegetation development; these sites were coincidently free or largely free of harmful nonnative species (Burger 2007, entire). Historical livestock grazing has damaged approximately 80 percent of stream, cienega, and riparian ecosystems in the western United States (Kauffman and Krueger 1984, pp. 433–435; Weltz and Wood 1986, pp. 367–368; Cheney *et al.* 1990, pp. 5, 10; Waters 1995, pp. 22–24; Pearce *et al.* 1998, p. 307; Belsky *et al.* 1999, p. 1). Fleischner (1994, p. 629) found that ''Because livestock congregate in riparian ecosystems, which are among the most biologically rich habitats in arid and semiarid regions, the ecological costs of grazing are magnified at these sites.'' Stromberg and Chew (2002, p. 198) and Trimble and Mendel (1995, p. 243) also discussed the propensity for cattle to remain within or adjacent to riparian communities. Expectedly, this behavior is more pronounced in more arid regions (Trimble and Mendel 1995, p. 243). Effects from historical or unmanaged grazing include: (1) Declines in the structural richness of the vegetative community; (2) losses or reductions of the prey base; (3) increased aridity of habitat; (4) loss of thermal cover and protection from predators; (5) a rise in water temperatures to levels lethal to larval stages of amphibian and fish development; and (6) desertification (Szaro *et al.* 1985, p. 362; Schulz and Leininger 1990, p. 295; Schlesinger *et al.* 1990, p. 1043; Belsky *et al.* 1999, pp. 8–11; Zwartjes *et al.* 2008, pp. 21–23). In one rangeland study, it was concluded that 81 percent of the vegetation that was consumed, trampled, or otherwise removed was from a riparian area, which amounted to only 2 percent of the total grazing space, and that these actions were 5 to 30 times higher in riparian areas than on the uplands (Trimble and Mendel 1995, pp. 243–244). However, according to one study along the Agua Fria River, herbaceous ground cover can recover quickly from heavy grazing pressure (Szaro and Pase 1983, p. 384). Additional information on the effects of historical livestock grazing can be found in Sartz and Tolsted (1974, p. 354); Rosen and Schwalbe (1988, pp. 32–33, 47); Clary and Webster (1989, p. 1); Clary and Medin (1990, p. 1); Orodho *et al.* (1990, p. 9); and Krueper *et al.* (2003, pp. 607, 613–614).

Szaro *et al.* (1985, p. 360) assessed the effects of historical livestock management on a related taxon and found that western (terrestrial) gartersnake (*Thamnophis elegans vagrans*) populations were significantly higher (versus controls) in terms of abundance and biomass in areas that were excluded from grazing, where the streamside vegetation remained lush, than where uncontrolled access to grazing was permitted. This effect was complemented by higher amounts of cover from organic debris from ungrazed shrubs that accumulate as the debris moves downstream during flood events. Specifically, results indicated that snake abundance and biomass were significantly higher in ungrazed habitat, with a five-fold difference in number of snakes captured, despite the difficulty of making observations in areas of increased habitat complexity (Szaro *et al.* 1985, p. 360). Szaro *et al.* (1985, p. 362) also noted the importance of riparian vegetation for the maintenance of an adequate prey base and as cover in thermoregulation and predation avoidance behaviors, as well as for foraging success. Direct fatalities of amphibian species, in all life stages, from being trampled by livestock has been documented (Bartelt 1998, p. 96; Ross *et al.* 1999, p. 163). Gartersnakes may, on occasion, be trampled by livestock. A black-necked gartersnake (*Thamnophis cyrtopsis cyrtopsis*) had apparently been killed by livestock trampling along the shore of a stock tank in the Apache–Sitgreaves National Forest, within an actively grazed allotment (Chapman 2005).

Subbasins where historical grazing has been documented as a suspected contributing factor for either northern Mexican or narrow-headed gartersnake declines include the Verde, Salt, Agua Fria, San Pedro, Gila, and Santa Cruz (Hendrickson and Minckley 1984, pp. 140, 152, 160–162; Rosen and Schwalbe 1988, pp. 32–33; Girmendonk and Young 1997, p. 47; Hale 2001, pp. 32–34, 50, 56; Voeltz 2002, pp. 45–81; Krueper *et al.* 2003, pp. 607, 613–614; Forest Guardians 2004, pp. 8–10; Holycross *et al.* 2006, pp. 52–61; Paradzick *et al.* 2006, pp. 90–92; USFS 2008). Livestock grazing still occurs in these subbasins but is a largely managed land use and is not likely to pose significant threats to either northern Mexican or narrow-headed gartersnakes where closely managed. In cases where poor livestock management results in fence lines in persistent disrepair, providing unmanaged livestock access to occupied habitat, adverse effects from loss of vegetative cover may result, most likely in the presence of harmful nonnative species. As we described above, however, we strongly suspect that northern Mexican and narrow-headed gartersnakes are somewhat resilient to physical habitat disturbance where harmful nonnative species are absent.

The creation and maintenance of stock tanks is an important component to livestock grazing in the southwestern United States. Stock tanks associated with livestock grazing may facilitate the spread of harmful nonnative species when they are intentionally or unintentionally stocked by anglers and private landowners (Rosen *et al.* 2001, p. 24). The management of stock tanks is an important consideration for northern Mexican gartersnakes in particular. Stock tanks associated with livestock grazing can be intermediary ''stepping stones'' in the dispersal of nonnative species from larger source populations to new areas (Rosen *et al.* 2001, p. 24). The effects of livestock grazing at stock tanks on northern Mexican gartersnakes depend on how they are managed. Dense bank and aquatic vegetation is an important habitat characteristic for the northern Mexican gartersnake in the presence of harmful nonnative species. This vegetation can be affected if the impoundment is poorly managed. When harmful nonnative species are absent, the presence of bank line vegetation is less important. Well-managed stock tanks provide important habitat for northern Mexican gartersnakes and their prey base, especially when the tank: (1) Remains devoid of harmful nonnative species while supporting native prey species; (2) provides adequate vegetation cover; and (3) provides reliable water sources in periods of prolonged drought. Given these benefits of well-managed stock tanks, we believe well-managed stock tanks are an important, even vital at this time, component to northern Mexican gartersnake conservation and recovery.

Road Construction, Use, and Maintenance (Northern Mexican and Narrow-Headed Gartersnake) (Factor A)

Roads can pose unique threats to herpetofauna, and specifically to species like the northern Mexican gartersnake, its prey base, and the habitat where it occurs. The narrow-headed gartersnake, alternatively, is probably less affected by roads due to its more aquatic nature. Roads fragment occupied habitat and can result in diminished genetic variability in populations from increased fatality from vehicle strikes and adverse human encounters as supported by current research on eastern indigo snakes (Breininger *et al.* 2012, pp. 364–366). Roads often track along streams and present a fatality risk to gartersnakes seeking more upland, terrestrial habitat for brumation and gestation. Roads may cumulatively impact both species through the following mechanisms: (1) Fragmentation, modification, and destruction of habitat; (2) increase in genetic isolation; (3) alteration of movement patterns and behaviors; (4) facilitation of the spread of nonnative species via human vectors; (5) an increase in recreational access and the likelihood of subsequent, decentralized urbanization; (6) interference with or inhibition of reproduction; (7) contributions of pollutants to riparian and aquatic communities; (8) reduction of prey communities; and (9) acting as population sinks (when population death rates from vehicle strikes exceed birth rates in a given area) (Rosen and Lowe 1994, pp. 146–148; Waters 1995, p. 42; Foreman and Alexander 1998, p. 220; Trombulak and Frissell 2000, pp. 19–26; Carr and Fahrig 2001, pp. 1074–1076; Hels and Buchwald 2001, p. 331; Smith and Dodd 2003, pp. 134–138; Angermeier *et al.* 2004, pp. 19–24; Shine *et al.* 2004, pp. 9, 17–19; Andrews and Gibbons 2005, pp. 777–781; Wheeler *et al.* 2005, pp. 145, 148–149; Roe *et al.* 2006, p. 161; Sacco 2007, pers. comm.; Ouren *et al.* 2007, pp. 6–7, 11, 16, 20–21; Jones *et al.* 2011, pp. 65–66; Hellekson 2012a, pers. comm.).

Perhaps the most common factor in road fatality of snakes is the propensity for drivers to unintentionally and intentionally run them over, both because people often dislike snakes (Rosen and Schwalbe 1988, p. 43; Ernst and Zug 1996, p. 75; Green 1997, pp. 285–286; Nowak and Santana-Bendix 2002, p. 39) and because they can be difficult to avoid when crossing roads at perpendicular angles (Klauber 1956, p. 1026; Langley *et al.* 1989, p. 47; Shine *et al.* 2004, p. 11). Fatality data for northern Mexican gartersnakes have been collected at the Bubbling Ponds Hatchery since 2006. Of the 15 dead specimens, 8 were struck by vehicles on roads within or adjacent to the hatchery ponds, perhaps while crossing between ponds to forage (Boyarski 2011, pp. 1–3). Van Devender and Lowe (1977, p. 47), however, observed several northern Mexican gartersnakes crossing the road at night after the commencement of the summer monsoon (rainy season), which highlights the seasonal variability in surface activity of this snake. Wallace *et al.* (2008, pp. 243–244) documented a vehicle-related fatality of a northern Mexican gartersnake on Arizona State Route 188 near Tonto Creek that occurred in 1995.

Adverse Human Interactions With Gartersnakes (Northern Mexican and Narrow-Headed Gartersnake) (Factor E)

A fear of snakes is generally and universally embedded in modern culture and is prevalent in the United States (Rosen and Schwalbe 1988, p. 43; Ernst and Zug 1996, p. 75; Green 1997, pp. 285–286; Nowak and Santana-Bendix 2002, p. 39). We use the phrase ''adverse human interaction'' to refer to the act of humans directly injuring or killing snakes out of a sense of fear or anxiety (ophidiophobia), or for no apparent purpose. One reason the narrow-headed gartersnake is vulnerable to adverse human interactions is because of its appearance. The narrow-headed gartersnake is often confused for a venomous water moccasin (cottonmouth, *Agkistrodon piscivorus*), because of its triangular-shaped head and propensity to be found in or near water (Nowak and Santana-Bendix 2002, p. 38). Although the nearest water moccasin populations are located over 700 miles (1,127 km) to the east in central Texas, these misidentifications prove fatal for narrow-headed gartersnakes (Nowak and Santana-Bendix 2002, p. 38).

Adverse human interaction may be largely responsible for highly localized extirpations in narrow-headed gartersnakes based on the collection history of the species at Slide Rock State Park along Oak Creek, where high recreation use is strongly suspected to result in direct fatality of snakes by humans (Nowak and Santana-Bendix 2002, pp. 21, 38). Declines in narrow-headed gartersnake populations in the North and East Forks of the White River have also been attributed to humans killing snakes (Rosen and Schwalbe 1988, pp. 43–44). Locations in New Mexico where this unnatural form of fatality has been observed include Wall Lake (Fleharty 1967, p. 219) and Whitewater Creek (Hellekson 2012a, pers. comm.). Areas with high visitation and recreation levels, where this type of fatality is most likely to be more common, include the Middle Fork and mainstem of the Gila River within 1 mile of Cliff Dwellings to Little Creek, from the confluence with the East Fork to Little Creek and the reach from Turkey Creek to the Gila Bird Area south of Highway 180 (Hellekson 2013, pers. comm.), in Whitewater Creek from the Catwalk to Glenwood (Hellekson 2012a, pers. comm.), near San Francisco Hot Springs along the San Francisco River (Hibbitts and Fitzgerald 2009, p. 466), the San Francisco River ''Box'', Black Canyon near the FR150 crossing, and the south Fork Negrito Creek (Hellekson 2013, pers. comm.).

Environmental Contaminants (Northern Mexican and Narrow-Headed Gartersnake) (Factor A)

Environmental contaminants, such as heavy metals, may be common at low background levels in soils and, as a result, concentrations are known to bioaccumulate in food chains. A bioaccumulative substance increases in concentration in an organism or in the food chain over time. A mid- to higher-order predator, such as a gartersnake, may, therefore, accumulate these types of contaminants over time in their fatty tissues, which may lead to adverse health effects (Wylie *et al.* 2009, p. 583, Table 5). Campbell *et al.* (2005, pp. 241–243) found that metal concentrations accumulated in the northern watersnake (*Nerodia sipedon*) at levels six times that of their primary prey item, the central stoneroller (a fish, *Campostoma anomalum*). Metals, in trace amounts, can be sequestered in the skin of snakes (Burger 1992, p. 212), interfere with metabolic rates of snakes (Hopkins *et al.* 1999, p. 1261), affect the structure and function of their liver and kidneys, and may also act as neurotoxins, affecting nervous system function (Rainwater *et al.* 2005, p. 670). Burger (1992, p. 209) found higher concentrations of mercury, lead, and chromium in the skin of snakes, as opposed to whole body tissue, ''suggesting that frequent shedding of skin can act as a method of toxic excretion by snakes.'' Drewett *et al.* (2013, entire) studied mercury accumulation in 4 species of snakes (including the common gartersnake) ranging from mostly aquatic to mostly terrestrial in an attempt to ascertain if a snake's ecology affected the risk of exposure and tissue accumulation levels. They found that the more aquatic the species' ecology and prey base, the higher risk for exposure and accumulation of mercury (Drewett *et al.* 2013, pp. 7–8).

Based on data collected in 2002–2010, mercury appears to be bioaccumulating in fish found in the lower reaches of Tonto Creek, where northern Mexican gartersnakes also occur (Rector 2010, pers. comm.; Arizona Department of Environmental Quality (ADEQ) 2011, Table 1). In fact, the State record for the highest mercury concentrations in fish tissue was reported in Tonto Creek from this investigation by Rector (2010, pers. comm.). Mean mercury levels in fish were found to range from 0.2–1.5 mg/kg. The mean mercury concentration for all fish was 1.1 mg/kg (ADEQ 2011, p. 3). Due to the risks of adverse human health effects, ADEQ (2011, p. 8) recommends that smallmouth bass, green sunfish, and black bullheads caught from Tonto Creek not be consumed, and common carp be consumed sparingly. Because gartersnakes eat fish, mercury may be bioaccumulating in resident populations, although no testing of gartersnakes has occurred.

Specific land uses such as mining and smelting, as well as road construction and use, can be significant sources of contaminants in air, water, or soil through point-source and non-point source mechanisms. Copper mining has occurred in Arizona and adjacent Mexico for centuries, and many of these sites have smelters (now decommissioned), which are former sources of airborne contaminants. Industrial mine sites occur in several counties in Arizona (Greenlee, Pima, Pinal, Yavapai, and Gila), as well as in Grant County, New Mexico. The current price of copper is high and is expected to continue to increase into the next several decades, fueled by international development and economic growth. Overall, 18 mines are either in production or in the pre-production phases of development in Arizona and New Mexico. The mining industry in Mexico is largely concentrated in the northern tier of that country, with the State of Sonora being the leading producer of copper, gold, graphite, molybdenum, and wollastonite, as well as the leader among Mexican States with regard to the amount of surface area dedicated to mining (Stoleson *et al.* 2005, p. 56). The three largest mines in Mexico (all copper) are found in Sonora (Stoleson *et al.* 2005, p. 57). One of these, the Cananea Copper Mine adjacent to the Upper San Pedro River in northern Sonora, was responsible for a massive spill event. For two consecutive years (1977–1978), two leaching ponds overflowed into the San Pedro River resulting in very acidic water conditions and high levels of heavy metals such as copper, zinc, and manganese (Eberhardt 1981, pp. 1, 16). These releases caused the death of all aquatic organisms in the San Pedro River for a 60-mile (97-km) reach downstream of the mine (Eberhardt 1981, pp. 1, 16).

The sizes of mines in Sonora vary considerably, as do the known environmental effects from mining-related activities (from exploration to long after closure), which include contamination and drawdown of groundwater aquifers, erosion, acid mine drainage, fugitive dust, pollution from smelter emissions, and landscape clearing (Stoleson *et al.* 2005, p. 57). We are aware of no specific research on potential effects of mining or environmental contaminants acting on northern Mexican gartersnakes, but conclude, based on the best available scientific and commercial information, that where this land use is prevalent, contaminants may be a concern for resident gartersnakes or their prey.

Northern Mexican Gartersnake Competition With Marcy's Checkered Gartersnake (Northern Mexican Gartersnake) (Factor E)

Preliminary research suggests that Marcy's checkered gartersnake (*Thamnophis marcianus marcianus*) may impact the future conservation of the northern Mexican gartersnake in southern Arizona. Rosen and Schwalbe (1988, p. 31) hypothesized that bullfrogs are more likely to eliminate northern Mexican gartersnakes when Marcy's checkered gartersnakes are also present. Marcy's checkered gartersnake is a semi-terrestrial species that is able to co-exist to some degree with harmful nonnative predators. This might be due to its apparent ability to forage in more terrestrial habitats, specifically during the vulnerable juvenile size classes (Rosen and Schwalbe 1988, p. 31; Rosen *et al.* 2001, pp. 9–10). In every age class, the northern Mexican gartersnake forages in aquatic habitats where nonnative predatory fish, bullfrogs, and crayfish are present, which increases not only the encounter rate between predator and prey, but also the juvenile fatality rate of the northern Mexican gartersnake, which negatively affects recruitment. As northern Mexican gartersnake numbers decline within a population, space becomes available for occupation by Marcy's checkered gartersnakes. If competitive pressure between these two species has existed over time, it is reasonable to conclude that northern Mexican gartersnakes were successfully out-competing Marcy's checkered gartersnake prior to the invasion of harmful nonnative species. Therefore, Marcy's checkered gartersnake may simply be filling the ecological void left by the decline of the northern Mexican gartersnake. At a minimum, more research is needed to determine the relationship between these two gartersnake species.

Fatality From Entanglement Hazards (Northern Mexican and Narrow-Headed Gartersnake) (Factor E)

In addressing the effects of soil erosion associated with road construction projects or post-fire remedial subbasin management, erosion control materials placed on the ground surface are often used. Examples of products used in erosion or sediment control include mulch control netting, erosion control blankets, fiber rolls (wattles), and reinforced silt fences (California Coastal Commission 2012, p. 1). Erosion control is considered a best management practice for most soil-disturbing activities, and is broadly required as mitigation across the United States, in particular to avoid excess sedimentation of streams and rivers. Rolled erosion control products, such as temporary erosion control blankets and permanent turf reinforcement mats, are two methods commonly used for these purposes (Barton and Kinkead 2005, p. 34). These products use stitching or net-like mesh products to hold absorbent media together. At a restoration site in South Carolina, 19 snakes (15 dead) representing 5 different species were found entangled in the netting and had received severe lacerations in the process of attempting to escape their entanglement (Barton and Kinkead 2005, p. 34). Stuart *et al.* (2001, pp. 162–164) also reported the threats of net-like debris to snake species. Kapfer and Paloski (2011, p. 4) reported at least 31 instances involving 6 different species of snake (including the common gartersnake) in Wisconsin that had become entangled in the netting used for either erosion control or as a wildlife exclusion product. In their review, Kapfer and Paloski (2011, p. 6) noted that 0.5-in.-by-0.5-in. mesh has the greatest likelihood of entangling snakes.

Similar snake fatalities have not been documented in Arizona or New Mexico, according to our files. However, given the broad usage of these materials across the distribution of the northern Mexican and narrow-headed gartersnakes, it is not unlikely that fatalities occur, but go unreported. The likelihood of either gartersnake species becoming entangled depends on the distance these erosion control materials are used from water in occupied habitat and the density of potentially affected populations. Because erosion control products are usually used to prevent sedimentation of streams, there is a higher likelihood for gartersnakes to become entangled. We encourage those who use these materials in or near gartersnake habitat to take necessary precautions and monitor their use as gartersnake fatalities could occur.

Discarded fishing nets have also been documented as a source of fatalities for northern Mexican gartersnakes in the area of Lake Chapala, Jalisco, Mexico (Barragán-Ramírez and Ascencio-Arrayga 2013, p. 159). Netting or seining is not an authorized form of recreational fishing for sport fish in Arizona or New Mexico, but the practice is allowed in either state for the collection of live baitfish (AGFD 2013a, p. 57; NMDGF 2013, p. 17). Arizona fishing regulations authorize seining for baitfish only where the baitfish will be used and specify that seining is not allowed in Coconino, Apache, Pima, and Cochise Counties. In other areas, it is suspected that most seinng activity occurs at sites dominated by warmwater sportfish, where these gartersnakes are less likely to occur. We are not certain of the frequency at which these techniques are used for such purposes in either state, but we do not suspect that discarded nets or seines are commonly left on-site where they could ensnarl resident gartersnakes. However, this practice is used in Mexico as a primary means of obtaining freshwater fish as a food source and may be more of a threat to local northern Mexican gartersnake populations where this practice occurs.

Disease and Parasites (Northern Mexican and Narrow-Headed Gartersnake) (Factor C)

Our review of the scientific literature did not find evidence that disease is a current factor contributing to the decline in northern Mexican or narrow-headed gartersnakes. However, a recent wildlife health bulletin announced the emergence of snake fungal disease (SFD) within the eastern and midwestern portions of the United States (Sleemen 2013, p. 1). SFD has now been diagnosed in several terrestrial and aquatic snake genera including *Nerodia, Coluber, Pantherophis, Crotalus, Sistrurus,* and *Lampropeltis.* Clinical signs of SFD include scabs or crusty scales, subcutaneous nodules, abnormal molting, white opaque cloudiness of the eyes, localized thickening or crusting of the skin, skin ulcers, swelling of the face, or nodules in the deeper tissues (Sleemen 2013, p. 1). While fatalities have been documented as a result of SFD, population-level impacts have not, due to the cryptic and solitary nature of snakes and the lack of long-term monitoring data (Sleemen 2013, p. 1). So far, no evidence of SFD has been found in the genus *Thamnophis,* but the documented occurrence of SFD in ecologically similar, aquatic colubrids such as *Nerodia* is cause for concern.

Parasites, such as the common plerocercoid larvae of a pseudophyllidean tapeworm (possibly *Spirometra* spp.), have been observed in northern Mexican gartersnakes (Boyarski (2008b, pp. 5–6), which may not be detrimental to the snake's health (Boyarski 2008b, p. 8). However, Gúzman (2008, p. 102) first documented a Mexican gartersnake fatality from a larval *Eustrongylides* sp. (endoparasitic nematode), which ''raises the possibility that infection of Mexican gartersnakes by *Eustrongylides* sp. larvae might cause fatality in some wild populations,'' especially if those populations are under stress as a result of the presence of other threats. Nowak *et al.* (2014, pp. 148–149) reported the first observation of what appears as maternal transmission of endoparasites, specifically of the genus (*Macdonaldius* sp.). We found no substantive evidence that parasites represent a significant threat to either gartersnake species.

Summary

We found numerous effects of livestock grazing that have resulted in the historical degradation of riparian and aquatic communities that have likely affected northern Mexican and narrow-headed gartersnakes. Mismanaged or unmanaged grazing can have disproportionate effects to riparian communities in arid ecosystems due to the attraction of livestock to water, forage, and shade. We found current livestock grazing activities to be more of a concern in Mexico, at least when it occurs in areas that also support harmful nonnative species. The most profound impacts from livestock grazing in the southwestern United States occurred nearly 100 years ago, were significant, and may still be affecting some areas that have yet to fully recover. Unmanaged or poorly managed livestock operations likely have more pronounced effects in areas impacted by harmful nonnative species through a reduction in cover. However, land managers in Arizona and New Mexico currently emphasize the protection of riparian and aquatic habitat in allotment management planning, usually through fencing, rotation, monitoring, and range improvements such as developing remote water sources. Collectively, these measures have reduced the likelihood of significant adverse impacts on northern Mexican or narrow-headed gartersnakes, their habitat, and their prey base. We also recognize that, while the presence of stock tanks on the landscape can benefit nonnative species, well-managed stock tanks are currently an invaluable tool in the conservation and recovery of northern Mexican gartersnakes and their prey.

Other activities, factors, or conditions that act in combination, such as road construction, use, and management, adverse human interactions, environmental contaminants, entanglement hazards, and competitive pressures from sympatric species, occur within the distribution of these gartersnakes and have the propensity to contribute to further population declines or extirpations where gartersnakes occur at low population densities. An emerging skin disease, SFD, has not yet been documented in gartersnakes but has affected snakes of many genera within the United States, including ecologically similar species, and may pose a future threat to northern Mexican and narrow-headed gartersnakes. Where low-density populations are affected by these types of threats described above, even the loss of a few reproductive adults, especially females, from a population can have significant population-level effects, most notably in the presence of harmful nonnative species. Continued population declines and extirpations threaten the genetic representation of each species because many populations have become disconnected and isolated from neighboring populations. This subsequently leads to a reduction in species redundancy and resiliency when isolated, small populations are at increased vulnerability to the effects of stochastic events, without a means for natural recolonization. Based on the best available scientific and commercial information, we conclude that these threats have the tendency to act synergistically and disproportionately on low-density gartersnake populations rangewide, now and in the foreseeable future.

Adequacy and Effectiveness at Reducing Identified Threats of Existing Regulatory Mechanisms (Northern Mexican and Narrow-Headed Gartersnake) (Factors D and E)

Below, we examine whether existing regulatory mechanisms are adequate to address the threats to the northern Mexican and narrow-headed gartersnakes discussed under other factors and whether these regulations are acting to alleviate the threats identified to the species. Section 4(b)(1)(A) of the Endangered Species Act requires the Service to take into account ''those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species.'' We interpret this language to require us to consider relevant Federal, State, and Tribal laws, regulations, and other such mechanisms that may minimize any of the threats we describe in the threats analysis under the other four factors, or otherwise influence conservation of the species. We give strongest weight to statutes and their implementing regulations, and management direction that stems from those laws and regulations. They are nondiscretionary and enforceable, and are considered a regulatory mechanism under this analysis. Having evaluated the significance of the threat as mitigated by any such conservation efforts, we analyze under Factor D the extent to which existing regulatory mechanisms are inadequate to address the specific threats to the species. Regulatory mechanisms, if they exist, may reduce or eliminate the impacts from one or more identified threats. In this section, we review existing State and Federal regulatory mechanisms to determine whether they effectively reduce or remove threats to the species.

A number of Federal statutes potentially afford protection to northern Mexican and narrow-headed gartersnakes or their prey species. These include section 404 of the Clean Water Act (33 U.S.C. 1251 *et seq.*), Federal Land Policy and Management Act (43 U.S.C. 1701 *et seq.*), National Forest Management Act (16 U.S.C. 1600 *et seq.*), National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq.*), and the Act. However, in practice, these statutes have not been able to provide sufficient protection to prevent the currently observed downward trend in northern Mexican and narrow-headed gartersnakes or their prey species, and the concurrent upward trend in threats.

Section 404 of the Clean Water Act regulates placement of fill into waters of the United States, including the majority of northern Mexican and narrow-headed gartersnake habitat. However, many actions with the potential to be highly detrimental to both species, their prey base, and their habitat, such as gravel mining and irrigation diversion structure construction and maintenance, may be exempted from the Clean Water Act. Other detrimental actions, such as bank stabilization and road crossings, are covered under nationwide permits that receive limited environmental review. A lack of thorough, site-specific analyses for projects can allow substantial adverse effects to northern Mexican or narrow-headed gartersnakes, their prey base, or their habitat.

The majority of the extant populations of northern Mexican and narrow-headed gartersnakes in the United States occur on lands managed by the U.S. Bureau of Land Management (BLM) and U.S. Forest Service. Both agencies have riparian protection goals that may provide habitat benefits to both species; however, neither agency has specific management plans for northern Mexican or narrow-headed gartersnakes. As a result, some of the significant threats to these gartersnakes, for example, those related to nonnative species, are not necessarily addressed on these lands. The BLM considers the northern Mexican gartersnake as a ''Sensitive Species'' by default, due to its status under the Act (U.S. Bureau of Land Management (USBLM) 2010), and agency biologists actively attempt to identify gartersnakes for their records for snakes observed incidentally during fieldwork (Young 2005). BLM policy (BLM Manual Section 6840) requires consideration of sensitive species during planning of activities and projects and mitigation of specific threats. The BLM's Resource Management Plans include objectives and management actions to benefit riparian habitat and native fish; with some addressing ''invasive wildlife species'' (USBLM 2013, p. 2). When the Agua Fria National Monument was created in January 2000, lowland leopard frogs, native fish, northern Mexican gartersnakes, and riparian habitat were designated as ''monument objects'' under protection by the National Monument (USBLM 2013, p. 3). Similar conservation provisions are in place on the BLM's National Conservation Areas (NCAs), such as the Las Cienegas NCA, San Pedro River NCA, and the Gila Box Riparian NCA. While these measures likely minimize the effect of otherwise adverse regional land use activities on the aquatic community, gartersnake populations in these areas remain in a precarious status.

The U.S. Forest Service does not include northern Mexican or narrow-headed gartersnakes on their Management Indicator Species List, but both species are included on the Regional Forester's Sensitive Species List (USFS 2007, pp. 38–39). This means they are considered in land management decisions, and protective measures can be implemented to minimize adverse effects of otherwise lawful activities. However we found no examples of specific protective measures that have been implemented for these species. Individual U.S. Forest Service biologists who work within the range of either northern Mexican or narrow-headed gartersnakes may opportunistically gather data for their records on gartersnakes observed incidentally in the field or coordinate with other collaborators on surveys, although it is not required. The Gila National Forest mentions the narrow-headed gartersnake in their land and resource management plan, which includes standards relating to forest management for the benefit of endangered and threatened species as identified through approved management and recovery plans (Center for Biological Diversity (CBD) *et al.* 2011, p. 18). Neither species is mentioned in any other land and resource management plan for the remaining national forests where they occur (CBD *et al.* 2011, p. 18).

The New Mexico Department of Game and Fish lists the northern Mexican gartersnake as State-endangered and the narrow-headed gartersnake as State-threatened (NMDGF 2006, Appendix H). A species is State-endangered if it is in jeopardy of extinction or extirpation within the State; a species is State-threatened if it is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in New Mexico (NMDGF 2006, p. 52). ''Take,'' defined as ''to harass, hunt, capture or kill any wildlife or attempt to do so'' by New Mexico Statutes Annotated (NMSA) 17–2–38.L., is prohibited without a scientific collecting permit issued by the New Mexico Department of Game and Fish as per NMSA 17–2–41.C and New Mexico Administrative Code (NMAC) 19.33.6. However, while the New Mexico Department of Game and Fish can issue monetary penalties for illegal take of either northern Mexican gartersnakes or narrow-headed gartersnakes, the same provisions are not in place for actions that result in loss or modification of their habitats (NMSA 17–2–41.C and NMAC 19.33.6) (Painter 2005).

Prior to 2005, the AGFD allowed for take of up to four northern Mexican or narrow-headed gartersnakes per person per year as specified in Commission Order 43. The AGFD defines ''take'' as ''pursuing, shooting, hunting, fishing, trapping, killing, capturing, snaring, or netting wildlife or the placing or using any net or other device or trap in a manner that may result in the capturing or killing of wildlife.'' The AGFD subsequently amended Commission Order 43, effective January 2005. Take of northern Mexican and narrow-headed gartersnakes is no longer permitted in Arizona without issuance of a scientific collecting permit (Ariz. Admin. Code R12–4–401 *et seq.*) or special authorization. While the AGFD can seek criminal or civil penalties for illegal take of these species, the same provisions are not in place for actions that result in destruction or modification of the gartersnakes' habitat. In addition to making the necessary regulatory changes to promote the conservation of northern Mexican and narrow-headed gartersnakes, the AGFD's Nongame Branch continues to be a strong partner in research and survey efforts that further our understanding of current populations, and assist with conservation efforts and the establishment of long-term conservation partnerships.

Throughout Mexico, the Mexican gartersnake is listed at the species level of its taxonomy as ''Amenazadas,'' or Threatened, by the Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT) (SEDESOL 2010, p. 71). Threatened species are ''those species, or populations of the same, likely to be in danger of disappearing in a short or medium timeframe, if the factors that negatively impact their viability, cause the deterioration or modification of their habitat or directly diminish the size of their populations continue to operate'' (Secretaría de Desarrollo Social (SEDESOL) 2010, p. 5). This designation prohibits taking of the species, unless specifically permitted, as well as prohibits any activity that intentionally destroys or adversely modifies its habitat. Additionally, in 1988, the Mexican Government passed a regulation that is similar to the National Environmental Policy Act of the United States. This Mexican regulation requires an environmental assessment of private or government actions that may affect wildlife or their habitat (SEDESOL 1988 Ley General del Equilibrio Ecológico y la Protección al Ambiente (LGEEPA)).

The Mexican Federal agency known as the Instituto Nacional de Ecología (INE) is responsible for the analysis of the status and threats that pertain to species that are proposed for listing in the Norma Oficial Mexicana NOM–059 (the Mexican equivalent to an endangered and threatened species list), and, if appropriate, the nomination of species to the list. INE is generally considered the Mexican counterpart to the United States' Fish and Wildlife Service. INE developed the Method of Evaluation of the Risk of Extinction of the Wild Species in Mexico (MER), which unifies the criteria of decisions on the categories of risk and permits the use of specific information fundamental to listing decisions. The MER is based on four independent, quantitative criteria: (1) Size of the distribution of the taxon in Mexico; (2) state (quality) of the habitat with respect to natural development of the taxon; (3) intrinsic biological vulnerability of the taxon; and (4) impacts of human activity on the taxon. INE began to use the MER in 2006; therefore, all species previously listed in the NOM–059 were based solely on expert review and opinion in many cases. Specifically, until 2006, the listing process under INE consisted of a panel of scientific experts who convened as necessary for the purpose of defining and assessing the status and threats that affect Mexico's native species that are considered to be at risk, and applying those factors to the definitions of the various listing categories. In 1994, when the Mexican gartersnake was placed on the NOM–059 (SEDESOL 1994 (NOM–059–ECOL–1994), p. 46) as a threatened species, the decision was made by a panel of scientific experts.

Although the Mexican gartersnake is listed as a threatened species in Mexico and based on our experience collaborating with Mexico on trans-border conservation efforts, no recovery plan or other conservation planning occurs because of this status, and enforcement of the regulation protecting the gartersnake is sporadic, depending on available resources and location. Based upon the best available scientific and commercial information on the status of the species, and the historic and continuing threats to its habitat in Mexico, our analysis concludes that regulatory mechanisms enacted by the Mexican Government to conserve the northern Mexican gartersnake are not adequate to address threats to the species or its habitat.

In summary, we reviewed a number of existing regulations that potentially address issues affecting the northern Mexican and narrow-headed gartersnakes and their habitats. Mexican law prohibits take of the northern Mexican gartersnake and the intentional destruction or modification of northern Mexican gartersnake habitat. However that law has not led to a reduction in threats such that they no longer meet the definition of endangered or threatened under the Act. Furthermore, most existing regulations in the United States within the range of northern Mexican and narrow-headed gartersnakes were not specifically designed to protect the gartersnakes or their habitats, which is the overarching threat to the species. For example, Arizona and New Mexico both have statutes designed for protection of state-listed species that prohibit the direct collection of individuals. However neither state law is designed to provide protection of habitat and ecosystems. Therefore, these laws are not reducing threats to the species such that they no longer meet the definition of endangered or threatened under the Act.

Current Conservation of Northern Mexican and Narrow-Headed Gartersnakes (Factor E)

Several conservation measures implemented by land and resource managers, private land owners, and other stakeholders can directly or indirectly benefit populations of northern Mexican and narrow-headed gartersnakes. For example, the AGFD's conservation and mitigation program (CAMP; implemented under an existing section 7 incidental take permit) has committed to either stocking (with captive-bred stock) or securing two populations each of northern Mexican and narrow-headed gartersnakes to help minimize adverse effects to these species from their sport fish stocking program through 2021 (USFWS 2011, Appendix C). Other CAMP commitments include: (1) Developing a gartersnake monitoring, research, and restocking plan to guide CAMP activities to establish or secure populations; (2) developing outreach material to reduce the deliberate killing or injuring of gartersnakes (placed in high angler access areas); (3) ensuring that chemically renovated streams are quickly restocked with native fish as gartersnake prey; (4) conducting a live bait assessment team to develop recommendations to amend live bait management; (5) reviewing and updating outreach programs on the risks to native aquatic species from the transport of nonnative aquatic species; (6) developing and implementing a public education program on gartersnakes; and (7) working with the New Mexico Department of Game and Fish to examine the roll of escaped rainbow trout from Luna Lake into tributaries to the San Francisco River in supporting narrow-headed gartersnakes. The programs' management strategy is encapsulated in AGFD (2014a, entire) and progress on activities through June 2013 is reported in AGFD (2012c, pp. 26–30; 2013b, pp. 37–44).

Significant challenges will have to be met for creating or securing two populations each of northern Mexican or narrow-headed gartersnakes. Captive propagation, if used to create stock for reintroductions, has only been possible for northern Mexican gartersnakes. Specifically, after approximately 6 years of experimentation with captive propagation at five institutions, using two colonies of northern Mexican gartersnakes and three colonies of narrow-headed gartersnakes, success has been limited (see Gartersnake Conservation Working Group (GCWG) 2007, 2008, 2009, 2010). In 2012 and 2013, approximately 60 northern Mexican gartersnakes were produced at one institution, 40 of which were subsequently marked and released along Cienega Creek. These were the first gartersnakes of either species to be produced under this program, but the current status of released individuals remains unknown. No narrow-headed gartersnakes have been produced in captivity under this program since its inception. Secondly, in order to have the greatest chance for success, the process of ''securing'' a population of either species will likely involve an aggressive nonnative removal strategy, and will have to account for habitat connectivity to prevent reinvasion of unwanted species. Therefore, securing a population of either species may involve removal of harmful nonnatives from an entire subbasin or on a landscape scale (Cotton *et al.* 2014, pp. 12–13). In situations where harmful nonnatives do not pose a threat to a given population, other types of recovery actions may suffice.

To protect habitat for candidate, threatened, and endangered species, including northern Mexican gartersnakes in the Agua Fria subbasin, the AGFD purchased the approximate 200-acre (81-ha) Horseshoe Ranch along the Agua Fria River located near the Bloody Basin Road crossing, east of Interstate 17 and southeast of Cordes Junction, Arizona. The AGFD plans (presumably in the next 5–10 years) to introduce northern Mexican gartersnakes, as well as lowland leopard frogs and native fish species, into a large pond, protected by bullfrog exclusion fencing, located adjacent to the Agua Fria River. The bullfrog exclusion fencing around the pond will permit the dispersal of northern Mexican gartersnakes and lowland leopard frogs from the pond, allowing the pond to act as a source population to the Agua Fria River. The AGFD's short- to mid-term conservation planning for Horseshoe Ranch will help ensure the northern Mexican gartersnake persists in this historical locality.

In 2007, the New Mexico Department of Game and Fish completed a recovery plan for narrow-headed gartersnakes in New Mexico (Pierce 2007, pp. 13–15) that included the following management objectives: (1) Researching the effect of known threats to, and natural history of, the species; (2) acquiring funding sources for research, monitoring, and management; (3) enhancing education and outreach; and (4) managing against known threats to the species. Implementation of the recovery plan was to occur between the second half of 2007 through 2011, and was divided into three main categories: (1) Improve and maintain knowledge of potential threats to the narrow-headed gartersnake; (2) improve and maintain knowledge of the biology of the narrow-headed gartersnake; and (3) develop and maintain high levels of cooperation and coordination between stakeholders and interested parties (Pierce 2007, pp. 16–17). Our review of the plan found that it lacked specific threat-mitigation commitments on the landscape, as well as stakeholder accountability for implementing activities prescribed in the plan. We also found that actions calling for targeted nonnative species removal or management were absent in the implementation schedule provided in Pierce (2007, p. 17). As we have discussed at length, harmful nonnative species are the primary driver of continued declines in both gartersnake species. No recovery plan, conservation plan, or conservation agreement currently exists in New Mexico with regard to the northern Mexican gartersnake (NMDGF 2006, Table 6–3).

In Arizona's State Wildlife Action Plan 2012–2022 (SWAP) (AGFD 2012b, Appendix E), both the northern Mexican and narrow-headed gartersnake are Tier 1A Species of Greatest Conservation Need (SGCN). SGCN include those ''species that each State identified as most in need of conservation actions'' and Tier 1A species include ''those species for which the Department has entered into an agreement or has legal or other contractual obligations, or warrants the protection of a closed season'' (AGFD 2012b, p. 16). The SWAP is not a regulatory document, and does not provide any specific protections for either the gartersnakes themselves, or their habitats. The AGFD does not have specified or mandated recovery goals for either the northern Mexican or narrow-headed gartersnake, nor has a conservation agreement or recovery plan been developed for either species.

Indirect benefits for both gartersnake species occur through recovery actions designed for their prey species. Since the Chiricahua leopard frog was listed as threatened under the Act, significant strides have been made in its recovery, and the mitigation of its known threats. The northern Mexican gartersnake, in particular, has likely benefitted from these actions, at least in some areas, such as at the Las Cienegas Natural Conservation Area and in Scotia Canyon of the Huachuca Mountains. However, much of the recovery of the Chiricahua leopard frog has occurred in areas that have not directly benefitted the northern Mexican gartersnake, either because these activities have occurred outside the known distribution of the northern Mexican gartersnake or because they have occurred in isolated lentic systems that are far removed from large perennial streams that typically provide source populations of northern Mexican gartersnakes. In recent years, significant strides have been made in controlling bullfrogs on local landscape levels in Arizona, such as in the Scotia Canyon area, in the Las Cienegas National Conservation Area, on the BANWR, and in the vicinity of Pena Blanca Lake in the Pajarito Mountains. Recent efforts to return the Las Cienegas National Conservation Area to a wholly native biological community have involved bullfrog eradication efforts, as well as efforts to recover the Chiricahua leopard frog and native fish species. These actions should assist in conserving the northern Mexican gartersnake population in this area. Bullfrog control has been shown to be most effective in simple, lentic systems such as stock tanks. Therefore, we encourage livestock managers to work with resource managers in the systematic eradication of bullfrogs from stock tanks where they occur, or at a minimum, ensure they are never introduced.

An emphasis on native fish recovery in fisheries management and enhanced harmful nonnative species control to favor native communities may be the single most efficient and effective manner to recover these gartersnakes, in addition to appropriate management for all listed or sensitive native fish and amphibian species upon which they prey. Alternatively, resource management policies that are intended to directly benefit or maintain harmful nonnative communities, and which will likely exclude native species, will significantly reduce the potential for the conservation and recovery of northern Mexican and narrow-headed gartersnakes, in those areas where they overlap with habitat occupied by either gartersnake.

Fisheries managers strive to balance the needs of the recreational angling community against those required by native aquatic communities. Fisheries management has direct implications for the conservation and recovery of northern Mexican and narrow-headed gartersnakes in the United States. Clarkson *et al.* (2005) discuss management conflicts as a primary factor in the decline of native fish species in the southwestern United States, and declare the entire native fish fauna as imperiled. The investigators cite nonnative species as the most consequential factor leading to rangewide declines of native fish, and that such declines prevent or negate species' recovery efforts from being implemented or being successful (Clarkson *et al.* 2005, p. 20). Maintaining the status quo of current management of fisheries within the southwestern United States will have serious adverse effects to native fish species (Clarkson *et al.* 2005, p. 25), which will affect the long-term viability of northern Mexican and narrow-headed gartersnakes and their potential for recovery. Clarkson *et al.* (2005, p. 20) also note that over 50 nonnative species have been introduced into the Southwest as either sportfish or baitfish, and some are still being actively stocked, managed for, and promoted by both Federal and State agencies as nonnative recreational fisheries.

To help resolve the fundamental conflict of management between native fish and recreational sport fisheries, Clarkson *et al.* (2005, pp. 22–25) propose the designation of entire subbasins as having either native or nonnative fisheries and manage for these goals aggressively. The idea of watershed-segregated fisheries management is also supported by Marsh and Pacey (2005, p. 62). As part of the AGFD's overall wildlife conservation strategy, the AGFD has planned an integrated fisheries management approach (AGFD 2012b, p. 106), which is apparently designed to manage subbasins specifically for either nonnative or native fish communities. This strategy is described in detail in AGFD (2009, entire), but the AGFD has not yet initiated implementation of this strategy or decided how fisheries will be managed in Arizona's subbasins, and we are not aware of a specific implementation timeline. However, the ''current fish assemblage,'' ''current recovery or conservation category,'' and ''current angling category'' inform what is referred to as Step 2c: Identification of Current Fishery Values'' (AGFD 2009, pp. 10–11). Factors such as angler access (which contributes directly to angler use days (AUD)), existing fish communities, and stream flow considerations are likely to inform such broadly based decisions.

Due to the relative scarcity of perennial streams in arid regions such as Arizona, several of Arizona's large perennial rivers present an array of existing sport fishing opportunities and angler access points, and already contain harmful nonnative fish species that are considered sport fish. We anticipate that these rivers may be preferred as nonnative fisheries under the watershed designation process. Another significant and confounding factor is the AGFD's ''no net loss'' policy that addresses sport fishery resources statewide. There is no official written AGFD Commission guidance on ''no net loss'' according to AGFD (2009, Appendix D), but ''Commission policy DOM [Arizona Game Fish Department Operating Manual] A2.24, Wildlife Management Program Goal and Objective #6 states, 'provide and promote fishing opportunities to sustain a minimum of 8,000,000 AUD per year by June 30, 1997.' Although this policy has yet to be revised by the Commission, based on current data, we remain below 8,000,000 AUD's statewide (AGFD 2009, Appendix D). As such, it was determined the Department's goal to manage for no net loss is consistent with current Commission policy (A2.24). The ''no net loss'' policy is a guiding tenet, and its implementation is directed as follows (AGFD 2009, Appendix D):

> ''When a sport fishery is valued less than a native aquatic conservation value within a management unit, the loss of sport fishing opportunity will be compensated for by gain of an equal number of AUDs in another area or management unit. This opportunity will be created within the same watershed when possible. For this purpose, a watershed is defined as a six-digit-numbered area referenced on the USGS's Hydrological Unit Map. If this is not possible, the opportunity will be created within the same Department regional boundaries. Again, if this is not possible, the opportunity will be created somewhere within the State with extensive coordination between regional staff. If a net loss cannot be avoided, the Director will evaluate if the loss is acceptable by gauging the input from the public process leading to the recommendation and may take the information to the Commission at his discretion. The replacement opportunity will be initiated no more than two years following the loss to anglers.''

Extensive coordination between AGFD and the Service will be required under the no net loss policy with regard to gartersnake conservation and recovery because the amount of suitable riparian and aquatic habitat is finite, yet, somehow, the existing opportunity for AUD must be maintained. This increases the uncertainty for the persistence of existing gartersnake populations in Arizona.

Large perennial rivers that serve as sport fisheries also currently serve as important habitat for northern Mexican or narrow-headed gartersnake. If designated for sportfishing, fisheries management of these rivers would likely include the maintenance of predatory sport fish species, which would likely diminish the recovery potential for gartersnakes in these areas, and, perhaps, even result in the local extirpations of populations of northern Mexican and narrow-headed gartersnakes. Alternatively, subbasins that are targeted for wholly native species assemblages would likely secure the persistence of northern Mexican and narrow-headed gartersnakes that occur there, if not result in their complete recovery in these areas. Specific subbasins where targeted fisheries management is to occur were not provided in AGFD (2012b), but depending on which areas are chosen for each management emphasis, the potential for future conservation and recovery of northern Mexican and narrow-headed gartersnakes could either be significantly bolstered, or significantly hampered. Close coordination with the AGFD on the delineation of fisheries management priorities in Arizona's subbasins will be instrumental to ensuring that conservation and recovery of northern Mexican and narrow-headed gartersnakes can occur.

Conservation of these gartersnakes has been implemented in the scientific and management communities as well. The AGFD recently produced identification cards for distribution that provide information to assist field professionals with the identification of each of Arizona's five native gartersnake species, as well as guidance on submitting photographic vouchers for university museum collections. Arizona State University and the University of Arizona now accept photographic vouchers in lieu of physical specimens, in their respective museum collections. These measures appreciably reduce the necessity for physical specimens (unless discovered postmortem) for locality voucher purposes and, therefore, further reduce impacts to vulnerable populations of northern Mexican or narrow-headed gartersnakes.

Despite these collective conservation efforts we have described above, northern Mexican and narrow-headed gartersnakes have continued to decline throughout their ranges due to past, current, and future threats that have not been addressed through conservation efforts.

Summary of Changes From the Proposed Rule

Based on information provided during the comment period by the general public, tribes, states, and peer reviewers, we updated the information contained in the proposed rule for incorporation into this final rule. In addition, new references were obtained, evaluated, and discussed in the deliberation of information in the final rule that were either not available or not obtained during the development of the proposed rule. For clarity, we also revised the language used in our Findings for the listing rule and in the background and regulatory language of the 4(d) rule. However, no substantive changes were made to either the conclusion of the final listing rule or the scope of the final 4(d) rule.

Summary of Comments and Recommendations

In the proposed rule published on July 10, 2013 (78 FR 41500), we requested that all interested parties submit written comments on the proposal by September 9, 2013. We also contacted appropriate Federal, State, and Tribal agencies, scientific experts and organizations, and other interested parties and invited them to comment on the proposal. Newspaper notices inviting general public comment were published in the Verde Valley Independent, Camp Verde Bugle, Arizona Daily Star, and the Silver City Sun News. We received a request for a public hearing from the Hereford Natural Resource Conservation District who later withdrew their request.

Our summary responses to the substantive comments we received on the proposed listing rules and proposed 4(d) rule are provided below. Comments simply providing support for or opposition to the proposed rule, without any supporting information, were not considered to be substantive and we do not provide a response.

Peer Reviewer Comments

In accordance with our peer review policy published on July 1, 1994 (59 FR 34270), we solicited expert opinion from eight knowledgeable individuals with scientific expertise that included familiarity with northern Mexican and narrow-headed gartersnakes and their habitat, biological needs, and threats. We received responses from five of the peer reviewers.

We reviewed all comments received from the peer reviewers for substantive issues and new information regarding the listing of northern Mexican and narrow-headed gartersnakes. All peer reviewers shared the opinion that a thorough examination of all available information was conducted in support of listing these gartersnakes. Peer reviewers also commented that the quality of the information presented in the proposed rule was very high and the analyses were thorough. There were concerns expressed regarding whether listing these gartersnakes as threatened would interfere with ongoing recovery actions for listed fish species where they co-occur. Another concern was based on how threats affecting these gartersnakes were prioritized in their scope and magnitude in the proposed rule. In general, peer reviewers generally concurred with our methods and conclusions and provided additional information, clarifications, and suggestions to improve the final rule. Peer reviewer comments are addressed in the following summary and incorporated into the final rule as appropriate.

Comment 1: The term ''spiny-rayed fish'' has a very specific scientific meaning, which is not consistent with its use in the proposed rule. While this group includes some of the nonnative species of concern, such as sunfish and bass, it does not include others, specifically the catfishes. Also, the term spiny-rayed fishes as used here excludes a suite of nonnative fishes that are problematic for native fish species and likely for northern Mexican gartersnake and narrow-headed gartersnake, such as nonnative trouts (especially highly predaceous brown trout (*Salmo trutta*), red shiner (*Cyprinella lutrensis*), and mosquitofish (*Gambusia affinis*)). The term ''spiny-rayed fishes'' should either be eliminated from the document and replaced with accurate terminology or be defined specifically for its intended use in the rule. The Service should dispense entirely with use of ''spiny-rayed fishes'' and use only the term ''nonnative fishes.''

Our Response: In the proposed rule, we intended to identify those species of nonnative fish that were both considered highly predatory on gartersnakes and also highly competitive with gartersnakes in terms of common prey resources. The nonnative fish species we view as most harmful to gartersnake populations include bass (*Micropterus* sp.), flathead catfish (*Pylodictis* sp.), channel catfish (*Ictalurus* sp.), sunfish, bullheads (*Ameiurus* sp.), bluegill (*Lepomis* sp.), crappie (*Pomoxis* sp.,) and brown trout (*Salmo trutta*). We agree that all nonnative fish species pose some level of threat to native aquatic ecosystems. However, it is important to highlight those nonnative fish species that pose the greatest threat to assist in prioritizing future conservation actions that are most beneficial to northern Mexican and narrow-headed gartersnakes. Therefore, we have specifically defined in the beginning of this final rule, what nonnative fish species are considered ''predatory'' and what nonnative species we consider ''harmful.''

Comment 2: It would be helpful to the reader to visualize the historical and current ranges of the two snakes if range maps were included.

Our Response: Current distribution maps were provided and are available in the proposed rule to designate critical habitat for the northern Mexican and narrow-headed gartersnake, which accompanied the proposed rule to list the species in the **Federal Register** (78 FR 41550, July 10, 2013, p. 41586).

Comment 3: The sentence ''Fleharty (1967, p. 227) reported narrow-headed gartersnakes eating green sunfish, but green sunfish is not considered a suitable prey item'' needs clarification. Specifically, the authors need to provide evidence that green sunfish is not a suitable prey item. Just because green sunfish has spines in their medial (caudal excluded) and lateral fins does not mean that it is not suitable prey.

Our Response: We added further clarification to this text to support this statement in the final rule under ''Habitat and Natural History'' for the narrow-headed gartersnake.

Comment 4: Please provide examples of ''barriers to movement'' of narrow-headed gartersnakes and additional information on the ''salvage efforts'' in the discussion leading into Table 2.

Our Response: We provided examples and additional information in the text in the final rule under ''Current Distribution and Population Status.''

Comment 5: With respect to nonnative fish species in the Gila River basin, all were either intentionally or accidentally introduced by humans; there is no evidence that any species gained access to the basin through natural colonization as inferred in the proposed rule.

Our Response: We agree that no evidence exists to support unassisted migration of nonnative fish species into the Gila River basin from outside the basin. However, we acknowledge that harmful nonnatives, once introduced, are fully capable of naturally dispersing within the watershed where habitat connectivity permits. This latter concept was the impetus for the notion of ''natural colonization'', which is also referred to as dispersal.

Comment 6: The proposed rule mentions only trout of the genus *Salmo* as occurring in habitat occupied by either gartersnake. Rainbow trout (*Oncorynchus mykiss*) and brook trout (*Salvelinus fontinalis*) also occur.

Our Response: This oversight has been corrected in the final rule in the subsection ''Fish'' within the subheading ''Decline of the Gartersnake Prey Base.''

Comment 7: The statements that nonnative fish ''tend to occupy the middle and upper zones in the water column'' while native fish tend to occur ''along the bottom'' is not entirely accurate. For example, all of the catfishes (all of which are nonnative in the Gila River system) are benthic in habit, and these are among the species considered harmful to gartersnakes and their prey. Among native fishes in the Gila River system only loach minnow would be characterized as benthic, although most native suckers and minnows (chubs largely excluded) do forage along surfaces, including the bottom. Moreover, large numbers of native fish, longfin dace (*Agosia chrysogaster*) in particular, occur in shallow habitats where differentiating a position in the water column is problematic.

Our Response: We have amended the discussion in the subsection ''Fish'' within the subheading ''Decline of the Gartersnake Prey Base'' in the final rule to specify which groups of native or nonnative fish are likely to occur where in the water column.

Comment 8: It seems unlikely that Yaqui catfish were suitable prey for gartersnakes, given their stiff pectoral and dorsal spines, and humpback chub likely never co-occurred with either gartersnake. Woundfin, conversely, has records from the lower Salt River at Tempe and would have been a listed prey species.

Our Response: We have removed humpback chub and Yaqui catfish, and added woundfin, as species noted that were possible prey species of either gartersnake and that are now listed under the Act.

Comment 9: Brown trout are highly predacious and should be considered as harmful nonnative wildlife by the Service.

Our Response: We have reevaluated potential effects of brown trout predation on native aquatic vertebrates and concur that brown trout are highly predatory in all size classes and in a wide range of water temperatures. Thus, we have identified the brown trout as a ''predatory'' nonnative fish species and discuss its ecological significance in the final rule in the subsection ''Fish'' within the subheading ''Decline of the Gartersnake Prey Base.''

Comment 10: In the proposed rule, the Service identified several streams in Arizona or New Mexico where nonnative fish present management issues. However, nonnative fish are a concern for management of native fish throughout Arizona and New Mexico, not only those streams specifically mentioned. They are an issue where they already are present and in those habitats where they may invade or be introduced in the future, which included virtually any watercourse or body of water throughout the region.

Our Response: We added language to reflect this fact in the subsection ''Fish'' within the subheading ''Decline of the Gartersnake Prey Base.''

Comment 11: With respect to potential effects from fisheries management activities, it would appear that gartersnakes still occur in many of the streams that have received piscicide treatments. If so, why are these streams and their renovation history discussed in the proposed rule because there is no evidence that chemical treatment in any of these instances eliminated, depleted, or otherwise impacted a resident gartersnake population. The loss of a major portion, or entire, prey base of a gartersnake population will result in the loss of individuals from starvation, which is expected to result in weakened population viability and, potentially, the loss of that population depending on the presence of other stressors, the proximity of the next-closest source population, and the status of the population prior to treatment.

Our Response: If the intent of a renovation is to remove all fish from a stream, and the stream is occupied by either gartersnake, which wholly or partially requires fish in their prey base, the logical conclusion is that adverse effects to gartersnakes, at least temporarily, are likely under these circumstances. The presence of either gartersnake in a treated stream after the treatment is not evidence that no adverse effects to individuals have occurred.

Comment 12: Traditionally, pre-treatment salvage and post-treatment restocking favor larger-bodied size classes of native fish, which could reproduce and provide smaller prey for gartersnakes over a period of time. Small-bodied species would also be saved for salvage and restocking, but are more difficult to find. How are the interests of the gartersnakes rectified in these situations? Alternatively, gartersnakes themselves could be salvaged and restocked at a later date after a prey base has been established.

Our Response: We agree that fish salvage operations, prior to treatment, are likely to favor larger individuals that may exceed the size classes most preferred by gartersnakes as prey. For this reason, we intend to explore partnerships and opportunities for raising native fish of appropriate size classes in hatchery settings for subsequent release into treated streams, post treatment. Based upon our evaluation of the literature and cooperative work with gartersnakes, alternative prey species and appropriate size classes are well-understood. We are not, however, aware of any studies that focused on how long a gartersnake could go without food before physiological stress or starvation. We do know that, compared to snakes within other genera or families, gartersnakes have a relatively fast metabolism and are active foragers, implying that physiological stress or starvation may be more of a concern in the absence of prey.

There are significant challenges with salvaging gartersnakes for long-term captivity. First, facilities with the space, equipment, and knowledge to care for larger numbers of gartersnakes for long periods of time are very few, and currently those that are capable, are nearly at full capacity because of their involvement with captive breeding efforts. Second, narrow-headed gartersnakes have proven to be difficult to maintain in captivity due to their unique physiological and prey requirements. Lastly, it may prove difficult if not impossible to salvage gartersnakes from low-density populations within complex habitat and therefore the risk of their complete extirpation from a renovation activity is elevated. In the event an isolated population is extirpated, the risk of forever losing their unique genetic lineage is also elevated and unacceptable.

Comment 13: The discussion about electrofishing impacts to gartersnakes is misleading and misinformed. The statement that ''gartersnakes present within the water are often temporarily paralyzed from electrical impulses intended for fish'' is true only to the extent that the gartersnake actually is present and available to intercept the electrical current. Personal experience and interviews with colleagues suggest that encounters of electroshockers and gartersnakes are exceptionally rare, not ''often'' as suggested by the Service. Next, use of the term ''electrocution'' is inappropriate as it by definition means killing, which is not only rare for electroshocked fishes, but unknown for gartersnakes.

Our Response: The statement in the proposed rule, ''gartersnakes present within the water are often temporarily paralyzed from electrical impulses intended for fish'' was intended to mean that gartersnakes had to be present in the water and within the affected radius of the electroshocker, otherwise the assumption is they would not be affected and thus, not detected. By use of the term ''electrocuted,'' it was not our intention to imply that gartersnakes which received an electrical charge were mortally wounded. We have removed the use of this term from the final rule. ''Detections'' as cited in the document are not ''electrocutions.'' Reports of gartersnakes detected during electrofishing may be misleading because it is unclear if those attributed to Hellekson (2012, pers. comm.) were during surveys for fishes or for reptiles and amphibians, while detections reported by Pettinger and Yori (2011) apparently were during surveys for Chiricahua leopard frog and not for fishes. Lastly, the references cited where gartersnakes were detected via electroshocking referred to fisheries surveys; electroshocking is not a recognized method for aquatic herpetofauna surveys. We amended the text in this final rule under the heading ''Risks to Gartersnakes from Fisheries Management Activities,'' subheading ''Mechanical Methods'' to better communicate our assessment of the potential effect of electrofishing surveys on gartersnakes.

Comment 14: The term ''self-baiting'' is rarely if ever used by fisheries professionals in reference to wire minnow traps.

Our Response: We used the term ''self-baiting'' with respect to how these types of mechanical traps work for gartersnake surveys, which is indeed through the function of self-baiting with minnows, amphibian larvae, etc. However, the term's use in discussing the use of these traps for fisheries surveys was inaccurate, and the term has been removed from the sentence where it was used in the proposed rule.

Comment 15: The proposed rule provides two references documenting examples of gartersnakes that drowned in wire minnow traps. One reported from Holycross *et al.* (2006) and the other from Boyarski (2011). Holycross *et al.* (2006) never mentions the word ''drown'' in their report. It is also noted that these few minnow-trap related fatalities occurred during surveys specifically to capture gartersnakes, that is, the investigators were targeting gartersnakes with this effort. The inadvertent capture of a gartersnake is an exceptionally rare occurrence and has not been reported from fisheries survey activities.

Our Response: The reference of Holycross *et al.* (2006) describes the flooding event, but not the death of an individual gartersnake, which was incidentally killed in a trap when flooding occurred (observed by Service biologists). We discuss the potential threat of gartersnake fatality from minnow traps used in fishery surveys because the threat is real. Gartersnakes will forage at any position within the water column; northern Mexican gartersnakes often forage at the water surface and in intermediate depths, while the narrow-headed gartersnake forages most frequently along the bottom. The fact that minnow traps for fishery surveys are generally set overnight and checked at least twice daily, and always during morning does not alleviate this threat. The reason that minnow traps used for gartersnake surveys are set at the surface with half of the trap above the water line is to prevent drowning of captured gartersnakes. When used for fisheries purposes, these traps incidentally self-bait with gartersnake prey species (the intended purpose is to capture fish) and are set below the water line. Checking the traps a few times daily will not prevent air-breathing, nontarget organisms from drowning if captured. We also note that both gartersnake species can be active at night, but are not certain their activity includes foraging. We did not intend to portray that the incidental capture of gartersnakes by minnow-trapping for fishery surveys happens frequently, but where it could incidentally result in the loss of one or more reproductive females in low population densities, a population-level effect could result. Lastly, we clarified in the final rule that funnel traps are not used in fishery surveys.

Comment 16: Relative to fisheries management activities, it cannot be stressed enough that there currently is no effective strategy to eliminate harmful nonnative fishes other than use of piscicides and their use is critical for native fish recovery. It should also be noted that fisheries activities effects are trivial compared to those attributed to herpetological activities and other human factors.

Our Response: We concur that chemical renovations are vital to native fish recovery. To further clarify the vital importance of piscicide use in the recovery of the gartersnakes' native prey base and the gartersnakes themselves, we amended the passage in the final rule under the heading ''Risks to Gartersnakes from Fisheries Management Activities,'' subheading ''Piscicides.''

We are confident that the discussion in the proposed and final rules attributed to the potential threats to these gartersnakes from the implementation of fishery management activities is objective, thoroughly referenced, and balanced. We agree that other human-caused threats can pose comparably greater risks to gartersnakes. But, we disagree with the notion that incidental fatality from herpetological surveys are potentially more significant than activities that eliminate an entire suite of prey species from habitat occupied by gartersnakes. We also stress that listing these two gartersnakes should not be construed as an obstacle to native fish recovery under any circumstances. Rather, the recovery of these gartersnakes is inextricably and ecologically linked to native fish recovery.

Comment 17: How many stock tanks are known within the range of northern Mexican gartersnake and what proportion of these meet criteria for being ''well-managed?'' Few stock tanks are well-managed, and most lack peripheral vegetation that would function as suitable habitat for gartersnakes. The Service provides no information to address these questions, which is necessary to evaluate the actual or potential contribution of stock tanks to gartersnake conservation.

Our Response: The actual number of stock tanks that occur within the distribution of the northern Mexican gartersnake is not currently known because not all tanks are georeferenced in GIS databases. However, based upon their common occurrence on the landscape, we conclude that the number is very large, possibly in the 100's. We also have no quantitative data on the number of tanks that are ''well-managed.'' Regardless, based upon our collective knowledge of how these habitats are used by northern Mexican gartersnakes and primary prey species, particularly in southern Arizona, we consider their existence as a vital contribution to conservation of the northern Mexican gartersnake. Based on our knowledge of habitat variables that best predict whether a gartersnake population could be sustained, the presence of a native prey community and the absence of harmful nonnative species appear to be the most predictive factors. Peripheral vegetation may provide cover for gartersnakes in stock tanks where harmful nonnatives occur, but it is not necessary for gartersnake populations in all circumstances. It may be possible that stock tanks have replaced, in part, the role of natural cienegas as important gartersnake habitat, although no direct study has been attributed to this hypothesis. While stock tanks in different drainages can be invaded by bullfrogs or crayfish by means of natural dispersal, they can also represent easily managed habitat to protect against (or rectify) invasion of harmful nonnative species. For these reasons, we currently value the existence of stock tanks for northern Mexican gartersnake conservation.

Comment 18: Mine spills are a threat to gartersnakes and to their fish prey. For example, mine spills made the San Pedro River toxic for a time, and a naturally occurring population of endangered Gila topminnow in Cocio Wash, Arizona, was exterminated by a mine spill. Numerous other examples of this threat are available and should be included.

Our Response: We expanded our discussion of the threat of mining pollution under the heading ''Environmental Contaminants,'' to include the example from the San Pedro River.

Comment 19: Regarding the discussion about management emphasis relative to native and nonnative fishes, it should be acknowledged that, at least in Arizona, the management priority is recreational fisheries, and the operative AGFD's policy is ''no net loss'' of sport fishing opportunities when attempting to balance sport fish and native fish management. It is well documented by literature cited in the proposed rule that native fishes and nonnative fishes cannot coexist in the long term other than under exceptional circumstances.

Our Response: We understand the concern for the future of native fish and by extension, northern Mexican and narrow-headed gartersnakes. We included discussion of the ''no net loss'' policy in the final rule under the heading ''Current Conservation of Northern Mexican and Narrow-headed Gartersnakes.''

Comment 20: The Service used the presence of a native prey species as evidence that a given area or stream may be occupied by northern Mexican gartersnakes. This approach seems optimistic at best, and perhaps, when the importance of habitat is also considered, not scientifically justified. If native prey species are present, but the habitat extent is too small, it is possible that northern Mexican gartersnakes did not occur or will not persist.

Our Response: In determining whether historically occupied habitat remains occupied, we considered habitat surrogates in the determination where gartersnake survey data was limited. Native prey species remain an important attribute for northern Mexican gartersnake habitat and their presence in an area is evidence that the resident, native biotic community may still offer native prey. It is also reasonable to assume that not every site along a stream course is suitable habitat for northern Mexican gartersnakes; these sites may be occupied by dispersing individuals, however. We think that using these habitat parameters as surrogates for occupied areas by the northern Mexican gartersnake is an appropriate use of the best available information, in the absence of more detailed information.

Comment 21: We have recently surveyed and trapped Little Ash Creek (August 2013); it has abundant nonnative fish species and crayfish, scarce native dace populations, and very few (n = 1 captured) bullfrogs. The habitat extent (creek size) is small and we suspect it no longer supports northern Mexican gartersnakes so the population is likely extirpated.

Our Response: We appreciate the updated information. However, the continued presence of some native fish and limited bullfrog detections are signs that northern Mexican gartersnakes could still exist, albeit at low or very low abundance, in Little Ash Creek. Moreover, individual gartersnakes could disperse from the Agua Fria River, to which Little Ash Creek is a tributary. We have not yet officially adopted a protocol to establish population extirpation, but at a minimum, we expect such a protocol should include robust survey data from multiple consecutive years to account for detectability constraints in low-density populations. Until such a protocol is adopted, we hesitate to conclude that gartersnakes are extirpated from a given area, such as Little Ash Creek.

Comment 22: Additional sites not encompassed by Table 1 include: Tavasci Marsh (Nowak *et al.* 2011; population possibly not viable but likely supported by recruitment from the Verde River); Peck's Lake (Schmidt *et al.* 2005; population possibly not viable but likely supported by recruitment from the Verde River), and Dead Horse Ranch State Park (Emmons and Nowak 2013; population likely viable).

Our Response: We are aware of these populations and included them with the Verde River mainstem due to their close proximity.

Comment 23: The proposed rule cites Rosen and Schwalbe (1988, pp. 34–35) for a list of plant species associations for narrow-headed gartersnake habitat. Reliance on a single citation (whose results were based on visual encounter surveys) to infer distribution-wide habitat use is inappropriate. Please include intensive study data from Nowak and Santana-Bendix (2002) and Nowak (2006) for a more complete look at narrow-headed gartersnake–plant associations.

Our Response: Rosen and Schwalbe (1988, entire) sampled narrow-headed gartersnake populations in a multitude of streams across their range in Arizona and, therefore, represent a more comprehensive list of plant species associations in a rangewide context. Nowak and Santana-Bendix (2002) and Nowak (2006) focus solely on one population at Oak Creek and, therefore, do not account for variability of preferred habitat across the species' range.

Comment 24: The Service stated that sexual maturity in narrow-headed gartersnakes occurs at 2.5 years of age in males and at 2 years of age in females (Deganhardt *et al.* 1996, p. 328). I suspect this assertion is overstated and scientifically inaccurate, based on field studies and on animals currently maintained in captivity. Captive-born female narrow-headed gartersnakes from the Black River (Arizona) maintained in captivity did not lay eggs until their third summer, even though they reached adult size within their second year (Nowak, unpublished data, 2012).

Our Response: In the absence of other published data, we will continue to rely on published information regarding the sexual maturity data presented and referenced. In addition, observations made in captive situations may be misleading because they may not reflect factors affecting wild populations.

Comment 25: The proposed rule provided a list of areas where narrow-headed gartersnakes could be reliably found. The Upper Verde River, Tonto Creek, and the Blue River should also be included in this list. While occurring in low densities, individuals in these populations can still be reliably found with minimal to moderate effort (e.g., Upper Verde River: Emmons and Nowak 2012a, Emmons and Nowak 2013; Tonto Creek: Madara-Yagla 2010, 2011; and Blue River: Rosen and Nowak unpubl. data, 2012).

Our Response: The population and survey data reported in Appendix A provide the basis for where narrow-headed gartersnakes are reliably found. Populations considered likely viable have received significantly more field study in most cases and, where they haven't, recent survey data show robust population densities with minimal survey effort. We understand the inherent challenges with defining a population's status with a single phrase or term, but the data do not currently show that narrow-headed gartersnake populations in the Upper Verde, Tonto Creek, or the Blue River are near as robust as those identified as likely viable in Table 2. In the case of Tonto Creek, narrow-headed gartersnake records are comparably few, and Madara-Yagla (2010, 2011) address only northern Mexican gartersnakes. Unpublished data from the Blue River were not provided to us, and until those data are provided and reviewed, we are unable to update the status of that population, if warranted.

Comment 26: If only 8 to 10 percent of historic populations are viable, with significant post-fire concerns for populations from Whitewater Creek and the Black River, should this species be proposed for listing as ''Endangered?''

Our Response: The current status of the northern Mexican and narrow-headed gartersnakes meets the definition of threatened, not endangered. We found that both gartersnakes are not currently in danger of extinction because they remain extant in most of the subbasins where they historically occurred, and known threats have not yet resulted in substantial range reduction or substantial number of population extirpations to put either species on the brink of extinction. However, we do find that the ongoing effects of the threats make both species likely to become endangered in the foreseeable future. Please see the sections entitled ''Determination for Northern Mexican Gartersnakes'' and ''Determination for Narrow-headed Gartersnakes'' for further discussion of our determinations.

Comment 27: Regarding Table 2, state that the population at Saliz Creek, New Mexico is introduced; three recaptured individuals were found there in 2013; however, the population is likely not viable. In addition, I do not know of any post 1990's records from the San Francisco River in New Mexico; this population is ''likely extirpated'' (Hibbitts *et al.* 2009).

Our Response: Saliz Creek is a tributary to the San Francisco River. The San Francisco River formerly had a robust population of narrow-headed gartersnakes. Saliz Creek lies between two additional tributaries to the San Francisco River, Whitewater Creek and the Tularosa River, which historically and currently (respectively) also had robust populations. Saliz Creek also boasts a largely native fish community, with the exception of its lower-most reach. Furthermore, prior to 2012, a total of 10 person-search hours were spent surveying for narrow-headed gartersnakes attributed to Saliz Creek, which does not constitute adequate survey effort to determine presence or absence. No compelling data suggest that narrow-headed gartersnakes never historically occurred in Saliz Creek prior to their release in 2012. Regarding population status in the San Francisco River, more recent survey efforts from 2009–2011, consisting of approximately 100 person-search hours, reconfirmed the narrow-headed gartersnake as extant in the San Francisco River in New Mexico with documentation of three narrow-headed gartersnakes (Hellekson 2012a, pers. comm.). Therefore, we treat this population as likely not viable rather than likely extirpated.

Comment 28: The statement attributed to Rosen *et al.* (2001, p. 22) that the presence and expansion of nonnative predators is the primary cause of decline in northern Mexican gartersnakes and their prey in southeastern Arizona may not have been properly characterized. This paper does not state that nonnative predators are the only factor, but instead it explicitly states the importance of other factors such as climate and interspecific competition. Also, the paper's conclusions are subjective and are generally presented as testable hypotheses, and should be cited with caution rather than presented as scientifically tested facts.

Our Response: We agree that Rosen (2001) did not state that nonnative species are the only reason for northern Mexican gartersnake declines in southern Arizona, rather harmful nonnatives were considered as the primary cause at most sites surveyed, as described in the proposed rule. Rosen (2001, p. 21) postulated that ''natural climatic fluctuation'' may be responsible for a northern Mexican population decline at one site in southern Arizona, which is not to say that it was regarded in equal value as harmful nonnative species in affecting northern Mexican gartersnakes in southern Arizona. Interspecific competition was also discussed in Rosen (2001) as a cause for concern at some sites. We evaluated the role of climate change and interspecific competition in other sections of the proposed and final rules as their discussion is not appropriately placed in the section referred to here. However, we changed the word ''concluded'' in this sentence to ''hypothesized.''

Comment 29: The proposed rule discusses the importance of a varied prey base and cites a study that experimented with food deprivation on the common gartersnake (*T. sirtalis*). There is no scientifically valid reason to conclude that a varied diet could not include bullfrogs as a replacement for native leopard frogs, especially where bullfrogs are currently abundant. It may not be scientifically valid to infer that foraging, physiological, and behavioral data collected from the common gartersnakes will be representative of the populations of southwestern gartersnakes. As such, I disagree that the common gartersnake is an ''ecologically similar species'' to northern Mexican gartersnake.

Our Response: We state on several occasions in the proposed rule that larval and sub-adult bullfrogs are eaten by northern Mexican gartersnakes in the mid- to larger-size classes. However, bullfrogs are not always available for gartersnake populations that exist where native ranid frogs have disappeared, and bullfrogs pose a significant threat to population recruitment of northern Mexican gartersnakes in many areas. This impact outweighs any benefit of their existence as a source of prey. We consider relevant data from the common gartersnake as valid for a general biology discussion as both species have a varied prey base and both species occupy varied habitats, albeit the northern Mexican gartersnake may be more aquatic.

Comment 30: In the discussion of the role of harmful nonnative species relative to other threats implicated in the decline of native fisheries, the proposed rule stated, ''Aquatic habitat destruction and modification is often considered a leading cause for the decline in native fish in the southwestern United States. However, Marsh and Pacey (2005, p. 60) predict that despite the significant physical alteration of aquatic habitat in the southwest, native fish species could not only complete all of their life functions but could flourish in these altered environments, but for the presence of (harmful) nonnative fish species, as supported by a 'substantial and growing body of evidence derived from case studies.''

I would like to see a more robust consideration, including citations beyond March and Pacey (2005), of the importance of the loss of habitat in native fish declines relative to harmful nonnative species. It is my understanding that many species of native fish rely on seasonal flooding to induce spawning.

Our Response: We agree that the role of a natural flood regime is extremely important to the maintenance of native fish populations as well as important in (temporarily) depressing resident harmful nonnative fish populations, and the proposed rule provides a thorough review of this topic, citing numerous references. Natural flood regimes have largely disappeared from several large perennial mainstem rivers and from a small number of streams associated with small reservoirs in Arizona and New Mexico. However, many native fish are doing markedly poorly across their ranges where they co-occur with harmful nonnative fish species, regardless of whether a natural flood regime exists or not. No other threat is as geographically ubiquitous as that from harmful nonnative species, which is clearly reflected, in robust fashion, within the published literature. The proposed and final rules review how threats to aquatic habitat that are not directly associated with nonnative species have also resulted, in part, in the decline of numerous native fish species in the United States and Mexico. Based on our consultations with native fish experts in private and public sectors and the breadth of available literature, the findings of Marsh and Pacey (2005) are consistent on the scope and magnitude of the effect of harmful nonnative fish on the decline of native fish species.

Comment 31: In the discussion of the effects of bullfrogs on gartersnake populations, the proposed rule states that bullfrogs may lower recruitment and lead to population declines of northern Mexican gartersnake populations. This is an over-generalization and is not supported by scientific data across the range of the species. In addition, the conclusion that bullfrogs more effectively prey on young age classes is likely true but has not been substantiated by experimental studies. This statement does not accurately reflect the situation in the Verde Valley (AZ), where all age classes of northern Mexican gartersnakes are well-documented to co-occur with bullfrogs. Low recruitment could be due to a number of factors other than nonnative species predation.

Our Response: The scientific community is in consensus, and we agree, that bullfrogs negatively affect recruitment of northern Mexican gartersnakes in areas where gartersnakes occur with bullfrogs in high densities. The presence of other harmful nonnatives or other possible threats can confound our understanding of the specific effects of bullfrogs, and we presented an extensive discussion of this issue citing numerous scientific references. We believe our treatment of the ecological effects of bullfrogs on northern Mexican gartersnakes is well supported by the best available scientific information. It is true that published examples of this concern come from gartersnake populations in southern Arizona, and we agree that any gartersnake population could face a unique array of potential threats that could also effect successful recruitment across its distribution.

Comment 32: Given that northern Mexican gartersnakes have been documented to prey on bullfrogs in multiple locations, it is misleading and scientifically inaccurate to imply that the recovery of northern Mexican gartersnakes is dependent on recovery of native leopard frogs.

Our Response: We agree that bullfrogs in their larval and subadult age classes can be prey for northern Mexican gartersnakes and, in some populations, may be their primary prey items. However, unlike native leopard frogs, bullfrogs in their adult age class become a significant threat to resident northern Mexican gartersnake populations and can depress or eliminate recruitment of young snakes into the reproductive age classes within a population. Adult bullfrogs can extirpate a population of northern Mexican gartersnakes by directly preying upon snakes and out-competing them for available prey. Bullfrogs can also prevent the recolonization of an area by dispersing gartersnakes via these same ecological mechanisms. The view that bullfrogs are an adequate substitute for native leopard frogs in the ecosystems of the northern Mexican gartersnake is not supported by the best available scientific information and, therefore, we do not support this supposition.

Comment 33: Regarding the incidence of tail injuries in gartersnake populations, observations of this phenomenon in upper Oak Creek, Arizona, at sites where crayfish and bullfrogs are absent, seem to point to fish or bird predation attempts, given wide oval injury marks with pointed ends.

Our Response: We noted in the final rule under the heading ‘‘The Effects of Predation-Related Injuries to Gartersnakes’’ that tail injuries could be caused by other predators other than strictly bullfrogs or crayfish.

Comment 34: A more quantitative evaluation on habitat loss to dewatering would be worth sharing, assuming any is available. Extensive dry reaches in the San Francisco River now exist, including locations that have historic records for the narrow-headed gartersnake.

Our Response: We agree that a quantitative evaluation of dewatered stream habitat would be important to fully characterize this threat. However, we were unable to locate georeferenced data to assist in this effort and had to rely on existing literature to describe this threat.

Comment 35: The adverse effects of crayfish on narrow-headed gartersnakes may be overstated, at least with respect to New Mexico. A clear connection between crayfish presence and declining narrow-headed gartersnake populations has yet to be definitely made in field study. The two sites with the highest apparent densities of narrow-headed gartersnakes in New Mexico also have fairly abundant crayfish and bullfrogs. When small- to medium-sized native fish are abundant, crayfish seem to be tolerated by the gartersnakes. In New Mexico very few sites have crayfish that can reach sizes where they would be a potential predator on narrow-headed gartersnakes; in virtually all other sites, the crayfish are uniformly small in size due to periodic years with flooding that extirpates them or drastically lowers their numbers.

Our Response: We added discussion under ‘‘Effects of Crayfish on Native Aquatic Communities’’ to reflect extraneous influences on the threat of crayfish to gartersnake populations while noting that the available literature strongly suggests that crayfish in larger size classes or in high densities are cause for significant concern for gartersnakes and their prey species, especially with other threats simultaneously affecting gartersnake populations.

Comment 36: The Middle Fork Gila River, Little Creek, and South Fork Negrito Creek populations of narrow-headed gartersnakes were identified as likely having been impacted by the 2012 Whitewater-Baldy Complex fire and considered as not likely viable. Post-fire condition data were largely not available in 2012, but information from 2013 indicated that fish populations were showing signs of recovery.

Our Response: Based on the potentially significant effects of wildfire on fish populations and, therefore, on the narrow-headed gartersnake (detailed in the proposed and final rules), we conservatively assessed these narrow-headed gartersnake populations as likely not viable, given the size and scope of the Whitewater-Baldy Complex Fire. We were also involved with narrow-headed gartersnake salvage operations from the Middle Fork Gila River, strictly because it was assessed to have been heavily impacted by wildfire. We treat Appendix A as a ‘‘living’’ document and can update the status of gartersnake populations as necessary and as population data become available, for sharing and conservation and recovery planning purposes.

Comment 37: Narrow-headed gartersnakes in the mainstem San Francisco River are reliably detected, and the population should be considered as likely viable.

Our Response: Gartersnake captures per unit effort have significantly declined in the San Francisco River since they first became regularly monitored in the 1980’s. While individuals are still detected, population data we present in Appendix A clearly describe the narrow-headed gartersnake population in the San Francisco River as one in significant decline.

Federal Agency Comments

Comment 38: The proposed rule references the Management Indicator Species, Regional Foresters' Sensitive Species List, and land management decisions, but states that there are no specific protective measures conveyed to these species. However, the northern Mexican and the narrow-headed gartersnakes have been considered sensitive species on the Regional Forester's sensitive species list for a long time. An impact to these species is, therefore, considered as part of the environmental analysis for every forest management action. The USFS Sensitive Species Policy is to manage for viable populations of these species. Further, the USFS policy for sensitive species provides protective measures such as direction to ''Avoid or minimize impacts to species whose viability has been identified as a concern'' (Forest Service Manual (FSM) 2670.32 #3). A decision that would impact sensitive species ''. . . must not result in loss of species viability or create significant trends toward Federal listing'' (FSM 2670.32 #4).

Our Response: We more accurately summarized what protections are afforded to ''sensitive species'' in the final rule. We found no examples (although we did not have the opportunity to review all previous planning documents the USFS has developed in the past), and we were not provided any examples of measures that have been implemented by the USFS to ''avoid or minimize impacts'' to either the northern Mexican or narrow-headed gartersnake. We look forward to working with the USFS in developing such measures.

Comment 39: What is the basis for assuming there is ''continued anxiety'' from the public regarding rotenone use?

Our Response: We have been an active participant in the public debate over potential threats to human health from rotenone use. The new and very process-rich procedures now in place for planning and implementing rotenone use in Arizona are testament that piscicide use in the recovery of rare and listed fish is still considered controversial; although it is scientifically well-supported that there is no public harm from its use.

Comment 40: We disagree that, on the Gila National Forest, heavy recreation use within occupied narrow-headed gartersnake habitat is thought to impact populations along the Middle Fork Gila River, mainstem Gila River between Cliff Dwellings and Little Creek, and Whitewater Creek from Catwalk to Glenwood. Recreation use along the Middle Fork Gila River is certainly not heavy; most use is by hikers and backpackers utilizing the existing trail to access the Gila Wilderness. The stream between the Cliff Dwellings and Little Creek is the West Fork Gila River not the mainstem. This reach of stream is located on National Park Service, NMDGF, and USFS lands. The majority of this reach is on the NMDGF's Heart Bar Wildlife Area. Whitewater Creek from the Catwalk to Glenwood is predominately private property. Approximately 0.25 mile of stream, downstream of the Catwalk, is USFS lands and the remainder of this reach is private property.

Our Response: We amended this discussion in the final rule to state that much of the recreation use in these areas is related to hiking and backpacking, which are generally not considered a threat to gartersnakes outside of the fact that increased human visitation leads to more gartersnake encounters and potentially more killing of gartersnakes where the foot trail is near the canyon bottom.

Comment 41: Throughout the proposed rule and during personal communications with the Service, livestock grazing has not been identified as a significant threat to these species. However, the Service appears to be saying that, unless livestock are excluded by fencing, adverse effects may occur. The Service goes further by stating that the adverse effects of livestock are somehow most likely to occur when nonnative species are present but that the species are resilient to these disturbances if nonnatives are absent. So, grazing along a stream adversely affects the species if nonnatives are present but does not have these same impacts if nonnatives are absent?

Our Response: We continue to believe that livestock grazing is largely compatible with northern Mexican and narrow-headed gartersnakes based on the species' apparent resiliency to perturbations to their physical habitat, depending on the resident aquatic community. In our literature review and field experience, we found populations of these gartersnakes to be resilient to activities that affect their physical habitat (vegetation abundance, structure, composition) when harmful nonnative species are absent or at low levels that allow for effective recruitment of snakes in the population. When recruitment of gartersnakes within a population is hampered by harmful nonnatives, this resiliency is diminished and the presence of adequate vegetation cover for protection against these nonnatives becomes more important. When Federal actions are planned, all aspects of project evaluations should consider potential effects to whatever prey base the gartersnake population is using in a given area. This idea should be the logical ''framework'' used in developing projects in gartersnake habitat to manage aggressively against harmful nonnatives to improve population resiliency and recruitment of gartersnakes. We also note that ''adverse effects'' can have varying degrees of magnitude and scope and that, through section 7 of the Act, most activities that could adversely affect species include measures to reduce effects and potential for take though the issuance of an incidental take permit.

Comment 42: While nonnative, spiny-rayed fish such as green sunfish and smallmouth bass were common in the lower reach of Turkey Creek near its confluence with the mainstem Gila River prior to the Dry Lakes Fire, they did not make up the majority of the fish community. More upstream reaches were occupied by native fishes including Gila chub, speckled dace, Sonora and desert suckers, and longfin dace along with Gila X Rainbow trout hybrids. All of the native species survived the fire runoff events, and, although populations were depressed for some time, they had recovered well until recent fires.

Our Response: We amended this discussion in the final rule to more accurately describe the fish community and effects of wildfire on Turkey Creek.

Comment 43: We disagree that significant threats to these gartersnakes, such as those related to nonnative species, are not addressed on USFS lands. The role of the USFS is to manage land, addressing the needs of species' habitat. Management actions related to nonnative fish and aquatic species stocking, control, or eradication is under direction of the State. Collaborative efforts are occurring on USFS lands to improve species' habitat through construction of fish barriers and stream chemical renovations.

Our Response: We acknowledge the proactive measures taken by the USFS to assist in restoring fish communities to wholly native assemblages.

Comment 44: The proposed rule states that USFS management policies of the past favored fire suppression. However, new policies have allowed for managing wildfires that have a resource benefit, as well as prescribed fire. The Guidance for Implementation of Federal Wildland Fire Management Policy is the Department of Agriculture's single cohesive Federal fire policy. This policy contributes to landscape restoration, controls invasive species, reduces uncharacteristic wildfire across the broader landscape, and improves the resiliency of these potential natural vegetation types to adapt to climate change.

Our Response: We have updated this discussion under the heading, ''High-Intensity Wildfires and Sedimentation of Aquatic Habitat'' in the final rule to include reference to the updated fire policy and what it hopes to achieve in the mid to long term.

Comment 45: The proposed rule states that the 2011 Wallow Fire impacted 97 percent of perennial streams in the Black River subbasin and 70 percent of perennial streams in the Gila River subbasin. We request the Service clarify how they are defining a subbasin. Typically, a subbasin is a fourth code Hydrologic Unit. We do not consider the Wallow Fire to have affected any of the Gila River subbasins in New Mexico.

Our Response: We use the term subbasin in a general sense as a stream basin within a larger stream basin. We further defined the area impacted by the 2011 Wallow Fire as within Apache-Sitgreaves National Forest, White Mountain Apache Indian Tribe, and San Carlos Apache Indian Reservation lands in Apache, Navajo, Graham, and Greenlee counties in Arizona, as well as Catron County, New Mexico. We recommend the review of InciWeb (2011), Meyer (2011; p. 3, Table 1), and Coleman (2011, pp. 2–3) for information on the effects of the 2011 Wallow Fire.

Comment 46: On the Apache-Sitgreaves National Forest forested vegetation types, historic fire-return intervals varied from frequent, low-intensity surface fires in ponderosa pine types (every 2–17 years), to mixed-severity fires in wet mixed-conifer forests (every 35–50 years), to high-severity, stand-replacement fires of the spruce-fir ecosystems (every 150–400 years).

Our Response: We included these fire-return interval data under the heading, ''High-Intensity Wildfires and Sedimentation of Aquatic Habitat'' in the final rule.

Comments From States

Comment 47: The AGFD recognizes that both species have declined considerably throughout their respective ranges in Arizona, and acknowledge that listing under the Act is warranted. We also applaud the Service's decision to propose a 4(d) rule that would exempt take of northern Mexican gartersnakes as a result of livestock use at or maintenance of livestock tanks located on non-federal lands. We also encourage the Service to continue to work closely with the AGFD to effect meaningful conservation actions for both species.

Our Response: We agree, and we look forward to continued coordination with the AGFD in addressing the most serious threats that affect either species and to exploring opportunities for recovery with Federal, State, and local partners and stakeholders.

Comment 48: The statement that ''The decline of the northern Mexican gartersnake is primarily the result of predation by and competition with harmful nonnative species . . .'' should be modified to reflect that this is a leading theory, but not necessarily true.

Our Response: We think that harmful nonnative species (bullfrogs, crayfish, and warm-water, predatory fish) are the primary driving factors behind the decline of the northern Mexican and narrow-headed gartersnake. In the proposed and final rules to list these gartersnakes, we reviewed the best available scientific and commercial information to reach this conclusion. We do acknowledge that other threats such as climate change-induced drought, dewatering of habitat, large-scale wildfires, and others may have also significantly contributed to the decline of these gartersnakes, often in synergistic fashion with other threats affecting primary prey species. We also acknowledge that some populations of northern Mexican gartersnakes in particular, have persisted in the presence of harmful nonnative species to which further study is under way. However, these ecological situations are rare within the distribution of these gartersnakes, as evidenced by widespread population declines, and they should not be construed as evidence that either gartersnake is ecologically compatible with harmful nonnative species in the long term. Rather, the scientific information is convincing that harmful nonnative species are largely responsible for the declines in these gartersnakes.

Comment 49: Reducing the status of the species at each historical locality as either ''likely viable,'' ''likely not viable,'' or ''likely extirpated'' as described in tables 1 and 2 may not accurately capture the status of gartersnake populations. Perhaps an ''Unknown'' category would have been useful. Also, a low-density population does not always indicate that the population is not viable.

Our Response: We agree that adequately describing the status of each population at each historic locality as falling into one of three categories is challenging. However, the general lack of data on many populations does not allow us to refine these categories further. In most cases, we have more information on the presence of threats at each locality than good information on the resident gartersnake population. It was our interpretation that, in the presence of known, and in some cases severe, threats that a low-density population is, at a minimum, at risk of losing viability, most notably from effects to reproduction and recruitment such as in the presence of harmful nonnative species.

Additionally, the process of designating critical habitat requires us to create a rule set for determining whether the species is present or not in each historic locality, therefore, a category called ''Unknown'' is not appropriate. Appendix A provides background information that contributed to our site-by-site determinations of population status.

Comment 50: We caution against using percentages to express possible population extirpations or shifts to low densities because unrealistic expectations of recovery can be established.

Our Response: We use percentages in this listing rule and others to capture the rangewide context of the status of a given species' populations to allow the public a coarse, quantitative assessment of the perceived status of a species, given the best available scientific and commercial data.

Comment 51: We suggest removing the word ''harmful'' when referring to the suite of nonnative species that have been identified as the most incompatible with the gartersnakes. While they may be incompatible, they are not harmful in a general context.

Our Response: We use the adjective ''harmful'' to distinguish those nonnative species that pose unique ecological risks to sustaining wild populations of northern Mexican and narrow-headed gartersnakes and their prey species. We consider bullfrogs, crayfish, and warm-water, predatory sport fish as ''harmful nonnative species.'' This distinction is based on the predatory, or otherwise, notably adverse interactions these species have with the gartersnakes and their prey. This distinction is important because not all nonnative species are completely incompatible with gartersnakes, and some are used as prey for wild gartersnake populations; nonnative trout are an example.

Comment 52: There are no direct data to prove that declines in native leopard frogs have contributed to declines in northern Mexican gartersnake populations. The Service should caveat the statement with a degree of uncertainty.

Our Response: We specifically used the word ''contributed'' to acknowledge that leopard frog declines are a contributing factor to northern Mexican gartersnake declines, not the sole factor. As noted by the AGFD, leopard frogs are an extremely important component to the northern Mexican gartersnake's prey base—a fact also accepted within the scientific community and demonstrated in field study.

Comment 53: Potential risks to gartersnake populations from fisheries management activities were mischaracterized in the proposed rule. Potential effects to gartersnakes are evaluated by the AGFD though an Environmental Assessment Checklist process.

Our Response: In our evaluation of how fisheries management activities could adversely affect gartersnake populations, we reviewed procedures specific to fisheries management as provided in adopted protocols. The Environmental Assessment Checklist process is a parallel, internal process implemented by the AGFD in planning exercises that applies to multiple types of management activities considered by the State. We have added discussion of this process to the final rule under the heading ''Risks to Gartersnakes from Fisheries Management Activities'' and appreciate that potential effects to these gartersnakes (or any nontarget species) are fully evaluated prior to implementing any activity within occupied or designated critical habitat for the gartersnakes.

Comment 54: In Arizona, the trapping and subsequent use of baitfish in angling is generally constrained to areas where sport fish and sport fishing dominate, and, therefore, there is little chance the activity would affect gartersnakes. In addition, regulations specify that bait fish must be used at the point of capture and not transported elsewhere for use.

Our Response: We agree that, where angling activities are concentrated, it is likely due to the presence of sport fish and in the case where warm-water, predatory fish species are present, it is less likely that northern Mexican or narrow-headed gartersnakes are immediately present. However, there are a few areas where angling is concentrated in habitat that could be occupied by either or both gartersnake species such as Oak Creek, the Verde River, Tonto Creek, or Parker Canyon Lake in Arizona where it is possible that effects to resident gartersnakes could occur. Regardless, we included a statement in this final listing rule that notes that AGFD requires that baitfish must be used where they are captured and appreciate being notified of the regulation and its benefits for gartersnake conservation.

Comment 55: Please elaborate on what is meant by the statement in reference to the rate of Lake Roosevelt water level fluctuation as a benefit to harmful nonnative fish species. Reservoir levels there fluctuate substantially.

Our Response: We agree that water levels in Lake Roosevelt do fluctuate and further qualified the statement on this issue in the final rule. We intended to frame this discussion for comparative purposes. That is to say, that compared to Horseshoe Reservoir, which is managed to minimize reproduction of harmful nonnative species in most years, Lake Roosevelt has several times the capacity of Horseshoe Reservoir and fluctuation in water levels occur at a slower rate. The rate at which water levels decline in these reservoir systems affects the reproduction and recruitment of harmful nonnative fish species; the faster the decline, the more negative the effect.

Comment 56: It is not clear how ''build-out'' (in reference to human population growth and urban development) will affect Redrock Canyon (in the vicinity of Patagonia, Arizona).

Our Response: The discussion in the proposed and final rules where the issue of build-out is addressed refers to the long-term development plan along the major transportation corridors of I–19, I–10, and I–17 in Arizona. We identified extant gartersnake populations that were geographically proximal to these proposed corridors which could experience indirect effects of development and growth in the human population (which is expected to double by 2030). Redrock Canyon is near the Town of Patagonia, which is near Nogales and the I–19 corridor. If predictions for development and human population growth in Arizona are accurate, we expect increased development in the Patagonia area, higher levels of human recreation on public lands, and possible effects to water availability as a result of increased regional groundwater pumping or additional diversions. We acknowledge in the final rule that, of the areas identified where there could be effects to gartersnake populations, Redrock Canyon is buffered geographically more so than other areas identified.

Comment 57: The section of the proposed rule that discusses the Arizona Department of Water Resources Active Management Areas (AMAs) overstates the significance of the AMA designation for both gartersnake species. For example, the Phoenix AMA includes no modern records of either species and will not affect long-term recovery. In another example, the Pima AMA includes only short stretches of the Gila River; the rest of the AMA is outside the range of either gartersnake's distribution.

Our Response: In our evaluation of the effect of groundwater pumping on gartersnake habitat, we found several references that discuss the known hydrological connection between groundwater and surface flow in southwestern streams. This is an established concept in the scientific community and the basis for widespread public concern in several areas of Arizona with respect to surface flows including the Verde and San Pedro Rivers. We explained how overdrafts in groundwater use exceed aquifer recharge (conditions that result in an AMA designation) and result in a cone of depression that can reduce or eliminate surface flows in affected streams. We listed the AMAs that both overlap with the historical range of either gartersnake and provide context for the discussion of effects of increasing human population growth on gartersnake populations through indirect effects of groundwater demands. In doing so, we accurately captured the links in this cause and effect relationship. With respect to the Phoenix AMA, we acknowledge that effects on gartersnake populations are no longer occurring. However, it was our intent to discuss the causes of historical population extirpations, which were a precursor to rangewide declines observed today. Effects of the development of the greater Phoenix metropolitan area include effects from increasing regional demands on groundwater. Aquifer overdrafts were likely contributing factors in the extirpation of northern Mexican gartersnake populations in the lower Salt, lower Gila, and lower Agua Fria River systems.

Comment 58: No scientific evidence has been produced that confirms a relationship between livestock grazing in occupied gartersnake habitat in the presence of harmful nonnative species and that without their presence.

Our Response: We concur that no specific scientific study has been afforded to this specific issue with respect to either the northern Mexican gartersnake or the narrow-headed gartersnake. However, we have documented observations made of gartersnake populations in Mexico in the presence of harmful nonnative species, as well as in their absence, in habitat heavily affected by other land uses such as unmanaged livestock grazing. As discussed at length in the subsection below entitled ''The Relationship between Harmful Nonnative Species and Adverse Effects to Physical Habitat,'' we found a unique opportunity in Mexico to observe populations in habitat significantly compromised by land use activities such as unmanaged livestock grazing where the aquatic community was considered wholly native. Opportunities to observe this scenario in the United States generally do not occur due to applied grazing management prescriptions that largely prohibit extreme effects to riparian habitat, and the fact that harmful nonnative species are largely ubiquitous in habitat occupied by these gartersnakes in the United States. Species experts involved in the Mexico survey effort were in consensus that the most significant predictor of gartersnake occupancy in these affected habitats was the presence or absence of harmful nonnative species. The fact that gartersnakes will use vegetative cover to hide from harmful nonnative species, and the fact that, in the United States, gartersnake populations that currently persist at seemingly adequate densities in the presence of harmful nonnatives also occur in habitat with adequate vegetative cover, provides further support of this relationship. The best available scientific and commercial data, coupled with the opinion of species experts, suggests this relationship is most likely real, and we fully endorse further scientific study of this issue, if that opportunity exists.

Comment 59: In Mexico, the Mexican gartersnake is listed as threatened throughout its range in that country and at the species level of its taxonomy. The discussion of the threatened status of northern Mexican gartersnake, as it applies to this rulemaking, is, therefore, misleading given that there are currently 10 subspecies, and the northern Mexican gartersnake in Mexico occurs in some of the least accessible and least likely disturbed aquatic habitats in the country.

Our Response: In Mexico, the clear majority of the distribution of the Mexican gartersnake (*T. eques*) is composed of the northern Mexican gartersnake (*T. e. megalops*). The Mexican gartersnake (*T. e. eques*) comprises the second highest percentage of the species' distribution along the southwestern quadrant of the species' distribution in Mexico (Rossman *et al.* 1996, p. 173). The remaining eight subspecies have much smaller distributions and in some cases are highly endemic; constrained to perhaps a single lake. In our analysis of the status of northern Mexican gartersnake in Mexico, we made every attempt to analyze only those threats that geographically overlap our understanding of the subspecies' distribution, which supports the position of a weakened status, commensurate with Mexico's listing. We do not disagree that there are likely habitats within its distribution in Mexico that remain largely intact, physically and ecologically. We also note that harmful nonnative species, once introduced into a system, have an ecological advantage over native species and will expand their distribution and, therefore, the scope of their effects on the landscape, much like what has been observed in Arizona for decades. This fact, and the preponderance of scientific and commercial data we evaluated that pertained to threats in Mexico, supports the position taken by the Mexican Government in listing the Mexican gartersnake (*T. eques*) as threatened and is largely applicable to the northern Mexican gartersnake.

Comment 60: We recommend removing the discussion referring to the fact that many of the recovery projects for the Chiricahua leopard frog have not provided direct benefits to the northern Mexican gartersnake. The Service does not provide citations for their statement that indirect benefits for both gartersnake species occur through recovery actions designed for their prey species, and since the Chiricahua leopard frog was listed under the Act, significant strides have been made in its recovery and the mitigation of its known threats.

Our Response: In assessing how recovery activities for currently listed species may benefit either gartersnake, it is important to discuss both the benefits and limitations of these activities on conserving or recovering nontarget species such as the northern Mexican gartersnake. We used reasonable principles in conservation biology in making the basic assertion that either gartersnake may benefit by recovery activities implemented for their native prey species, such as the Chiricahua leopard frog. For example, when harmful nonnative species removal projects are implemented on regional scales, such as for bullfrogs, the predation and competition pressure on gartersnake prey species are reduced, which may lead to significant expansions in prey species distribution or increases in their biomass or population densities. This activity benefits the gartersnakes that use these prey communities. In another example, the construction of a fish barrier to prevent the upstream migration of harmful nonnative fish into a stream provides direct benefits to the resident gartersnake population by reducing predation pressure on the gartersnakes and their prey base. As for the recovery achievements made for the Chiricahua leopard frog, we agree that, in some areas, these activities have benefited the gartersnakes, particularly for the northern Mexican gartersnake where they have occurred in lentic habitat on landscape scales, and specifically in southern Arizona. However, many recovery actions specific to the Chiricahua leopard frog have occurred at specific tanks higher in the watershed, not within the floodplain of larger perennial stream systems, where they would yield much more significant benefits to gartersnake populations.

Comment 61: Maintaining nonnative sport fish populations does not necessarily ''significantly reduce the potential for the conservation and recovery on northern Mexican and narrow-headed gartersnakes.'' The Biological and Conference Opinion issued by the Service that addresses the AGFD's 10-year sport fish stocking program (''sport fish consultation'') includes mitigation measures to ''address the effects of the proposed action and improve the baseline conditions for native aquatic species.''

Our Response: We agree that maintaining nonnative sport fish populations in some areas may have little effect or may even benefit some gartersnake populations. Not all nonnative species have the same ecological effect on native aquatic communities. For this reason, and for the purposes of the greater listing analysis afforded to these two gartersnakes in this rulemaking, we specifically use the phrase ''harmful nonnative species'' when discussing those which significantly threaten the northern Mexican or narrow-headed gartersnake. As previously stated, we consider harmful nonnative species to include bullfrogs, crayfish, and warm-water, predatory fish. The majority of specific stocking activities that were subject to the sport fish consultation involved primarily salmonids (*i.e.,* trout), which we do not consider to be particularly harmful to these gartersnakes or many of their prey species. For example, in some areas, nonnative trout are an important component to the narrow-headed gartersnake prey base. Stocking activities under the sport fish consultation that involved harmful nonnative species were few, were constrained to lentic habitat (lakes, ponds, etc.), and were a significant factor behind the ''likely to adversely affect'' determination made for these gartersnakes and several of their prey species.

Comment 62: In the discussion regarding potential ramifications for gartersnake recovery with respect to watershed-level fisheries management designations, the conclusions that were drawn seem premature. Not all nonnative fishes are considered as, or managed as, sport fish in Arizona, including many of the nonnative fishes that are problematic for gartersnakes.

Our Response: Our intention was not to predict which watersheds or particular streams would likely be designated as nonnative sport fisheries in the future. Rather, we simply acknowledged that surface water is generally scarce in the arid Southwest and large perennial streams, even more so. We assume that some streams currently occupied by the gartersnakes are likely to be designated for nonnative fisheries because of the scarcity of these aquatic systems in Arizona, the existing access infrastructure, and the fish communities that currently reside in larger perennial streams. We are concerned that if large, perennial streams, which are important occupied habitat for northern Mexican and narrow-headed gartersnakes (as well as their prey species), are designated as nonnative sport fisheries in the future, they will be lost to the gartersnakes, which would negatively affect their recovery rangewide. Furthermore, we have a high degree of certainty that if any habitat occupied by either gartersnake is designated strictly as a nonnative fishery (that includes warm-water, predatory species), that habitat will no longer possess the values that are important (or imperative) for species recovery and the value of these areas for recovery will be largely eliminated. Regarding nonnative species that are problematic to gartersnakes and which are not considered sport fish by the AGFD, we look forward to partnering with the AGFD and other public and private stakeholders in the removal of these species where they occur, and view this and similar recovery actions as the highest priority.

Comment 63: The proposed rule discussed at length the issue of declining native fishes and degradation of aquatic systems in Mexico but did so without discussing the status of the northern Mexican gartersnake. This type of argument is an apparent effort to build the case for listing the subspecies throughout its range based on inferred effects of the decline of native fish communities and habitat degradation, despite the fact that clear data for the northern Mexican gartersnake decline are only available for Arizona and New Mexico.

Our Response: We do not have population studies of northern Mexican gartersnakes in Mexico. However, we have used the best scientific and commercial data available. The information shows the status of native aquatic vertebrates in habitat currently or formerly occupied by the northern Mexican gartersnake generally correlate to the status of northern Mexican gartersnakes. We cited examples of how aquatic ecosystems are adversely affected by leading threats, such as dewatering or the expansion of harmful nonnative species, can affect the northern Mexican gartersnake and its native prey species, such as fish. Native fish comprise an important prey source for northern Mexican gartersnakes. Gartersnakes need them for nutrition in order to carry out their life-history functions. We found a significant amount of information that concluded that native fish communities were significantly at risk, as documented by declines of many species in several subbasins across the distribution of the northern Mexican gartersnake in Mexico. Therefore, when a major source of prey for northern Mexican gartersnakes becomes rare or disappears entirely, the gartersnake population will be negatively affected through declines in the fitness of individuals associated with poor nutrition, stress, and starvation. Several different factors that are contributing to the decline in native fish communities include harmful nonnative species, dewatering of habitat, and pollution of habitat. These stressors also negatively affect northern Mexican gartersnake populations both directly and indirectly. Native fish are, therefore, an effective surrogate for use in determining how threats are acting on individual northern Mexican gartersnakes and their populations throughout their distribution in Mexico.

Comment 64: We caution against extrapolation, such as the statement that there has been a 17-fold increase (since 1961) in the number of native fish species in Mexico that have been listed by the Mexican Federal Government as either endangered, facing extinction, under special protection, or likely extinct. The data cited do not speak to the status of these native fish species rangewide.

Our Response: We cited references that discuss the status of native fish in Mexico in our discussion of the status of the northern Mexican gartersnake in Mexico, and we did not imply those trends represented their status rangewide.

Comment 65: The Service identified a number of streams or aquatic communities in Mexico that have been adversely affected by threats such as declining native fisheries, sedimentation from logging, pollution, etc. Yet, our observations often point to the inverse in several headwaters of these identified streams. In other examples, such as the Río Colorado in Sonora, the vicinity of Mexico City, or unnamed streams draining the Sierra Madre, evidence that these areas were occupied by the northern Mexican gartersnake or occur within its distribution was not clearly presented.

Our Response: Much like what has been observed and documented in the southwestern United States, headwater streams are often less impacted than the mainstem rivers they feed. This is often because of the remote nature of these headwaters, which can limit the effect of human-caused threats (watershed-scale effects increase in the downstream direction), as well as the presence of natural or man-made barriers that prevent upstream migration of harmful nonnative species. Therefore, it may not be appropriate to infer that, simply because a headwater system is intact, that the same holds true for the system lower in the watershed. With respect to whether streams identified as being impacted by various threats in Mexico are within the distribution of the northern Mexican gartersnake, the references cited were not presented at a geographic scale fine enough to definitively conclude that a complete overlap with the distribution of the northern Mexican gartersnake exists, but rather a portion of the stream overlaps. In addition, a number of the streams that were called into question by the AGFD occur at the periphery of the subspecies' range in Mexico, which is still not precisely understood by the scientific community. Therefore, we presented the data in a regional context, as evidence that such threats could affect the gartersnake where they overlap.

Regarding whether the northern Mexican gartersnake ever existed in the Río Colorado in Sonora, there are two verified records from the Colorado River at Yuma from 1889 and 1890. We assume the species also occurred downstream into Mexico where suitable habitat historically existed. We also presented data on threats to aquatic habitat in the vicinity of Mexico City. While we agree that this area represents the extreme southern end of the subspecies' distribution, we also acknowledge that threats, particularly harmful nonnative species, can have a larger geographic impact over time. Lastly, we presented information that suggested that threats may be affecting streams that drain the Sierra Madre, which in some cases were not specifically identified by the principal investigators. Considering that the Sierra Madre represents a large portion of the northern Mexican gartersnakes' distribution in Mexico, it was appropriate to include these data in our evaluation in a conservative assumption that many, if not most, of the streams were historically or currently occupied by this subspecies.

Comment 66: The New Mexico Department of Game and Fish encourages an expansion of activities authorized under a special rule under section 4(d) of the Act to exempt landowners from prohibitions of take under section 9 of the Act, for those actions that benefit the two gartersnakes, such as: (1) Enhancement and restoration of native riparian vegetation and stream structure; (2) control of harmful nonnative species, such as American bullfrogs and crayfish; (3) intensive research into the biology of the two species of gartersnake; and (4) continuing research into captive rearing and repatriation of the northern Mexican and narrow-headed gartersnakes.

Our Response: We agree that section 4(d) of the Act can provide important conservation potential in the recovery of these two gartersnakes, and we appreciate the New Mexico Department of Game and Fish's willingness to explore such opportunities. We have included a section 4(d) rule for the northern Mexican gartersnake in this rulemaking, which addresses the management of livestock tanks on non-Federal lands. Of the four special rule possibilities offered by the New Mexico Department of Game and Fish, controlling (removing) harmful nonnative species is most likely to provide the highest conservation benefit for northern Mexican and narrow-headed gartersnakes, and we are interested in looking further into this issue with our cooperators and stakeholders, such as the New Mexico Department of Game and Fish. In order to be most effective, such a 4(d) rule would have to be developed in close coordination with affected agencies, explicitly authorize the removal of bullfrogs, crayfish, and predatory fish species, and include precautions to minimize potential harm to affected gartersnake populations during project implementation. However, at this time, we do not have sufficient information to allow us to adequately confirm whether such a 4(d) rule would be necessary and advisable for the conservation of the species. We can consider such a rule in the future. Permitting authority for research needs is addressed through the issuance of section 10(a)(1)(A) permits. With respect to the enhancement and restoration of native riparian vegetation and stream structure, where water occurs, the vegetative structure is not viewed as limiting for gartersnake occupation in most cases. Where water has been removed from streams by dams, diversions, or groundwater pumping, correcting these scenarios and returning water to the system would be construed as a beneficial effect. For any activity not explicitly addressed in our proposed 4(d) rule that would result in take of either gartersnake, a section 10 permit would be required to avoid a violation of section 9 of the Act.

Tribes

Comment 67: In discussing the potential impacts of dams and reservoirs on resident fish communities, the proposed rule identifies the San Carlos Reservoir as an example of a reservoir that benefits harmful nonnative species and, therefore, negatively affects the northern Mexican and narrow-headed gartersnakes. This statement should be omitted from the final rule for two reasons. First, the proposed rule makes this conclusory adverse effect determination without any support whatsoever. Second, this conclusory determination is unnecessary to establish that the northern Mexican gartersnake or the narrow-headed gartersnake should be designated as threatened. In 1924, Congress enacted the San Carlos Project Act, which authorized the construction of the Coolidge Dam and the creation of the San Carlos Reservoir ''for the purpose . . . of providing water for the irrigation of lands allotted to the Pima Indians on the Gila River Reservation, Arizona.'' A statement in the proposed rule that the San Carlos Reservoir adversely affects northern Mexican and narrow-headed gartersnakes could affect the federally mandated delivery of water to the Gila River Indian Community. Any impediment to the Gila River Indian Community's irrigation system threatens the Gila River Indian Community's agriculture, economy, and most importantly, the survival of its culture, the value of which is immeasurable.

Our Response: In the final rule, we deleted the reference to the San Carlos Reservoir as an example of a reservoir within the range of the gartersnakes that may be benefitting harmful nonnative species, because there are several other examples. USFWS (2008, pp. 112–131) provides a complete scientific analysis of the relationship of reservoirs to resident aquatic communities upstream and downstream, includes many scientific references that have been incorporated by reference in this final rule, and comprises the basis for the issuance of a section 10(a)(1)(B) incidental take permit for the operation of Horseshoe and Bartlett Reservoirs, in that case. We believe the same relationships likely are true at San Carlos Reservoir. We look forward to work with interested parties to identify solutions that meet water use interests and the conservation needs of listed species.

Public Comments

General

Comment 68: Threats to the gartersnakes are those caused by Federal and State fish and wildlife management actions, or on Federal lands that can be dealt with outside of the Act. Approximately 85 percent of the habitat for the northern Mexican gartersnake is in Mexico. In Mexico, any activity that intentionally destroys or adversely modifies occupied northern Mexican gartersnake habitat is prohibited.

Our Response: As stated in the proposed rule, the Act requires us to make listing determinations based on the five threat factors, singly or in combination, as set forth in section 4(a)(1) of the Act. The Act further requires us to make listing determinations solely on the basis of the best scientific and commercial data available after taking into account those efforts, if any, being made by any State or foreign nation, or any political subdivision of a State or foreign nation, to protect such species, whether by predator control, protection of habitat and food supply, or other conservation practices within any area under its jurisdiction. The Act requires us to give consideration to species that have been designated as requiring protection from unrestricted commerce by any foreign nation or pursuant to any international agreement; or identified as in danger of extinction or likely to become so within the foreseeable future, by any State agency or by any agency of a foreign nation that is responsible for the conservation of fish or wildlife or plants.

A number of existing regulations potentially address issues affecting the northern Mexican and narrow-headed gartersnakes and their habitats. However, existing regulations within the range of northern Mexican and narrow-headed gartersnakes typically address only the direct take of individuals without a permit and provide little, if any, protection of gartersnake habitat. Arizona and New Mexico statutes do not provide protection of habitat and ecosystems. Legislation in Mexico prohibits intentional destruction or modification of northern Mexican gartersnake habitat, but neither that, nor prohibitions of take, appear to be adequate to address ongoing threats. See ''The Inadequacy of Existing Regulatory Mechanisms'' in the proposed rule for further information.

Comment 69: There is more recent data on surface activity of northern Mexican gartersnakes than Rosen (1991, pp. 308–309). More recent observations indicate radio-tracked snakes were not surface active 64 percent of the time at Bubbling Ponds and 60 percent of the time at Tavasci Marsh (upper Verde River) and the middle Verde River.

Our Response: We have updated the discussion under ''Habitat and Natural History'' for the northern Mexican gartersnake in this final rule to reflect more recent information, such as the information provided in the comment.

Comment 70: The proposed rule states that the northern Mexican gartersnake appears to be most active during July and August, followed by June and September. Based on recent survey efforts it would probably be most accurate to state that the species appears to be most active between May and September.

Our Response: We have updated the discussion under ''Habitat and Natural History'' for the northern Mexican gartersnake in this final rule to reflect more recent information, such as the information provided in the comment.

Comment 71: The proposed rule so broadly describes the species' physical habitat that it is difficult to determine what types of riparian, wetland, and terrestrial habitats are important to each of the gartersnakes and is conflicting with previous characterizations.

Our Response: The habitat descriptions we provide in the proposed and final rules reflect the current understanding of the types of habitat that are used by either gartersnake species. The descriptions appear broad because these gartersnakes, in particular the northern Mexican gartersnake, can occur in varied ecological settings.

Comment 72: All five of the waters where there are viable populations of Mexican gartersnakes are already protected and do not need further protection under the Act. Oak Creek, Tonto Creek, and the Upper Verde River are protected by spikedace and loach minnow critical habitat. The San Rafael Valley is protected by The Nature Conservancy and San Rafael State Park. The Bill Williams River is a National Wildlife Refuge.

Our Response: We acknowledged in our proposed rule that other listed species' historic ranges overlap with the historical distribution of northern Mexican and narrow-headed gartersnakes. However, as stated above and in the proposed rule, the Act requires us to make listing determinations based on the five threat factors, singly or in combination, after taking into account those efforts being made by any State or foreign nation to protect such species. Management by Federal or State agencies, or non-governmental organizations does not necessarily eliminate activities that threaten these subspecies.

Comment 73: The northern Mexican gartersnake in the United States is not a distinct population segment and does not require protection under the Act.

Our Response: We did not propose to list either gartersnake as a distinct population segment. We proposed to list the northern Mexican and narrow-headed gartersnakes as threatened throughout their ranges. We also reviewed the best available scientific and commercial information to conclude that the northern Mexican gartersnake is a valid subspecies as defined under the Act.

Comment 74: The Service must follow the guidance of Executive Order 13563 of January 18, 2011, concerning making a new Federal rule.

Our Response: Executive Order (E.O.) 13563 reaffirms the principles of E.O. 12866 while calling for improvements in the nation's regulatory system to promote predictability, to reduce uncertainty, and to use the best, most innovative, and least burdensome tools for achieving regulatory ends. The executive order directs agencies to consider regulatory approaches that reduce burdens and maintain flexibility and freedom of choice for the public where these approaches are relevant, feasible, and consistent with regulatory objectives. E.O. 13563 emphasizes further that regulations must be based on the best available science and that the rulemaking process must allow for public participation and an open exchange of ideas. We have developed this rule in a manner consistent with these requirements.

Comment 75: These gartersnakes are already protected by the New Mexico Department of Game and Fish.

Our Response: A number of existing regulations potentially address issues affecting the northern Mexican and narrow-headed gartersnakes and their habitats. However, existing regulations within the range of northern Mexican and narrow-headed gartersnakes typically address only the direct take of individuals without a permit, and provide little, if any, protection of gartersnake habitat. Arizona and New Mexico statutes do not provide protection of habitat and ecosystems. Legislation in Mexico prohibits intentional destruction or modification of northern Mexican gartersnake habitat, but neither that legislation, nor prohibitions of take, completely address ongoing threats. See ''The Inadequacy of Existing Regulatory Mechanisms'' in this final rule for further information.

Comment 76: The Strategic Water Reserve, managed by the New Mexico Interstate Stream Commission, already holds and utilizes water rights to benefit endangered fish and wildlife species in New Mexico. Since the Service gives strongest weight to statutes because they are nondiscretionary and enforceable, the New Mexico Interstate Stream Commission expects the Service to give weight to the Strategic Water Reserve statute in this final rule.

Our Response: We considered the Strategic Water Reserve managed by the New Mexico Interstate Stream Commission and have updated the discussion in the final rule with this new information. However, collectively, existing regulations within the range of northern Mexican and narrow-headed gartersnakes are not fully ameliorating ongoing threats such that the subspecies would not meet the definition of threatened. See ''The Inadequacy of Existing Regulatory Mechanisms'' in this final rule for further information.

Comment 77: Contrary to what is implied in the proposed rule, Clean Water Act section 404 nationwide permits receive rigorous environmental review by the Corps.

Our Response: We recognize that the Clean Water Act section 404 nationwide permits receive environmental review by the Corps; however, this process does not appear to be ameliorating ongoing threats to northern Mexican or narrow-headed gartersnakes such that the subspecies would not meet the definition of threatened. See ''The Inadequacy of Existing Regulatory Mechanisms'' in this final rule for further information.

Comment 78: What is the problem with the management or resources at the

Buenos Aires National Wildlife Refuge (BANWR) that makes populations likely not viable.

Our Response: The abundance of bullfrogs on the BANWR, specifically in the vicinity of Arivaca Lake and Arivaca Cienega, contributes to the northern Mexican gartersnake population being categorized as likely not viable. As stated in our proposed rule, bullfrogs (and other harmful nonnatives) are a primary threat to the gartersnakes. The presence of a single juvenile northern Mexican gartersnake was confirmed on the BANWR in 2000 (Rosen *et al.* 2001, Appendix I). The observation of this juvenile suggests that at least some level of reproduction had occurred and may still be occurring but more recent survey work has not occurred there. The presence of dense cover probably helps any remaining northern Mexican gartersnakes to avoid predation.

In recent years, there has been a concerted management effort on the BANWR to recover the Chiricahua leopard frog in an array of tanks and their associated drainages, all of which have been designated as critical habitat for the Chiricahua leopard frog. As a result, it is likely that any northern Mexican gartersnakes that successfully immigrate into the central tanks area of the BANWR have an increased chance of persistence because of improved available habitat and a stable prey base in an area that is likely free of nonnative predators. We also expect that dispersing Chiricahua leopard frogs might help sustain a low-density population of northern Mexican gartersnakes on the refuge. We consider the northern Mexican gartersnake to be extant as a low-density population on the BANWR based on historical and recent records and the abundance of available, suitable habitat and prey populations in the vicinity of the most recent record. Appendix A contains additional details on the status of the northern Mexican gartersnake at this and other refuges.

Comment 79: What is the relationship of the Arizona Department of Water Resource laws and the proposed listing of the two gartersnakes? For New Mexico, the New Mexico State Engineer indicated that any person in New Mexico can apply to the State Engineer for a permit for the lease of a valid existing water right to augment or maintain stream flow for the beneficial use of fish and wildlife habitat, maintenance or restoration. Further, permits for the permanent transfer of water rights for such purposes have already been granted to the New Mexico Interstate Stream Commission. Both the Strategic Water Reserve option and the leasing option retain a water right's original priority date.

Our Response: Existing water laws in Arizona and New Mexico may not be fully adequate to protect gartersnake habitat from the dewatering effects of groundwater withdrawals. New Mexico water law now includes provisions for instream water rights to protect fish and wildlife and their habitats. Arizona water law also recognizes such provisions; however, because this change is relatively recent, instream water rights have low priority and are often never fulfilled because more senior diversion rights have priority. With respect to New Mexico, we have updated the discussion on New Mexico water rights laws in the final rule to correct any inaccuracies.

Comment 80: The information in Table 1 of the proposed rule does not match the information on page 41515. Page 41515 states that a former large, local population of northern Mexican gartersnakes at the San Bernardino National Wildlife Refuge has experienced correlative decline of leopard frogs and are now thought to occur at very low population density or may be extirpated. Table 1 states likely not viable.

Our Response: We consider gartersnake populations with very low population densities, and thus at higher risk of extirpation, such as the one at San Bernardino National Wildlife Refuge, to be likely not viable. While the population could already be extirpated, we did not have sufficient information to categorize it as likely extirpated and so called it likely not viable.

Surveys and Monitoring

Comment 81: The proposed rule states that the northern Mexican gartersnake has declined significantly in the last 30 years, but then goes on to state that there are several areas where the species was known to occur but has received no or very little survey effort in the past decades.

Our Response: We based our conclusions on the best scientific and commercial data available at the time of listing. We have concluded that, in as many as 24 of 29 known localities in the United States (83 percent), the northern Mexican gartersnake population is likely not viable and may exist at low population densities that could be threatened with extirpation or may already be extirpated. In most localities where the species may occur at low population densities, existing survey data are insufficient to verify extirpation. Only five populations of northern Mexican gartersnakes in the United States are considered likely viable.

Comment 82: The Service assumes the populations at Whitewater Creek and Middle Fork Gila River are likely deteriorated or have been severely jeopardized after the Whitewater-Baldy Complex Fire, but subsequent survey data have not been collected. In the absence of subsequent survey data, the Service lacks information to supports its assumption that the narrow-headed gartersnake populations have deteriorated. Further, we understand that some of the northern Mexican gartersnakes discovered in the Gila National Forest in June 2013 were found precisely in Whitewater Creek. Among the discovered snakes were young males and at least one viable reproducing female, suggesting that the populations of northern Mexican gartersnakes are living and reproducing in the area. The discovery of a reproducing population of northern Mexican gartersnakes in this area suggests that populations of narrow-headed gartersnakes may not be as likely deteriorated as the Service suggests.

Our Response: The proposed rule states that the status of those populations has likely deteriorated as a result of subsequent declines in resident fish communities due to wildfires followed by heavy ash and sediment flows, resulting fish kills, and the removal of snakes. Immediately after the Whitewater-Baldy Complex Fire, but before the subsequent monsoon, we were actively working with other agencies and species experts on assessing the likely damage to the resident fish community and planning salvage operations for narrow-headed gartersnakes. As stated in Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071), populations are thought to remain extant at Whitewater Creek and Middle Fork Gila River, but in the short to mid term we anticipate the density of the narrow-headed gartersnake population to be low due to the Whitewater-Baldy Complex Fire. These sites may rebound in the mid to long term when subbasin conditions stabilize and fish begin to recolonize the stream or are otherwise reintroduced through restoration efforts. See ''High-Intensity Wildfires and Sedimentation of Aquatic Habitat'' section of the final rule for additional information. The best available scientific and commercial data indicated that high-intensity wildfires have the potential to eliminate gartersnake populations through a reduction or loss of their prey base.

Northern Mexican gartersnakes have never been documented in Whitewater

Creek, but were rediscovered in the Gila River in 2013.

Comment 83: Haney *et al.* (2008, p. 61) declared the northern Mexican gartersnake as nearly lost from the Verde River, but also suggested that diminished river flow may be an important factor. Given the multiple recent detections of northern Mexican gartersnakes along the upper and middle Verde River, this statement does not seem relevant to include in the proposed rule.

Our Response: More recent population status data for the northern Mexican gartersnake for the Verde River were preliminary and unpublished at the time the proposed rule was drafted. These newer data have been incorporated into the final rule and Appendix A.

Comment 84: Is a consistent survey protocol being followed each year? Is data collected from different surveys comparable? Without scientific survey protocol implemented consistently for at least 10 years, there can be no real evidence of population trends.

Our Response: There is currently no accepted protocol for northern Mexican or narrow-headed gartersnake surveys; however, some investigators have attempted to revisit locations where others have surveyed in the past in an attempt to establish population trends. Variability in survey design and effort makes it difficult to compare population sizes or trends among sites and between sampling periods. For each of the sites discussed in Appendix A, we have attempted to translate and quantify search and capture efforts into comparable units (*i.e.,* person-search hours and trap-hours) and have conservatively interpreted those results. Where population trends have been established, they have been reported and reflect significant declines in both species.

Comment 85: The Service has failed to survey, analyze data, and incorporate the effects of the thousands of livestock tanks and other impoundments that have been constructed in recent times that are now occupied by the narrow-headed and northern Mexican gartersnakes. These stock tanks and manmade impoundments offer the best opportunity for refugia for the narrow-headed and northern Mexican gartersnakes and could prove to be very important for the future survival of these gartersnakes, as well as the Chiricahua leopard frog. Given the quantity of tanks and other impoundments constructed in the last 50 years, the number of these structures that are used by the gartersnakes could be substantial, and, therefore, the potential population count for the species could be significantly higher than speculated.

Our Response: Surveys of every stock tank that could occur within the distribution of both gartersnake species have not been done. The Act requires that we base our evaluation on the best scientific and commercial information available. We agree that well-managed stock tanks represent conservation and recovery opportunities for the northern Mexican gartersnake and have consequently developed a rule under section 4(d) of the Act that exempts otherwise unauthorized take of northern Mexican gartersnakes from livestock use or maintenance of stock tanks on non-Federal lands. Stock tanks are not considered suitable habitat for narrow-headed gartersnakes, and the species has never been reported using a stock tank.

Harmful Nonnative Species and Other Threats

Comment 86: No information is provided describing San Carlos Reservoir operations and their effects on nonnative and native aquatic species, whether there are or ever has been gartersnakes in or near the San Carlos Reservoir and the status of any nonnative fish populations on the Gila River at San Carlos Reservoir. This is not based on the best available science.

Our Response: Distribution data strongly suggest that northern Mexican and narrow-headed gartersnakes historically occurred along the middle Gila River, as this was formerly a major perennial river with several known populations both upstream and within numerous tributaries, with suitable habitat, and a robust native prey base. Post-construction of the San Carlos Reservoir, survey data are limited. Thus it remains difficult to ascertain the current status of gartersnake populations upstream, downstream, or within the reservoir itself. As far as the effect of the reservoir on the up- or downstream aquatic community, similar analysis have been performed for the Horseshoe and Bartlett Reservoirs, which resulted in the issuance of a section 10(a)(1)(B) permit for the incidental take of native fish species, the lowland leopard frog, the northern Mexican gartersnake, and the narrow-headed gartersnake. USFWS (2008, pp. 112–131) supports our rationale as to how adverse effects to native aquatic species occur from the presence and operation of reservoirs in the Gila River basin of Arizona.

Comment 87: In the proposed rule, the Service refers to the potential development of the Hooker Dam on the mainstem Gila River above Mogollon Creek and below Turkey Creek. The U.S. Bureau of Reclamation has abandoned any intention of completing Hooker Dam, and its reference as a possible future project should be deleted from the final rule.

Our Response: We have confirmed with the U.S. Bureau of Reclamation that there are no current plans to develop Hooker Dam, and it is not referenced in the final rule.

Comment 88: Barriers to fish movement out of Roosevelt Lake should be acknowledged in the final rule. The Roosevelt Dam on the Salt River serves as an effective barrier to upstream fish movement, which would prevent nonnative fish from moving upstream.

Our Response: In the final rule, we added a statement in our discussion of dams to reflect this fact.

Comment 89: The proposed rule states that additional land and water use activities along Tonto Creek and the Salt River, including areas upstream of Roosevelt Lake, contribute to the persistence of nonnative aquatic species that negatively affect the gartersnakes. However, the Tonto Creek exhibits seasonally intermittent flows in the lower reaches below Gun Creek. Sections of dry streambed serve as a barrier to upstream fish migration. Further, high flow events have been documented to remove nonnative species by flushing them downstream. In addition, nonnative spiny-rayed fish are not typically motivated to migrate upstream out of lakes because they prefer lentic over lotic habitats.

Our Response: Connectivity between otherwise spatially intermittent reaches is established during seasonal periods of snowmelt runoff as well as during medium- to large-scale flood pulses. These opportunities contribute to the distribution of harmful nonnative fish throughout Tonto Creek, as demonstrated in fish survey data that has been collected, reviewed, and reported in Appendix A. With respect to whether harmful nonnative fish are ''not typically motivated to migrate upstream out of lakes,'' the data are lacking to clearly defend this statement, especially when reservoir levels decrease, which lessens the amount of space available in reservoirs, which may in turn trigger dispersal or movement behaviors in harmful nonnative fish that are known to be territorial by their nature. Additionally, the simple presence of otherwise ''lentic'' nonnative species in lotic habitat upstream of reservoirs to which they are hydrologically connected, suggests this perceived preference may not be altogether true; green sunfish are an excellent example.

Comment 90: A number of other activities (both present and historical) in the area of Tonto Creek and the Salt River in the vicinity and upstream of Roosevelt Lake are likely contributing to the decline of gartersnakes and the aquatic and riparian habitat on which they depend. Specifically, a historical stocking program of nonnatives, manmade impoundments within the Tonto Creek floodplain, and other activities identified in the proposed rule, such as groundwater pumping, flood control projects, urbanization, and livestock grazing. The major activities reducing flows and dewatering habitat are occurring upstream of Roosevelt Lake. A bridge is proposed over Tonto Creek, and 320 to 640 residences are projected to be built on the east side of Tonto Creek, under the Gila County's comprehensive plan. This would increase water and recreational use. The U.S. Forest Service's Motorized Travel Management Plan has the potential to open 2,567 miles (4,131 km) of road to high clearance vehicles and 967 miles (1,556 km) to passenger vehicles. The Tonto National Forest's Salt River Allotments Vegetative Management Plan would allow continued grazing on more than 275,000 acres (111,000 ha) along the Upper Salt River. Potential impacts to the narrow-headed gartersnake are noted, and the potentially suitable habitat for the northern Mexican gartersnake that occurs along the Salt River is the same area that the USFS proposes for grazing.

Our Response: We agree that numerous threats are affecting the status of both gartersnake species in Tonto Creek. The final rule (see ''Altering or Dewatering Aquatic Habitat'') references land use activities in this area that we consider as having an effect on resident gartersnake populations.

Comment 91: The Service's generalized and unsupported assertions that all dams have the same impacts on gartersnakes should be removed from the final rule. The ''Altering or Dewatering Aquatic Habitat'' section of the proposed rule is not supported by any citations regarding water level fluctuations in reservoirs and cross-section profiles of a reservoir. This section should provide citations and recognize the diversity of the various types of reservoirs.

Statements regarding the effect of Roosevelt Lake on gartersnake populations in Tonto Creek and the upper Salt River lack any scientific or technical basis and should be removed from the final rule. Other than referencing a biological opinion (USFWS 2008, pp. 112–131), the proposed rule provides no basis for the assertion that harmful nonnative fish are moving upstream out of Roosevelt Lake into Tonto Creek or the Salt River. Since the biological opinion in 2008, monitoring conducted under the Horseshoe-Bartlett Habitat Conservation Plan has been implemented to document the movement of nonnative fish upstream of the Horseshoe Reservoir into the Verde River, and reaches of the Verde River have been sampled, and to date no evidence of fish movement has been detected.

Our Response: We agree that not every dam has the same effect on the stream on which it is located. We disagree that our treatment of the effects of dams on occupied lotic habitat are unsupported. The identified section discusses general effects of dams, based on available literature, as a suite of effects common in all instances in various degrees. This same section also includes referenced discussion of specific dams or diversions and their specific effects on certain gartersnake populations. The relationship of the cross-sectional profiles and water level fluctuations of reservoirs to benefits to harmful nonnative fish communities was an integral part of a 4-year evaluation, in close collaboration with the operators of those reservoirs themselves, dedicated to the development of the habitat conservation plan for Bartlett and Horseshoe Reservoirs on the Verde River. We incorporated by reference this exhaustive analysis, which used the best available data to date (see SRP 2008, entire; USFWS 2008, pp. 112–131).

We are not aware of any analysis afforded specifically to the potential benefits of Roosevelt Dam operations to the sustainment or production of harmful nonnative fish populations in Roosevelt Lake, Tonto Creek, or the Salt River, upstream of Roosevelt Dam. The exhaustive analysis of these effects as they are attributed to similarly sized dams and reservoirs on the Verde River system referenced immediately above represent the most applicable, current, and robust analyses to date. We do note that Roosevelt Lake does not fluctuate as much as does Horseshoe Reservoir on the Verde River and, therefore, most likely provides greater benefits to the resident harmful nonnative fish community. With respect to fish sampling data from the implementation of the Horseshoe and Bartlett HCP, sampling events do not occur during the most appropriate time to capture movement of fish out of the reservoir (during periods of rapid drawdown or during drawdown after periods of prolonged storage) and thus may not adequately capture these relationships. Additionally, more fish have to be marked in the reservoir to create better opportunities for their discovery elsewhere in the watershed. Lastly, recent northern Mexican gartersnake records have been reported immediately upstream, if not adjacent to, Roosevelt Lake, which affirms that adverse effects from harmful nonnative species that occur in Roosevelt Lake present a demonstrable threat to that population of northern Mexican gartersnakes.

Comment 92: The proposed rule states that, on the upper Verde River, native species dominated the total fish community at greater than 80 percent from 1994 to 1996, before dropping to approximately 20 percent in 1997 and 19 percent in 2001. This statement points to specific empirical data regarding declining native fish species in the upper Verde River watershed, but there is no reference to verify the sources, context, or specific species to which it is referring.

Our Response: Rinne *et al.* (2005, pp. 6–7) contains a discussion of shifting fish communities in the Verde River, and Bonar *et al.* (2004, entire) contains a detailed analysis of the role harmful nonnative fishes have had on the native fish community of the Verde River. Also Bonar *et al.* (2004, pp. 6–7) summarizes this information.

Comment 93: If it is true that the narrow-headed and northern Mexican gartersnakes have declined substantially in the United States and the decline of these species is most likely due to the introduction of nonnative predator and competitor species as stated in the 2006 and 2008 status reports, then the listing of these species as threatened will do little for their recovery.

Our Response: As stated in the proposed rule, conservation measures provided to species listed as endangered or threatened species under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition of conservation needs of species through listing under the Act results in public awareness and conservation by Federal, State, tribal, and local agencies, private organizations, and individuals. The Act encourages cooperation with the States and recovery plans will identify recovery actions that will benefit listed species. See ''Available Conservation Measures'' in this final rule for additional information on this subject.

Comment 94: Local persons are catching gartersnakes in contests and seeing how many they can kill to win the contest.

Our Response: We have no information to indicate that collection of gartersnakes is a significant threat. However, if this activity is occurring, it will be considered a prohibited take of the species, once listed.

Comment 95: The Service should take into account the adverse effects of the past Federal land management agency burning programs and the recent wildfires that have occurred in the narrow-headed and northern Mexican gartersnakes home ranges. Closer scrutiny of the current Federal land management burning program, and lack of a coherent thinning and logging program, coupled with a better understanding of the effects of the recent large wildfires, should be completed in order to focus future protection and restoration efforts towards what is truly causing the decline of the narrow-headed and northern Mexican gartersnakes. There is no benefit to immediately listing these gartersnakes as threatened when there is doubt concerning the current and future potential cause for decline of the species.

Our Response: In the proposed rule, we discuss effects of recent fire management policies on aquatic communities in Madrean Oak Woodland biotic communities in the southwestern United States. Existing wildfire suppression policies intended to protect the expanding number of human structures on forested public lands have altered the fuel loads in these ecosystems and increased the probability of high-intensity wildfires (Rinne and Neary 1996, p. 143). The historical actions affecting a species are considered as background in our assessment in terms of their contribution to the present-day status of these species. However, in evaluating the status of the species, the Act requires that we assess present and future factors that may threaten the species. If past actions are continuing threats, these threats are evaluated under the five-factor analysis. If these past actions are not continued factors, then these actions are not assessed in the analysis of the future status because they are no longer present or future factors threatening the species.

Section 7(a)(1) of the Act requires that all Federal agencies shall utilize their authorities in furtherance of the purposes of the Act by carrying out programs for the conservation of endangered and threatened species. Section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with us. Lastly, while we acknowledge in the proposed and final rules that large wildfires can have significant adverse effects on gartersnake populations and their prey base (in particular for narrow-headed gartersnakes), the literature is clear that harmful nonnative species pose the most significant threat to both species, rangewide, through a variety of ecological mechanisms.

Comment 96: The proposed rule states that Cavazos and Arriaga (2010, entire) found that average temperatures along the Mexican Plateau in Mexico could rise by as much as 1.8 °F (1 °C) in the next 20 years and by as much as 9 °F (5 °C) in the next 20 years, according to their models. This statement is confusing because the reference cites two different temperatures for the same timeframe in the same area.

Our Response: Climate models often report a range of scenarios, as was the case in this instance. We did revise that language for clarity. However, we expect precipitation and temperature trends, as modeled under future climate change projections, to increase regional aridity in Mexico within the distribution of the northern Mexican gartersnake, which is expected to place additional drought stress on stream flow and reduce the permanency of cienegas, marshes, and livestock tanks. As streams dry, they will become unsuitable as habitat for this gartersnake and its prey base over the next several decades.

Comment 97: We request that the Service provide clarification and more information regarding the presence of mercury in Tonto Creek and likely sources of this substance. No study was cited for the claim that mercury appears to be bioaccumulating in fish in the lower reaches of the Tonto Creek, only a personal communication with Arizona Department of Environmental Quality. The information in the proposed rule is contrary to the Arizona Department of Environmental Quality's 2011 report on ''Fish Consumption Risk Analysis for Tonto Creek, Arizona.'' Specifically, desert suckers have the fourth highest mercury levels, not the second.

Our Response: We updated this discussion under ''Environmental Contaminants'' in the final rule to include data reported by ADEQ (2011, entire), as well as other information, and acknowledged in the proposed and final rules that no study on the bioaccumulation of mercury in resident gartersnakes has been implemented that we are aware of. The suggestion that bioaccumulation of mercury could be occurring is based on the accepted scientific premise regarding the toxicology of mercury in ecosystems and its ability to increase its concentration in tissue with increasing trophic orders. Gartersnakes are tertiary consumers and, therefore, are expected to bioaccumulate contaminants such as mercury in their tissues.

Comment 98: The term excessive sedimentation as used in the proposed rule is open to interpretation and should be defined to eliminate unnecessary waste of resources of the Service in defending its finding. Any large storm event that changes the morphology of a channel or adjoining riparian habitat can be used to control all human activities in that they can be construed to have caused the resulting flooding.

Our Response: It is beyond our scope to quantitatively define what level of sedimentation is excessive for every stream. However, we agree that flood pulses naturally liberate sediment in arid southwestern watersheds. In the absence of absolute values or metrics, we consider excessive sedimentation that level in which resident gartersnake prey species or gartersnakes themselves are not able to adequately carry out life-history functions such as feeding, sheltering, or breeding as a result of the effects of sedimentation. Arizona and New Mexico also have turbidity or total dissolved solid standards for surface water, which can also be used as a reference.

Comment 99: The proposal to list is based on the false premise that riparian habitats are declining in the Southwest (see Webb *et al.* 2007).

Our Response: A comprehensive analysis of the scientific literature supports our evaluation of the status of habitat where these gartersnakes historically or currently occur.

Comment 100: We request the Service clarify the year of reference in their projection that annual precipitation amounts in the southwestern United States may decrease by 10 percent by the year 2100.

Our Response: Overpeck (2008, entire) is a presentation where this information was originally presented although much of the information used in Overpeck (2008) was from the Intergovernmental Panel on Climate Change (IPCC 2007). We presume the year(s) of reference may be 2007–2008 because that is the time period when the reference was created.

Comment 101: The Service should acknowledge the uncertainty of broad predictions associated with climate change in their final rule.

Our Response: In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change and their predicted effects on northern Mexican and narrow-headed gartersnakes.

Comment 102: The Service states that wildfire is a threat to the narrow-headed gartersnake throughout its range. However, the Service also discusses the Dry Lakes Fire of 2002, which resulted in a complete fish kill in Turkey Creek. Turkey Creek has since been recolonized by native fish species almost exclusively. Consequently, it is conceivable that snakes that survived a period without fish might then find themselves in an environment better suited to their needs (i.e., devoid of nonnative species) than before the fire. Further, the Service states that both species of gartersnakes are somewhat resilient to physical habitat disturbance where harmful nonnative species are absent.

Our Response: We agree that if enough individual narrow-headed gartersnakes can survive the post-fire period of ash flows and fish kills, without risking genetic bottlenecking within the population, that an ensuing native-only fish community would be highly beneficial. However, field research has proven that over time and without a barrier to upstream movement, harmful nonnative fish ultimately make their way back into these streams and negatively affect the native aquatic community. Therefore, any plausible post-fire benefits to surviving narrow-headed gartersnakes are most likely short-lived.

Information Quality and Quantity

Comment 103: Personal communications of a graduate student are a weak basis for determining the current status of the narrow-headed gartersnake in New Mexico (or, as found in other citations, the effects of the Whitewater Baldy fire on the narrow-headed and northern Mexican gartersnakes). Personal communications or gray literature are not subject to the necessary vigorous peer review and substantiation that would meet the Act's requirements for science-based or commercial data.

Our Response: As required by the Act, we based our proposal and this final rule on the best available scientific and commercial data. Our Policy on Information Standards Under the Act (published in the **Federal Register** on July 1, 1994 (59 FR 34271)), the Information Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001 (Pub. L. 106–554; H.R. 5658)), and our associated Information Quality Guidelines, provide criteria, establish procedures, and provide guidance to ensure that our decisions are based on the best scientific data available. Information sources may include the recovery plan for the species, articles in peer-reviewed journals, conservation plans developed by States and counties, scientific status surveys and studies, biological assessments, other unpublished materials, or experts' opinions or personal knowledge. We receive and use information on the biology, ecology, distribution, abundance, status, and trends of species from a wide variety of sources as part of their responsibility to implement the Act. This information includes status surveys, biological assessments, and other unpublished material (that is, ''gray literature'') from State natural resource agencies and natural heritage programs, Tribal governments, other Federal agencies, consulting firms, contractors, and individuals associated with professional organizations and higher educational institutions. We also use published articles from juried professional journals. The reliability of the information contained in these sources can be as variable as the sources themselves. As part of their routine activities, our biologists are required to gather, review, and evaluate information from these sources prior to undertaking listing, recovery, consultation, and permitting actions.

Comment 104: If science-based and commercial data are not available for populations, then any projections for populations in the United States based on northern Mexican gartersnake populations would necessarily be speculative.

Our Response: The Act requires that we use the best scientific and commercial data available at the time of listing. Appendix A (available at *http://www.regulations.gov,* Docket No. FWS–R2–ES–2013–0071) discusses such considerations as the physical condition of habitat, the composition of the aquatic biological community, the existence of significant threats, and the length of time since the last known observation of the subspecies in presenting rationale for determining occupancy status at each locality.

Comment 105: The Service's statement that as much as 90 percent of historical populations in the United States either occur at low densities or are extirpated due to the total number of stream miles that are now permanently dewatered appears to be pure speculation and not supported by factual data. It is doubtful that an accurate accounting exists of stream miles in the United States that historically supported the northern Mexican gartersnakes, and it is further doubtful that an accurate accounting exists of stream miles that historically were perennial and are now ephemeral. This kind of information would require dealing with specific time periods and specific stream reaches, which is not offered in the statement.

Our Response: This assessment is based on the best available scientific and commercial data for northern Mexican gartersnakes in the United States. Museum records and habitat requirements indicate the species technically occurred in every county and nearly every subbasin within Arizona. We used GIS and information on threats and status of historical populations as well as habitat preferences, in arriving at the 90 percent figure, which we consider to be reasonably accurate given the information available. Considering the large number of stream miles that were historically perennial within the historical distribution of the northern Mexican gartersnake in Arizona that are now ephemeral, and the degraded status of populations as a result of a multitude of threats, our presentation of the data represents the most accurate possible.

Effect of Listing on Non-Federal Interests

Comment 106: The language in the proposed rule that lists activities which could result in the reduction of the distribution or abundance of important gartersnake prey species, as well as reduce the distribution and amount of suitable physical habitat on a regional landscape for the gartersnakes themselves, is an invitation for many organizations to sue the Service for allowing activities deemed to affect the gartersnake on a regional landscape basis. This gives the gartersnakes' prey species endangered status under the Act also.

Our Response: The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all wildlife listed under the ESA. The prohibitions of section 9(a)(2) of the Act make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed species.

We may issue permits to carry out otherwise prohibited activities involving endangered and threatened wildlife species under certain circumstances. A permit must be issued for the following purposes: For scientific purposes, to enhance the propagation or survival of the species, and for incidental take in connection with otherwise lawful activities.

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a proposed listing on proposed and ongoing activities within the range of species proposed for listing. See the **Available Conservation Measures** section in the proposed rule for a list of activities that could potentially result in a violation of section 9 of the Act. Lastly, it is important to note that our emphasis for the recovery of listed species is to assess and improve ecosystem function as a basic tenant of conservation biology; this includes the physical habitat and biological community where a listed species occurs. This management construct is not unique to these gartersnakes.

Comment 107: Listing will hinder conservation efforts of the New Mexico Department of Game and Fish.

Our Response: We disagree. Once these species are listed, funding for recovery actions may be more accessible from a variety of sources, including Federal grants, State programs, and cost-share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, pursuant to section 6 of the Act, the States of Arizona and New Mexico will be eligible for Federal funds to implement management actions that promote the protection or recovery of the narrow-headed and northern Mexican gartersnakes.

Section 4(d) Rule

Comment 108: If the Service decides to list the species, then we recommend the development of a 4(d) rule to exempt landowners from prohibitions of take under section 9 of the Act for those actions benefitting the two species of gartersnakes, as was the case for the Chiricahua leopard frog.

Our Response: We proposed a special rule for the northern Mexican gartersnake under section 4(d) of the Act that would exempt take of northern Mexican gartersnakes as a result of livestock use at or maintenance of livestock tanks located on non-Federal lands, and a final 4(d) rule is incorporated into this final rule. We do not have the necessary information at this time to determine that general actions benefitting the two species of gartersnakes would meet the standard of a 4(d) rule to be necessary and advisable for the conservation of the species. We would need more specific information regarding the actions under consideration.

Comment 109: Concerned with the language in the proposed 4(d) rule, which states: ''Incidental take of northern Mexican gartersnakes is not a violation of section 9 of the Act if it occurs from any other otherwise legal activities involving northern Mexican gartersnakes and their habitat that are conducted in accordance with applicable State, Federal, tribal, and local laws and regulations.'' This language could be interpreted to allow incidental take for any activity in the snake's habitat as long as the activity was legal. We suggest the following language: (3) What activities are allowed? Incidental take of northern Mexican gartersnakes is not a violation of section 9 of the Act if it occurs from (a) otherwise legal activities involving northern Mexican gartersnakes and their habitat that are conducted in accordance with applicable State, Federal, tribal, and local laws and regulations, and (b) such activities occurring in northern Mexican gartersnake habitat pertain to maintenance activities at livestock tanks located on private, State, or tribal lands. A livestock tank is an existing or future impoundment in an ephemeral drainage or upland site constructed primarily as a watering site for livestock.

Our Response: We have amended the 4(d) rule, in the final rule, to reflect this recommendation. We revised the language in the 4(d) rule to better describe our intention for the rule to exempt only activities related to the construction, use, and maintenance of stock tanks for livestock watering. These changes did not alter the scope of the 4(d) rule.

Determination—Standard for Review

Section 4 of the Act (16 U.S.C. 1533), and its implementing regulations at 50 CFR part 424, set forth the procedures for adding species to the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, we may list a species based on (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade factors affecting its continued existence. Listing actions may be warranted based on any of the above threat factors, singly or in combination.

Until recently the Service has presented its evaluation of information under the five listing factors in an outline format, discussing all of the information relevant to any given factor and providing a factor-specific conclusion before moving to the next factor. However, the Act does not require findings under each of the factors, only an overall determination as to the species' status (for example, threatened, endangered, or not warranted). Ongoing efforts to improve the efficiency and efficacy of the Service's implementation of the Act have led us to present this information in a different format that we believe leads to greater clarity in our understanding of the science, its uncertainties, and our application of our statutory framework to that science. Therefore, while the presentation of information in this rule differs from past practice, it differs in format only. We have evaluated the same body of information we would have evaluated under the five listing factors outline format in the past, we are applying the same information standard, and we are applying the same statutory framework in reaching our conclusions.

Determination for Northern Mexican Gartersnake

The Act defines an endangered species as any species (or subspecies) that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' We have carefully assessed the best scientific and commercial information available regarding the status of the northern Mexican gartersnake and have determined that this subspecies meets the definition of a threatened subspecies under the Act based on its current status and the future threats to the subspecies.

We find that the northern Mexican gartersnake is not currently in danger of extinction because it remains extant in most of the subbasins where it historically occurred, and its known threats have not yet resulted in substantial range reduction or a substantial number of population extirpations to put the subspecies on the brink of extinction. Currently, only 6 former United States populations were found to be likely extirpated, and 29 populations are believed to remain extant. Therefore, we determined that the present risk of extinction is not sufficient to warrant a finding of endangered under the Act.

However, the northern Mexican gartersnake has undergone declines in its abundance, and we found only 5 of 29 current populations in the United States are likely viable into the foreseeable future, or what we consider to be the next several decades. While we are not able to quantify the status of all populations in Mexico, based on the threats and the declining status of aquatic communities there, we assume a similar status in the Mexican portion of its range. We expect the status of the subspecies will decline in the next several decades mainly as a result of the continuing and expanding impacts of harmful nonnative species and the increasing nature of threats associated with human population growth and climate change. As the effects of these threats escalate on the landscape (as summarized below), we expect that additional populations will be extirpated, and that the northern Mexican gartersnake will be in danger of extinction in the foreseeable future.

In our review of the best available scientific and commercial information, we found that aquatic ecosystems upon which the northern Mexican gartersnake relies have been significantly degraded by the introduction and proliferation of harmful nonnative species (Factors C and E). Harmful nonnative species (mainly predatory fishes, bullfrogs, and crayfish) have been intentionally released or have naturally moved into nearly every subbasin throughout the range of the northern Mexican gartersnake. This has resulted in widespread declines in native fish and amphibian communities, which are integral to the continued survival of the northern Mexican gartersnake because they serve as their primary food source. Harmful nonnative species have indirectly impacted northern Mexican gartersnakes by predation on their prey base (native fish and amphibians) and have directly impacted them through preying on young gartersnakes (Factor B), which impacts gartersnake populations through declines in the recruitment of young snakes into the reproductive age class. In combination, these factors have resulted in population declines, range restrictions within subbasins, and some population extirpations. We found the threat related to harmful nonnative species to be the most significant and pervasive of all threats affecting the subspecies.

Additional threats to the habitat of northern Mexican gartersnakes include water use activities, climate change, and drought (Factor A). Dams, water diversions, flood-control projects, and groundwater pumping have dewatered entire reaches of historically occupied habitat in some areas. The rapidly growing human population in the arid southwestern United States, combined with a drought-limited supply of surface water, will further increase future needs for water supplies and associated infrastructure (dams, diversions, and groundwater pumping) that will also contribute to habitat losses in the next several decades. Losses of aquatic habitats are also expected due to the impacts of climate change, which includes increased aridity, lower annual precipitation totals, lower snow pack levels, higher variability in flows (lower low-flows and higher high-flows) in the southwestern United States and northern Mexico. The population-level effect of factors that modify or destroy the physical attributes of gartersnake habitat is amplified when they act in the presence of harmful nonnative species.

Other factors act in combination to negatively affect the northern Mexican gartersnake, including mismanaged or unmanaged livestock grazing (Mexico; Factor A); road construction, use, and maintenance (Factor A); adverse human interactions (Factor E); environmental contaminants (Factor A); erosion control techniques (Factor A); and possible competitive pressures from sympatric species (Factor E). These threats occur within the distribution of this gartersnake and contribute to further population declines or extirpations where gartersnakes already occur at low population densities due to the impacts of harmful nonnative species. The existing regulatory mechanisms currently in place (Factor D) do not target the conservation of this subspecies or its habitat in the United States or Mexico.

Therefore, on the basis of the best available scientific and commercial information, we find the northern Mexican gartersnake is likely to become in danger of extinction throughout all of its range within the foreseeable future, and we are listing the northern Mexican gartersnake as a threatened subspecies in accordance with sections 3(20) and 4(a)(1) of the Act.

Determination for Narrow-Headed Gartersnakes

The Act defines an endangered species as any species that is ''in danger of extinction throughout all or a significant portion of its range'' and a threatened species as any species ''that is likely to become endangered throughout all or a significant portion of its range within the foreseeable future.'' We have carefully assessed the best scientific and commercial information available regarding the status of the narrow-headed gartersnake and have determined that this species meets the definition of a threatened subspecies under the Act based on its current status and the future threats to the species.

We find that the narrow-headed gartersnake is not currently in danger of extinction because it remains extant in most of the subbasins where it historically occurred, and its known threats have not yet resulted in substantial range reduction or a substantial number of population extirpations to put the species on the brink of extinction. Currently, only 5 former populations were found to be likely extirpated, and 36 populations are believed to remain extant. Therefore, we determined that the present risk of extinction is not sufficient to warrant a finding of endangered under the Act.

However, the narrow-headed gartersnake has undergone declines in its abundance, and we found only 5 of 36 current populations are likely viable into the foreseeable future, or what we consider to be the next several decades. We expect the status of the species will decline in the next several decades mainly as a result of the continuing and expanding impacts of harmful nonnative species and the increasing nature of threats associated with human population growth and climate change. As the effects of these threats escalate on the landscape (as summarized below), we expect that additional populations will be extirpated, and that the narrow-headed gartersnake will be in danger of extinction in the foreseeable future.

In our review of the best available scientific and commercial information, we found that native fish communities, upon which the narrow-headed gartersnake relies heavily, have been significantly degraded by the introduction and proliferation of harmful nonnative species (Factors C and E). Harmful nonnative species (mainly predatory fishes, bullfrogs, and crayfish) have been intentionally released or have naturally moved into nearly every subbasin throughout the range of the narrow-headed gartersnake. This has resulted in widespread declines in native fish communities, which are integral to the continued survival of the narrow-headed gartersnake because they serve as their primary food source. Harmful nonnative species have indirectly impacted narrow-headed gartersnakes by predation on their prey base (native fish) and have directly impacted them through preying on young gartersnakes (Factor B), which impacts gartersnake populations through the decline in recruitment of young snakes into the reproductive age class. In combination, these factors have resulted in population declines, range restrictions within subbasins, and some population extirpations. We found the threat related to harmful nonnative species to be the most significant and pervasive of all threats affecting the species.

Additional threats to the habitat of narrow-headed gartersnakes include water use activities, climate change, and wildfires (Factor A). Dams, water diversions, flood-control projects, and groundwater pumping have dewatered entire reaches of historically occupied habitat in some areas. The rapidly growing human population in the arid southwestern United States, combined with a drought-limited supply of surface water, will further increase future needs for water supplies and associated infrastructure (dams, diversions, and groundwater pumping) that will also contribute to habitat losses in the next several decades. Losses of aquatic habitats are also expected due to the impacts of climate change, which includes increased aridity, lower annual precipitation totals, lower snow pack levels, higher variability in flows (lower low-flows and higher high-flows), and enhanced stress on ponderosa pine communities in the southwestern United States. Wildfires in the arid southwestern United States have grown more frequent and severe, due in part to the fire management policies of past decades. High-intensity wildfires that affect large areas contribute to significant flooding and sedimentation, resulting in fish kills and the filling-in of interstitial spaces in river cobble, which the species uses for hunting fish), as well as important pool habitat. These impacts negatively affect the fish and amphibian prey base for narrow-headed gartersnakes for extended periods of time. The frequency and intensity of large wildfires is likely to increase in the foreseeable future as an indirect effect of drier and hotter landscape conditions associated with climate change. The population-level effect of factors that modify or destroy the physical attributes of gartersnake habitat is amplified when they act in the presence of harmful nonnative species.

Other factors act in combination to negatively affect the narrow-headed gartersnake, including road construction, use, and maintenance (Factor A); adverse human interactions (Factor E); environmental contaminants (Factor A); and erosion control techniques (Factor A). These threats occur within the distribution of this gartersnake and contribute to further population declines or extirpations where gartersnakes already occur at low population densities due to the impacts of harmful nonnative species. The existing regulatory mechanisms currently in place (Factor D) do not target the conservation of this species or its habitat.

Therefore, on the basis of the best available scientific and commercial information, we find the narrow-headed gartersnake is likely to become in danger of extinction throughout all of its range within the foreseeable future, and we are listing the narrow-headed gartersnake as a threatened species in accordance with sections 3(20) and 4(a)(1) of the Act.

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing results in public awareness and conservation by Federal, State, Tribal, and local agencies, private organizations, and individuals. The Act encourages cooperation with the States and requires that recovery actions be carried out for all listed species. The protection required by Federal agencies and the prohibitions against certain activities are discussed, in part, below.

The primary purpose of the Act is the conservation of endangered and threatened species and the ecosystems upon which they depend. The ultimate goal of such conservation efforts is the recovery of these listed species, so that they no longer need the protective measures of the Act. Subsection 4(f) of the Act requires the Service to develop and implement recovery plans for the conservation of endangered and threatened species. The recovery planning process involves the identification of actions that are necessary to halt or reverse the species' decline by addressing the threats to its survival and recovery. The goal of this process is to restore listed species to a point where they are secure, self-sustaining, and functioning components of their ecosystems.

Recovery planning includes the development of a recovery outline shortly after a species is listed, preparation of a draft and final recovery plan, and revisions to the plan as significant new information becomes available. The recovery outline guides the immediate implementation of urgent recovery actions and describes the process to be used to develop a recovery plan. The recovery plan identifies site-specific management actions that will achieve recovery of the species, measurable criteria that determine when a species may be downlisted or delisted, and methods for monitoring recovery progress. Recovery plans also establish a framework for agencies to coordinate their recovery efforts and provide estimates of the cost of implementing recovery tasks. Recovery teams (composed of species experts, Federal and State agencies, nongovernmental organizations, and stakeholders) are often established to develop recovery plans. When completed, the recovery outline, draft recovery plan, and the final recovery plan will be available on our Web site (*http://www.fws.gov/endangered*), or from our Arizona Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Implementation of recovery actions generally requires the participation of a broad range of partners, including other Federal agencies, States, Tribal, nongovernmental organizations, businesses, and private landowners. Examples of recovery actions include habitat restoration (e.g., restoration of native vegetation), research, captive propagation and reintroduction, and outreach and education. The recovery of many listed species cannot be accomplished solely on Federal lands because their range may occur primarily or solely on non-Federal lands. To achieve recovery of these species requires cooperative conservation efforts on private, State, and Tribal lands.

Following publication of this final listing rule, funding for recovery actions will be available from a variety of sources, including Federal budgets, State programs, and cost-share grants for non-Federal landowners, the academic community, and nongovernmental organizations. In addition, under section 6 of the Act, the States of Arizona and New Mexico would be eligible for Federal funds to implement management actions that promote the protection and recovery of the northern Mexican and narrow-headed gartersnakes. Information on our grant programs that are available to aid species recovery can be found at: *http://www.fws.gov/grants*.

Please let us know if you are interested in participating in recovery efforts for these species. Additionally, we invite you to submit any new information on these species whenever it becomes available and any information you may have for recovery planning purposes (see **FOR FURTHER INFORMATION CONTACT**).

Section 7(a) of the Act requires Federal agencies to evaluate their actions with respect to any species that is proposed or listed as endangered or threatened and with respect to its critical habitat, if any is designated. Regulations implementing this interagency cooperation provision of the Act are codified at 50 CFR part 402. Section 7(a)(4) of the Act requires Federal agencies to confer with the Service on any action that is likely to jeopardize the continued existence of a species proposed for listing or result in destruction or adverse modification of proposed critical habitat. If a species is listed subsequently, section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of the species or destroy or adversely modify its critical habitat. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Service.

Federal agency actions within the species' habitats that may require conference or consultation or both as described in the preceding paragraph include management and any other landscape-altering activities on Federal lands administered by the Fish and Wildlife Service, U.S. Bureau of Reclamation, or U.S. Forest Service; issuance of section 404 Clean Water Act permits by the U.S. Army Corps of Engineers; construction and management of gas pipeline and power line rights-of-way by the Federal Energy Regulatory Commission; construction and maintenance of roads or highways by the Federal Highway Administration; and other discretionary actions that affect the species composition of biotic communities where these species or their habitats occur, such as funding or permitting programs that result in the continued stocking of nonnative, predatory fish.

The Act and its implementing regulations set forth a series of general prohibitions and exceptions that apply to all endangered wildlife. The prohibitions of section 9(a)(2) of the Act, codified at 50 CFR 17.21 for endangered wildlife, in part, make it illegal for any person subject to the jurisdiction of the United States to take (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect; or to attempt any of these), import, export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any listed species. Under the Lacey Act (18 U.S.C. 42–43; 16 U.S.C. 3371–3378), it is also illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken illegally. Certain exceptions apply to agents of the Service and State conservation agencies. The prohibitions of section 9(a)(2) of the Act, codified at 50 CFR 17.31 for threatened wildlife, make it such that all the provisions of 50 CFR 17.21 apply, except § 17.21(c)(5).

We may issue permits to carry out otherwise prohibited activities involving endangered and threatened wildlife species under certain circumstances. Regulations governing permits are codified at 50 CFR 17.22 for endangered species, and at § 17.32 for threatened species. A permit must be issued for the following purposes: For scientific purposes, to enhance the propagation or survival of the species, and for incidental take in connection with otherwise lawful activities.

It is our policy, as published in the **Federal Register** on July 1, 1994 (59 FR 34272), to identify to the maximum extent practicable at the time a species is listed, those activities that would or would not constitute a violation of section 9 of the Act. The intent of this policy is to increase public awareness of the effect of a proposed listing on proposed and ongoing activities within the range of species proposed for listing. The following activities could potentially result in a violation of section 9 of the Act; this list is not comprehensive:

(1) Unauthorized collecting, handling, possessing, selling, delivering, carrying, or transporting of the species, including import or export across State lines and international boundaries, except for properly documented antique specimens of these taxa at least 100 years old, as defined by section 10(h)(1) of the Act;

(2) The unauthorized introduction of harmful nonnative species that compete with or prey upon northern Mexican and narrow-headed gartersnakes or their prey species, such as the stocking of nonnative, predatory fish, or illegal transport, use, or release of bullfrogs or crayfish in the States of Arizona and New Mexico;

(3) The unauthorized release of biological control agents that attack any age class of northern Mexican and narrow-headed gartersnakes or any life stage of their prey species;

(4) Unauthorized modification of the channel, reduction or elimination of water flow of any stream or water body, or the complete removal or significant destruction of riparian vegetation associated with occupied northern Mexican or narrow-headed gartersnake habitat; and

(5) Unauthorized discharge of chemicals or fill material into any waters in which northern Mexican and narrow-headed gartersnakes are known to occur.

Questions regarding whether specific activities would constitute a violation of section 9 of the Act should be directed to the Arizona Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**). Requests for copies of the regulations concerning listed animals and general inquiries regarding prohibitions and permits may be addressed to the U.S. Fish and Wildlife Service, Endangered Species Permits, P.O. Box 1306, Albuquerque, New Mexico 87103 (telephone (505) 248–6920, facsimile (505) 248–6922).

Rule for the Northern Mexican Gartersnake Under Section 4(d) of the Act

The Act does not specify particular prohibitions, or exceptions to those prohibitions, for threatened species. Instead, under section 4(d) of the Act, the Secretary of the Interior has the discretion to issue such regulations as she deems necessary and advisable to provide for the conservation of such species. The Secretary also has the discretion to prohibit by regulation with respect to any threatened species, any act prohibited under section 9(a)(1) of the Act. Exercising this discretion, the Service developed general prohibitions (50 CFR 17.31) and exceptions to those prohibitions (50 CFR 17.32) under the Act that apply to most threatened species. Alternately, for other threatened species, the Service may develop specific prohibitions and exceptions that are tailored to the specific conservation needs of the species. In such cases, some of the prohibitions and authorizations under 50 CFR 17.31 and 17.32 may be appropriate for the species and incorporated into a rule under section 4(d) of the Act. However, these rules, known as 4(d) rules, will also include provisions that are tailored to the specific conservation needs of the threatened species and may be more or less restrictive than the general provisions at 50 CFR 17.31.

Provisions of the Section 4(d) Rule

Under section 4(d) of the Act, the Secretary may promulgate a special rule that modifies the standard protections for threatened species with measures tailored to the conservation of the species that are determined to be necessary and advisable. Under this 4(d) rule, all of the prohibitions under 50 CFR 17.31 and 17.32 will apply to the northern Mexican gartersnake, except as discussed below. The 4(d) rule will not remove or alter in any way the consultation requirements under section 7 of the Act.

The creation, use, and maintenance of stock tanks are important components of livestock grazing in the southwestern United States. A stock tank (or livestock tank) is defined as an existing or future impoundment in an ephemeral drainage or upland site (as opposed to an active stream channel) constructed primarily as a watering site for livestock. Well-managed stock tanks can provide important habitats for northern Mexican gartersnakes and their prey base, especially when the tank: (1) Remains devoid of harmful nonnative species while supporting native prey species; (2) provides adequate vegetation cover for predator aversion and prey base support; and (3) provides reliable water sources in periods of prolonged drought. However, to create or maintain these physical attributes of well-managed tanks, management and maintenance can be necessary, which may have temporary negative effects to these habitat attributes, but also long-term beneficial effects to wildlife, including the northern Mexican gartersnake and its prey. Therefore, the management of stock tanks is an important consideration for northern Mexican gartersnakes.

The 4(d) rule allows for use of stock tanks by livestock and construction, continued use, and maintenance of those stock tanks. Stock tanks provide habitat for northern Mexican gartersnakes, and thus their presence within the gartersnake's range provides a conservation benefit to the species. This 4(d) rule allows landowners to construct new stock tanks and to continue to use and maintain those stock tanks on non-Federal lands without the need for Federal permitting or oversight regarding compliance with the Act.

This provision may result in some harm or disturbance of individual northern Mexican gartersnakes as a result of livestock or human activities at the stock tanks; however, the level of disturbance is expected to be minimal and outweighed by the benefit to the species from the presence of these habitats that are provided by stock tanks.

Given the benefits of well-managed stock tanks, the presence of well-managed stock tanks are an important component to northern Mexican gartersnake conservation and recovery. This stock tank provision in the 4(d) rule allows for construction, continued use, and maintenance of stock tanks on non-Federal lands, and, therefore, because of the benefits associated with the habitat provided by well-managed stock tanks, the 4(d) rule is necessary and advisable for the conservation of the northern Mexican gartersnake.

Nothing in this 4(d) rule changes in any way the recovery planning provisions of section 4(f) and consultation requirements under section 7 of the Act or the ability of the Service to enter into partnerships for the management and protection of the northern Mexican gartersnake. Livestock use and maintenance of stock tanks on Federal lands will be addressed through the section 7 consultation process; this 4(d) rule applies only to non-Federal lands.

4(d) Rule Determination

Section 4(d) of the Act states that ''the Secretary shall issue such regulations as she deems necessary and advisable to provide for the conservation'' of species listed as a threatened species. Conservation is defined in the Act to mean ''to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to (the Act) are no longer necessary.'' Additionally, section 4(d) states that the Secretary ''may by regulation prohibit with respect to any threatened species any act prohibited under section 9(a)(1).''

The courts have recognized the extent of the Secretary's discretion under this standard to develop rules that are appropriate for the conservation of a species. For example, the Secretary may find that it is necessary and advisable not to include a taking prohibition, or to include a limited taking prohibition. See *Alsea Valley Alliance* v. *Lautenbacher,* 2007 U.S. Dist. Lexis 60203 (D. Or. 2007); *Washington Environmental Council* v. *National Marine Fisheries Service,* and 2002 U.S. Dist. Lexis 5432 (W.D. Wash. 2002). In addition, as affirmed in *State of Louisiana* v. *Verity,* 853 F.2d 322 (5th Cir. 1988), the rule need not address all the threats to the species. As noted by Congress when the Act was initially enacted, ''once an animal is on the threatened list, the Secretary has an almost infinite number of options available to her with regard to the permitted activities for those species.'' She may, for example, permit taking, but not importation of such species, or she may choose to forbid both taking and importation but allow the transportation of such species, as long as the measures will ''serve to conserve, protect, or restore the species concerned in accordance with the purposes of the Act'' (H.R. Rep. No. 412, 93rd Cong., 1st Sess. 1973).

Section 9 prohibitions make it illegal for any person subject to the jurisdiction of the United States to take (including harass, harm, pursue, shoot, wound, kill, trap, capture, or collect; or attempt any of these), import or export, ship in interstate commerce in the course of commercial activity, or sell or offer for sale in interstate or foreign commerce any wildlife species listed as an endangered species, without written authorization. It also is illegal under section 9(a)(1) of the Act to possess, sell, deliver, carry, transport, or ship any such wildlife that is taken illegally. Prohibited actions consistent with section 9 of the Act are outlined for threatened species in 50 CFR 17.31(a) and (b). This 4(d) rule applies all of the prohibitions in 50 CFR 17.31(a) and (b) to the northern Mexican gartersnake, except activities on non-Federal lands that are incidental to construction, continued use, and maintenance of stock tanks. Based on the rationale explained above, the provisions included in this 4(d) rule are expected to contribute to the conservation of the northern Mexican gartersnake and are, therefore, necessary and advisable to provide for the conservation of the northern Mexican gartersnake.

Required Determinations

National Environmental Policy Act (42 U.S.C. 4321 et seq.)

We have determined that environmental assessments and environmental impact statements, as defined under the authority of NEPA, need not be prepared in connection with listing a species as an endangered or threatened species under the Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244). As documented in the Service's Endangered Species Listing Handbook (Service 1994), it is the position of the Service that rules promulgated under section 4(d) of the Act concurrently with listing of the species fall under the same rationale as outlined in the October 25, 1983, determination; thus preparation of an environmental assessment for the 4(d) rule is not required.

Government-to-Government Relationship With Tribes

In accordance with the President's memorandum of April 29, 1994 (Government-to-Government Relations with Native American Tribal Governments; 59 FR 22951), Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments), and the Department of the Interior's manual at 512 DM 2, we readily acknowledge our responsibility to communicate meaningfully with recognized Federal Tribes on a government-to-government basis. In accordance with Secretarial Order 3206 of June 5, 1997 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities, and the Endangered Species Act), we readily acknowledge our responsibilities to work directly with tribes in developing programs for healthy ecosystems, to acknowledge that tribal lands are not subject to the same controls as Federal public lands, to remain sensitive to Indian culture, and to make information available to tribes.

Native American tribes potentially affected by the listing of these two gartersnakes include the San Carlos Apache Tribe, White Mountain Apache Tribe, and Yavapai Apache Tribe. On March 12, 2013, we mailed correspondence to these three tribes to request to meet with each tribe to discuss our listing recommendations for the gartersnakes. We met with representatives of the San Carlos Apache Tribe on May 1, 2013, and no concerns regarding the proposed listings were noted. We held a government-to-government meeting with the White Mountain Apache Tribe on September 27, 2013, to discuss the gartersnake listing recommendations, and we agreed to review their Native Fish Management Plan for conservation benefit to proposed and listed aquatic vertebrate species that occur on their lands. We provided comments on that plan during a conference call discussion on December 16, 2013. The Yavapai Apache Tribe did not have any comments on the proposed gartersnake listings.

References Cited

A complete list of references cited in this rulemaking is available on the Internet at *http://www.regulations.gov* and upon request from the Arizona Ecological Services Field Office (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this final rule are the staff members of the Arizona Ecological Services Field Office.

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

Regulation Promulgation

Accordingly, we amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as follows:

PART 17—[AMENDED]

■ 1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 1531–1544; and 4201–4245, unless otherwise noted.

■ 2. Amend § 17.11(h) by adding entries for ''Gartersnake, narrow-headed'' and ''Gartersnake, northern Mexican'' to the List of Endangered and Threatened Wildlife in alphabetical order under Reptiles to read as follows:

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	Scientific name						
*	*	*	*	*	*		*
Reptiles.							
*	*	*	*	*	*		*
Gartersnake, narrow-headed.	*Thamnophis rufipunctatus*.	U.S.A. (AZ, NM)	Entire	T		NA	NA.
Gartersnake, northern Mexican.	*Thamnophis eques megalops*.	U.S.A. (AZ, NM), Mexico.	Entire	T		NA	17.42(g).
*	*	*	*	*	*		*

■ 3. Amend § 17.42 by adding a new paragraph (g) to read as follows:

§ 17.42 Special rules—reptiles.

* * * * *

(g) Northern Mexican gartersnake (*Thamnophis eques megalops*). (1) *Prohibitions.* Except as noted in paragraph (g)(2) of this section, all prohibitions and provisions of §§ 17.31 and 17.32 apply to the northern Mexican gartersnake.

(2) *Exemptions from prohibitions.* Incidental take of the northern Mexican gartersnake will not be considered a violation of section 9 of the Act if the take occurs on non-Federal land and is incidental to activities pertaining to construction, continued use, and maintenance of stock tanks. A stock tank is an existing or future impoundment in an ephemeral drainage or upland site constructed primarily as a watering site for livestock.

Dated: June 9, 2014.

Stephen Guertin,

Acting Director, U.S. Fish and Wildlife Service.

[FR Doc. 2014–14615 Filed 7–7–14; 8:45 am]

BILLING CODE 4310–55–P