DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[FWS–R2–ES–2008–0065; MO 9221050083–B2]

Endangered and Threatened Wildlife and Plants; 12-Month Finding on a Petition To List the Northern Mexican Gartersnake (Thamnophis eques megalops) as Threatened or Endangered with Critical Habitat

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), announce a 12-month finding on a petition to list the northern Mexican gartersnake (*Thamnophis eques megalops*) as threatened or endangered with critical habitat under the Endangered Species Act of 1973, as amended (Act). The petitioners provided three listing options for consideration by the Service: (1) Listing the U.S. population as a Distinct Population Segment (DPS); (2) listing *Thamnophis eques megalops* throughout its range in the United States and Mexico based on its rangewide status; or (3) listing *Thamnophis eques megalops* throughout its range in the United States and Mexico based on its status in the United States. On the basis of the best scientific and commercial information available, we find that listing the northern Mexican gartersnake as threatened or endangered throughout its range in the United States and Mexico, based on its rangewide status, is warranted under the Act, due to the present or threatened destruction, modification or curtailment of its habitat; predation; and the inadequacy of existing regulatory mechanisms. Currently, listing is precluded by higher priority actions to amend the Lists of Endangered and Threatened Wildlife and Plants. Upon publication of this 12-month petition finding, the northern Mexican gartersnake will be added to our candidate species list. We will develop a proposed rule to list the northern Mexican gartersnake as our priorities allow. Any determination on critical habitat will be made during development of the proposed rule.

DATES: The finding announced in this document was made on November 25, 2008.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* at Docket Number FWS–R2–ES–2008–0065. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, Arizona Ecological Services Office, 2321 West Royal Palm Road, Suite 103, Phoenix, AZ 85021–4951. Please submit any new information, materials, comments, or questions concerning this finding to the above address.

FOR FURTHER INFORMATION CONTACT: Steve Spangle, Field Supervisor, Arizona Ecological Services Office (see **ADDRESSES**), telephone 602–242–0210. If you use a telecommunications device for the deaf (TDD), please call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Act (16 U.S.C. 1531 *et seq.*), requires that, for any petition containing substantial scientific and commercial information indicating that listing may be warranted, we make a finding within 12 months of the date of receipt of the petition on whether the petitioned action is: (a) Not warranted, (b) warranted, or (c) warranted, but immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are threatened or endangered, and expeditious progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding; that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register**.

On December 19, 2003, we received a petition dated December 15, 2003, requesting that we list the northern Mexican gartersnake as threatened or endangered, and that we designate critical habitat concurrently with the listing. The petition, submitted by the Center for Biological Diversity, was clearly identified as a petition for a listing rule and contained the names, signatures, and addresses of the requesting parties. Included in the petition was supporting information regarding the species' taxonomy and ecology, historical and current distribution, present status, and actual and potential causes of decline. We acknowledged the receipt of the petition in a letter to Mr. Noah Greenwald, dated March 1, 2004. In that letter, we also advised the petitioners that, due to funding constraints in fiscal year (FY) 2004, we would not be able to begin processing the petition at that time.

Previous Federal Actions

The Mexican gartersnake (*Thamnophis eques*) (which included the subspecies *megalops*) was placed on the list of candidate species as a Category 2 species in 1985 (50 FR 37958). Category 2 species were those for which existing information indicated that listing was possibly appropriate, but for which substantial supporting biological data to prepare a proposed rule were lacking. In the 1996 Candidate Notice of Review (February 28, 1996; 61 FR 7596), the use of Category 2 candidates was discontinued, and the northern Mexican gartersnake was no longer recognized as a candidate.

On May 17, 2005, the petitioners filed a complaint for declaratory and injunctive relief, challenging our failure to issue a 90-day finding in response to the petition as required by 16 U.S.C. 1533(b)(3)(A) and (B). In a stipulated settlement agreement, we agreed to submit a 90-day finding to the **Federal Register** by December 16, 2005, and if substantial, submit a 12-month finding to the **Federal Register** by September 15, 2006 (*Center for Biological Diversity* v. *Norton*, CV–05–341–TUC–CKJ (D. Az)). The settlement agreement was signed and adopted by the District Court of Arizona on August 2, 2005.

On December 13, 2005, we made our 90-day finding that the petition presented substantial scientific information indicating that listing the northern Mexican gartersnake (*Thamnophis eques megalops*) may be warranted, but we did not discuss the applicability of any of the three listing scenarios that were provided in the petition. The finding and our initiation of a status review was published in the **Federal Register** on January 4, 2006 (71 FR 315).

On September 26, 2006, we published a 12-month finding that listing of the northern Mexican gartersnake was not warranted because we determined that not enough information on the subspecies' status and threats in Mexico was known at that time (71 FR 56227). On November 17, 2007, the petitioners filed a complaint for declaratory and injunctive relief pursuant to section 11 of the Act (16 U.S.C. 1540), seeking to set aside the 12-month finding. Additionally, a formal opinion was issued by the Solicitor of the Department of the Interior, ''The Meaning of In Danger of Extinction Throughout All or a Significant Portion of Its Range'' (U.S. DOI 2007), which provides further guidance on how to conduct a detailed analysis of whether a species is in danger of extinction throughout a significant portion of its range. In December 2007, the Service withdrew the September 26, 2006, 12-month finding to consider the new ''Significant Portion of the Range'' policy. In a stipulated settlement agreement with the petitioners, we agreed to submit a new 12-month finding to the **Federal Register** by November 17, 2008 (*Center for Biological Diversity* v. *Kempthorne*, CV–07–596–TUC–RCCJ (D. Az)). The settlement agreement was signed and adopted by the District Court of Arizona on June 18, 2008.

This notice constitutes a new 12-month finding for the petition to list the northern Mexican gartersnake as threatened or endangered. The petitioners described three potentially listable entities of gartersnake for consideration by the Service: (1) Listing the U.S. population as a Distinct Population Segment (DPS); (2) listing *Thamnophis eques megalops* throughout its range in the United States and Mexico based on its rangewide status; or (3) listing *Thamnophis eques megalops* throughout its range in the United States and Mexico based on its status in the United States. Because we found that listing the northern Mexican gartersnake rangewide was warranted, there was no need to conduct any further analysis of the remaining two options, which are smaller geographic entities and are subsumed by the rangewide listing.

Biology

Species Description. The northern Mexican gartersnake ranges in color from olive to olive-brown or olive-gray with three stripes that run the length of the body, the middle of which darkens towards the tail. It may occur with other native gartersnake species and can be difficult for people without herpetological 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 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). A more detailed species description can be found in our 2006 12-month finding for this species (71 FR 56227), or by reviewing Rosen and Schwalbe (1988, p.4), Rossman *et al.* (1996, pp. 171–172), or Manjarrez and Garcia (1993, pp. 1–5).

Taxonomy. The northern Mexican 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), but also 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).

In recent history and 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. inspiratus;* (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 finding, 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). There are no known challenges within the scientific literature of the validity of current taxonomy of any of the 10 subspecies of *T. eques.* A more detailed description of the taxonomy of the northern Mexican gartersnake is found in our September 26, 2006 12-month finding for this species (71 FR 56227). Additional information regarding this species' 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, pp. 171–175), Rosen and Schwalbe (1988, pp. 2–3), Liner (1994, p. 107), and Crother (2008, p. 63).

On many occasions throughout this finding, we discuss the status of and threats to several prey species of the northern Mexican gartersnake, including anuran (frog and toad) species of the genera historically known as *Rana* and *Bufo* (true frogs and true toads, respectively). Frost *et al.* (2006, pp. 9–11) proposed several taxonomic name changes, including many species under the genus *Rana* to *Lithobates,* and many species under the genus *Bufo* to *Anaxyrus.* Crother (2008, pp. 2–12), Committee Chair for the Standard English and Scientific Names Committee, adopted these scientific name changes. However, these taxonomic revisions have not escaped significant scrutiny in the scientific literature. Weins (2007, pp. 55–56) criticized the methodologies and analysis of Frost *et al.* (2006, pp. 9–11). Subsequently, Frost *et al.* (2008, pp. 385–395) rebutted these criticisms. Throughout this finding, we continue to use the genera *Rana* and *Bufo* to maintain taxonomic familiarity among the interested parties, retain consistency in the **Federal Register** with respect to notices regarding the northern Mexican gartersnake, and allow ample opportunity for peer review and deliberation in the scientific community with respect to the findings of Frost *et al.* (2006, pp. 9–11).

Habitat. 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). The northern Mexican gartersnake is a riparian obligate (restricted to riparian areas when not engaged in dispersal behavior) and occurs chiefly in the following general habitat types: (1) Source-area wetlands (e.g., cienegas (mid-elevation wetlands with highly organic, reducing (basic or alkaline) soils), stock tanks (small earthen impoundment), etc.); (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; Arizona Game and Fish Department 2001). Additional information on the habitat requirements of the northern Mexican gartersnake within the United States and Mexico can be found in our 2006 12-month finding for this species (71 FR 56227) and in Rosen and Schwalbe (1988, pp. 14–16), Rossman *et al.* (1996, p. 176), McCranie and Wilson (1987, pp. 11–17), and Cirett-Galan (1996, p. 156).

Behavior, Prey Base, and Reproduction. The northern Mexican gartersnake is surface active at ambient 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, pp. 308–309) found that northern Mexican gartersnakes spent approximately 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; body temperatures ranged from 24–33 °C (75–91 °F) and averaged 28 °C (82 °F), which is lower than other, similar species with comparable habitat and prey preferences. Rosen (1991, p. 310) suggested that lower preferred body temperatures exhibited by northern Mexican gartersnakes may be due to both (1) their tendency to occupy cienega-like habitat where warm ambient temperatures are relatively unavailable; and, (2) their tendency to remain in dense cover.

The northern Mexican gartersnake is an active predator and is believed to heavily depend upon a native prey base (Rosen and Schwalbe 1988, pp. 18, 20). Northern Mexican gartersnakes forage generally along vegetated banklines, searching for prey in water and on land, using different strategies (Alfaro 2002, p. 209). Generally, its diet consists predominantly of amphibians and fishes, such as adult and larval native leopard frogs (e.g., lowland leopard frog (*Rana yavapaiensis*) and Chiricahua leopard frog (*Rana 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). Auxiliary prey items may also include young Woodhouse's toads (*Bufo woodhousei*), treefrogs (Family Hylidae), earthworms, deermice (*Peromyscus spp.*), lizards of the genera *Aspidoscelis* and *Sceloporus,* larval tiger salamanders (*Ambystoma tigrinum*), and leeches (Gregory *et al.* 1980, pp. 87, 90–92; 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). To a much lesser extent, this snake's diet may include nonnative species, including larval and juvenile bullfrogs, and mosquitofish (*Gambusia affinis*) (Holycross *et al.* 2006, p. 23). 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 by a Mexican gartersnake of a Mexican alpine blotched gartersnake (*Thamnophis scalaris*).

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 snakes fed primarily upon aquatic vertebrates (fishes, frogs, and larval salamanders) and leeches, whereas smaller snakes fed primarily upon earthworms and leeches (Marcías-García and Drummond 1988, p. 131). Marcías-García and Drummond (1988, p. 130) also found that parturition (birth) of neonatal *T. eques* tended to coincide with the annual peak density of annelids (earthworms and leeches). 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/or prey species scarce, Mexican gartersnake capture rates declined (Marcías-García and Drummond 1988, p. 132). This indicates 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.

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 ovoviviparous (eggs develop and hatch within the oviduct of the female). Mating occurs in April and May followed by the live birth of between 7 and 26 newborns (newly born individuals) (average is 13.6) in July and August (Rosen and Schwalbe 1988, p. 16). Unlike other gartersnake species, which typically breed annually, approximately half of the sexually mature females within a population of northern Mexican gartersnake reproduce in any one season (Rosen and Schwalbe 1988, p. 17). This may have negative implications for the species' ability to rebound in isolated populations facing threats such as nonnative species, habitat modification or destruction, and other perturbations. Low birth rates will impede recovery of such populations by accentuating the effects of these threats.

Distribution

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) in elevation. It was generally found where water was relatively permanent and supported suitable habitat. The northern Mexican gartersnake historically occurred in every county within Arizona, within several perennial or intermittent drainages and disassociated wetlands (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; Rosen 2006; Holycross 2006).

Historically, the northern Mexican gartersnake had a limited distribution in New Mexico that consisted of scattered locations throughout the Gila and San Francisco headwater drainages in Grant and western Hidalgo Counties (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 (De Queiroz and Smith 1996, p. 155). The species 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 likely pertained directly to the Colorado River and are extirpated.

Within Mexico, northern Mexican gartersnakes historically occurred within the Sierra Madre Occidental and the Mexican Plateau in the Mexican states of Sonora, Chihuahua, Durango, Coahila, 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 species (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).

Status in the United States. Variability in survey design and effort makes it difficult to compare population trends among sites and between sampling periods. Thus, for each of the sites considered in our analysis, 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. Given the data provided, it is not possible to determine population densities at the sites.

A detailed status of the northern Mexico gartersnake in the United States and Mexico can be found in our 2006 12-month finding (71 FR 56227) and in Holycross *et al.* (2006, p. 12); Rosen and Schwalbe (1988, Appendix 1); Rosen *et* *al.* (2001, pp. 21–22, Appendix 1); d'Orgeix (2008); Holm and Lowe (1995, pp. 27–35). Subsequent to our 2006 12-month finding, we have obtained and analyzed additional information pertinent to the status of the northern Mexico gartersnake and present it below.

Scotia Canyon was the last area intensively resurveyed by Rosen *et al.* (2001, pp. 15–16). In comparing capture rates from Holm and Lowe (1995, pp. 27–35), northern Mexican gartersnake populations in this area appear to have declined from 1980–1982, to low capture rates in 1993, and even lower capture rates in 2000 (Boyarski 2008c, p. 1). In 2008, a multi-party effort was initiated within Scotia Canyon, including the Peterson Ranch Pond and vicinity, to eradicate bullfrogs as well as record observations of Chiricahua leopard frogs or northern Mexican gartersnakes (Frederick 2008, 2008b). These efforts occurred in the same area investigated by Holm and Lowe (1995, pp. 27–35) and Rosen *et al.* (2001, pp. 15–16). After many surveys of herpetofauna (reptiles and amphibians) in this area to identify the presence of bullfrogs for eradication, a single, large adult northern Mexican gartersnake was observed, the first in over 8 years of informal surveys at this site (Frederick 2008b), which is frequently visited by biologists. This observation suggests that the species continues to occur in the upper Scotia Canyon area, but, given the extensive survey effort, it occurs in exceptionally low densities and no longer represents a stable population because of problems with reproduction and survivorship that exist with populations comprised of very low numbers of individuals.

A significant amount of survey effort for northern Mexican gartersnakes was conducted at the Las Cienegas National Conservation Area (Cienega Creek and Empire Cienega) from 2002–2008. During the 2002 and 2003 field seasons, Rosen and Caldwell (2004, pp. 1–52) conducted an in-depth assessment of the riparian herpetofaunal community of this area and in 11,784 trap-hours captured by hand and trap, 29 northern Mexican gartersnakes that were marked and released. Twenty-one northern Mexican gartersnakes were trapped, which equates to 561 trap-hours per snake. In 2004, Rosen and Caldwell (2004, p. 21) considered the species to be ''widely distributed, though perhaps reduced in abundance'' in this area.

In 2007 and 2008, significant effort to collect northern Mexican gartersnakes was given to this same area using similar techniques as Rosen and Caldwell (2004) (Gartersnake Conservation Working Group (GCWG) 2008, pp. 1–10). Servoss *et al.* (2007, p. 4) captured one juvenile northern Mexican gartersnake by hand after 27 person search-hours and 1,000 trap-hours of effort.

Due to limited success in collecting the species in 2007, in 2008, the Arizona Game and Fish Department contracted with a recognized reptile and amphibian researcher familiar with the area to collect specimens for captive propagation (GCWG 2008, pp. 1–10). The herpetologist trapped a single juvenile northern Mexican gartersnake in 3,612 trap-hours and 104 person search-hours of effort (Caldwell 2008a, 2008b).

The wildlife biologist for the Bureau of Land Management (BLM) Tucson Field Office (who has conducted fish sampling at the Las Cienegas National Conservation Area since 1998) expressed concerns for the apparent population decline of northern Mexican gartersnakes in this area. Several fish sampling techniques he employs are also used specifically to sample aquatic snake species such as the northern Mexican gartersnake. Simms (2008) stated that seining and hoop netting at 40 locations, as well as visual surveys of this area performed in 2008, have yielded no observations of Mexican gartersnakes.

The data from 2007 and 2008 confirm that this formerly stable population at the Las Cienegas National Conservation Area is experiencing significant declines, may no longer be viable, and could become extirpated in the near-term. In 2007 and 2008, more than 2,300 trap-hours were required per snake captured (Caldwell 2008a, 2008b; Servoss *et al.* 2007, p. 1–12), compared with Rosen and Caldwell's (2004, p. 21 Table 2) capture rates of 561 trap-hours per snake in 2002 and 2003. This is a more than four-fold increase in the effort needed to capture northern Mexican gartersnakes.

The recently documented population of northern Mexican gartersnakes within Tonto Creek is the only known population that remains from the Salt River Basin (the status of the species in the basin on the White Mountain Apache and San Carlos Apache reservations remains unknown). Wallace *et al.* (2008, pp. 243–244) documented the first record of northern Mexican gartersnakes from the Tonto Creek watershed in Gila County, from a specimen that was observed in the road (killed by a vehicle) on State Route 188 in 1995. Seventeen individual northern Mexican gartersnakes were subsequently captured in Tonto Creek with 20,444 trap-hours of effort (1,202 trap-hours per snake) in 2004 and 2005 (Holycross *et al.* 2006, pp. 41–44; Wallace *et al.* 2008, pp. 243–244). Wallace *et al.* (2008, pp. 243–244) suggest northern Mexican gartersnakes in Tonto Creek persist in low densities and raise the possibility that recruitment (the process by which individuals within a population achieve reproductive maturity) may be in decline because only adult and newborn specimens were captured, with no intermediate age classes observed.

The population of northern Mexican gartersnakes along the Verde River within the Verde Valley of Yavapai County is presumed to remain as a low-density population. Approximately 15 individuals, including agency personnel and private citizens, surveyed the Verde River within the Verde Valley (including Dead Horse Ranch State Park) for the purpose of collecting 5 Mexican gartersnakes for captive propagation in 2007 (GCWG 2007, p. 2). Approximately 120 person-search hours resulted in no observations of northern Mexican gartersnakes (GCWG 2007, p. 2). Haney *et al.* (2008, p. 61) declared the northern Mexican gartersnake nearly lost from the Verde River.

A population of northern Mexican gartersnakes that remains at the Arizona Game and Fish Department's Page Springs and Bubbling Ponds fish hatcheries (hatcheries), located adjacent to Oak Creek, upstream of its confluence with the Verde River, represents the highest density population in Arizona and potentially the last remaining viable population in the United States. Boyarski (2008b, pp. 1–10) summarizes the first (2007) field season of a northern Mexican gartersnake monitoring project at the hatcheries, which had the objective of establishing the baseline population demographics from which to launch future investigations (Boyarski 2008b, p. 4). Although several capture techniques were employed, trapping was the most effective by far. In total, 52 individual northern Mexican gartersnakes were captured in 2007; 42 from Bubbling Ponds, 8 from Page Springs, and 2 from the adjacent Oak Creek (Boyarski 2008b, p. 5). In total, 19,457 trap-hours captured 56 northern Mexican gartersnakes (including 7 recaptures), which equates to 347 trap-hours per capture (Boyarski 2008b, p. 6). As this was the first year to acquire population data for northern Mexican gartersnakes within the hatcheries, population trends at these sites cannot be determined. However, hatchery personnel stated that northern Mexican gartersnakes are not observed as frequently and do not appear to be as common as they once were at these sites

(Boyarski 2008b, p. 8). While not associated with a scientific study, this statement by hatchery personnel, who spend most of their time in the immediate vicinity of occupied habitat, is of special concern because it illustrates the potential that long-term declines may have been occurring at the hatchery although potential declines can not be quantified.

Sonoita Creek in Santa Cruz County in southern Arizona was a historical location for northern Mexican gartersnakes. Turner (2006, pp. 1–21) found no northern Mexican gartersnakes in a herpetological inventory conducted from April through September 2006, in the Sonoita Creek State Natural Area. The last record of a northern Mexican gartersnake in this area was in 1974 and the subspecies was not found during Turner's 204-person-search-hour, 5,472-trap-hour survey effort (Turner 2006, pp. 3, 9). Crayfish, bullfrogs, and nonnative fish were observed by Turner (2006, p. 10) throughout the riparian area of the study area, as was evidence of improper livestock grazing.

In our 2006 12-month finding for this species, we specified that the last known observation of the northern Mexican gartersnake in New Mexico occurred in 1994 on private land (Painter 2000, p. 36, Painter 2005). In 2007, we became aware of a single photo-vouchered record of a northern Mexican gartersnake in New Mexico. The specimen was discovered and photo-vouchered in August 2002, observed in a debris pile along the Gila River off Highway 180 in Grant County, New Mexico (Hill 2007). Subsequent searches for northern Mexican gartersnakes were conducted in the same vicinity in 2006 and 2007, but no individuals were observed (Hill 2007). In our 2006 finding (71 FR 56227), we considered the northern Mexican gartersnake as extirpated from New Mexico. In consideration of: (1) A single observation of the species in New Mexico within the last 14 years that occurred in 2002; (2) 2 years of survey effort in 2006 and 2007 within the Gila River in the area of the 2002 observation by Hill (2007); and (3) additional survey effort of historical habitat for the species in New Mexico in 2007, we consider the status of the northern Mexican gartersnake in the Gila River at the Highway 180 crossing in New Mexico as unknown at this time (Painter 2008; Cotton 2008; Kindscher *In Prep.*, pp. 1–26). All other historical locations of the northern Mexican gartersnake in New Mexico are considered extirpated (Painter 2005).

General concerns within the scientific community exist for age class structure within northern Mexican gartersnake populations that have been affected by nonnative species. It is widely believed that recruitment of northern Mexican gartersnakes may be significantly impeded by nonnative predation on the neonate and juvenile age classes. Individuals that survive past these age classes are likely to have increased survivorship, in part by foraging on the nonnative species that preyed upon them during their younger age classes. These population-level observations have been made in several populations including Scotia Canyon (Holm and Lowe 1995, p. 34), Tonto Creek (Wallace *et al.* 2008, pp. 243–244), and the San Bernardino National Wildlife Refuge (Rosen and Schwalbe 1988, p. 18).

Our analysis of the best available data on the status of the northern Mexican gartersnake distribution in the United States indicates that its distribution has been significantly reduced, and it is likely extirpated from a large portion of its historical distribution within the United States. We define a population as ''likely extirpated'' when there have been no northern Mexican gartersnakes reported for a decade or longer at a site within the historical distribution of the species, despite survey efforts, and there is no expectation of natural recovery at the site due to the presence of known or strongly suspected causes of extirpation. The perennial or intermittent stream reaches and disassociated wetlands (i.e., stock tanks, ponds, cienegas, etc.) where the northern Mexican gartersnake has likely been extirpated in Arizona include: (1) The Gila River; (2) the Lower Colorado River from Davis Dam to the International Border; (3) the San Pedro River; (4) the Santa Cruz River downstream from the International Border at Nogales; (5) the Salt River; (6) the Rio San Bernardino from International Border to headwaters at Astin Spring (San Bernardino National Wildlife Refuge); (7) the Agua Fria River; (8) the Verde River upstream of Clarkdale; (9) the Verde River from the confluence with Fossil Creek downstream to its confluence with the Salt River; (10) Tanque Verde Creek in Tucson; (11) Rillito Creek in Tucson; (12) Agua Caliente Spring in Tucson; (13) Potrero Canyon/Springs; (14) Babocamari Cienega; (15) Barchas Ranch, Huachuca Mountain bajada; (16) Parker Canyon Lake and tributaries in the Canelo Hills; and (17) Oak Creek at Midgley Bridge (Rosen and Schwalbe 1988, pp. 25–26, Appendix I; 1997, pp. 16–17; Rosen *et al.* 2001, Appendix I; Brennan and Holycross 2006, p. 123; Holycross 2006; Holycross *et al.* 2006, pp. 15–51, 66; Radke 2006; Rosen 2006).

In New Mexico, the following historical populations are considered extirpated: (1) Mule Creek; (2) the Gila River, 5 miles (mi) (8 kilometers (km)) east of Virden; (3) Spring Canyon; (4) the West Fork Gila River at Cliff Dwellings National Monument; (5) the Tularosa River at its confluence with the San Francisco River; (6) the San Francisco River at Tub Spring Canyon; (7) Little Creek at Highway 15; (8) the Middle Box of Gila River at Ira Ridge; (9) Turkey Creek; (10) Negrito Creek; and (11) the Rio Mimbres (Fitzgerald 1986, Table 2; Painter 2005, 2006; 2008; Cotton 2008; Kindscher *In Prep.,* pp. 1–26).

Conversely, our review of the best available information indicates the northern Mexican gartersnake likely occurs in a fraction of its former range in Arizona. We define populations as ''likely occurring'' when the species is expected to reliably occur in appropriate habitat as supported by recent museum records and/or recent (i.e., less than 10 years) reliable observations. The perennial or intermittent stream reaches and disassociated wetlands where we conclude northern Mexican gartersnakes remain include: (1) The Santa Cruz River/Lower San Rafael Valley (headwaters downstream to the International Border); (2) the Verde River from the confluence with Fossil Creek upstream to Clarkdale; (3) Oak Creek at Page Springs; (4) Tonto Creek from the mouth of Houston Creek downstream to Roosevelt Lake; (5) Cienega Creek from the headwaters downstream to the ''Narrows'' just downstream of Apache Canyon; (6) Pantano Wash (Cienega Creek) from Pantano downstream to Vail; (7) Appleton-Whittell Research Ranch and vicinity near Elgin; and (8) Red Rock Canyon east of Patagonia (Rosen *et al.* 2001, Appendix I; Caldwell 2005; Brennan and Holycross 2006, p. 123; Holycross 2006; Holycross *et al.* 2006, pp. 15–51, 66; Rosen 2006; Jones 2008a).

The current status of the northern Mexican gartersnake is unknown in several areas within Arizona and New Mexico where the species is known to have historically occurred. We base this determination primarily on historical museum records for locations where survey access is restricted, survey data are unavailable or insufficient, and/or current threats could preclude occupancy. The perennial or intermittent stream reaches and disassociated wetlands where the status of the northern Mexican gartersnake remains uncertain include: (1) The downstream portion of the Black River drainage from the Paddy Creek confluence; (2) the downstream portion of the White River drainage from the confluence of the East and North forks; (3) Big Bonito Creek; (4) Lake O'Woods near Lakeside; (5) Spring Creek above the confluence with Oak Creek; (6) Bog Hole Wildlife Area; (7) Upper 13 Tank, Patagonia Mountain bajada; (8) Babocamari River; (9) Upper Scotia Canyon in the Huachuca Mountains; (10) Arivaca Cienega; and, (11) Gila River at Highway 180 (in New Mexico) (Rosen and Schwalbe 1988, Appendix I; Rosen *et al.* 2001, Appendix I; Brennan and Holycross 2006, p. 123; Holycross 2006; Holycross *et al.* 2006, pp. 15–51; Rosen 2006).

In summary, based upon our analysis of the best available scientific and commercial data, we conclude that the northern Mexican gartersnake has been extirpated from approximately 90 percent of its historical distribution in the United States.

Status in Mexico. Determining the status and current distribution of the northern Mexican gartersnake in Mexico is difficult because of the lack of large-scale surveys, research, and other pertinent information. We can determine that there have been important large-scale losses of northern Mexican gartersnake habitat, and that, at least locally, northern Mexican gartersnake populations have been extirpated or are declining. We relied, in part, on information that addresses the status of both riparian and aquatic biological communities that are habitat for the northern Mexican gartersnake and the status of native freshwater fish species that are documented prey species for the northern Mexican gartersnake from areas within its historical distribution in Mexico. From the status of those communities or fish species, we inferred a similar status for the northern Mexican gartersnake as we have no reason to conclude these particular predator-prey relationships respond any differently to biological community-level perturbations in Mexico as has been observed reliably in the United States. See Factors A and C for analysis of threats to the habitat and prey base.

A large number of springs have dried up in several Mexican states within the distribution of the northern Mexican gartersnake, particularly from the years 1974–1994 in states including Chihuahua, Durango, Coahila, and San Luis Potosí (Contreras Balderas and Lozano 1994, p. 381). Because this has eliminated the habitat and aquatic prey base of the snake, we conclude that the northern Mexican gartersnake has also been lost from these sites. Contreras Balderas and Lozano (1994, p. 381) stated that several streams and rivers throughout Mexico and within the distribution of the northern Mexican gartersnake have also dried up or become intermittent due to overuse of surface and groundwater supplies. Ramirez Bautista and Arizmendi (2004, p. 3) stated that the principal threats to northern Mexican gartersnake habitat in Mexico include the drying of wetlands. Because this has decreased the amount of habitat and the aquatic prey base of the snake, we conclude that the northern Mexican gartersnake has likely declined at these sites.

Burger (2008) provides a preliminary data set of survey effort for Mexican gartersnakes (*Thamnophis eques*), southern Durango spotted gartersnakes (*T. nigronuchalis*), and narrow-headed gartersnakes (*T. rufipunctatus*) from the United States and Mexico through 2007 (*T. nigronuchalis* only occurs in Mexico). The Burger (2008) data set provides information from surveys of 17 stream systems in the Mexican states of Durango and southern Chihuahua along the Sierra Madre Occidental during June 2007. Mexican gartersnakes were observed at 5 of the 17 sites visited; however, specimens were not identified to subspecies, and some sites visited may not have been within the historical distribution of the northern Mexican gartersnake. Individuals observed from locations in southern Durango were likely *T. e. virgatenuis,* rather than the northern Mexican gartersnake. This sampling effort in Mexico geographically constitutes a small portion of the range of the northern Mexican gartersnake in that country, but it provides limited regional insight into the species' status. Population trends at locations visited cannot be assessed because these sites have only been visited once.

A research biologist with the Universidad Autonoma del Estado de México, who has been doing field research on Mexican gartersnakes in central Mexico (within the distribution of northern Mexican gartersnakes) for approximately two decades, has documented the decline or disappearance of populations from drying of water bodies, water contamination, and other human impacts where, 20 years ago, the species was abundant (Manjarrez 2008).

Determining the status of the northern Mexican gartersnake in Mexico is hampered by the lack of large-scale surveys, research, and other pertinent information for that country. We can determine that there have been important large-scale losses of northern Mexican gartersnake habitat, including surface waters such as rivers, streams, wetlands, and springs, that certainly have affected gartersnake populations. We can also determine that, where local surveys have been conducted, northern Mexican gartersnakes have been extirpated or are declining (Manjarrez 2008).

Summary of Factors Affecting the Northern Mexican Gartersnake

Section 4 of the Act (16 U.S.C. 1533), and implementing regulations at 50 CFR 424, set forth 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 on the basis of any of five factors, as follows: (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. In making this finding, information regarding the status of, and threats to, the northern Mexican gartersnake in relation to the five factors provided in section 4(a)(1) of the Act is discussed below and summarized in Table 1 below.

Table 1—Summary of northern Mexican gartersnake status and threats by population in the United States. (**Note**: "Extirpated" means that there have been no northern Mexican gartersnakes reported for a decade or longer at a site within the historical distribution of the species, despite survey efforts, and there is no expectation of natural recovery at the site due to the presence of known or strongly suspected causes of extirpation. "Extant" means areas where the species is expected to reliably occur in appropriate habitat as supported by museum records or recent, reliable observations. "Unknown" means areas where the species is known to have occurred based on museum records (mostly historical) but access is restricted, or survey data is unavailable or insufficient, or where threats could preclude occupancy.)

Population locality	Current status	Regional historical or current threats
Gila River (outside of Highway 180 crossing) (Arizona, New Mexico).	Extirpated	*Factor A:* Improper grazing, recreation, development, groundwater pumping, water diversions, channelization, dewatering, road construction/use, wildfire, intentional harm, dams. *Factor C:* Nonnative species, prey base reduction.
Gila and San Francisco Headwaters (New Mexico).	Extirpated	*Factor A:* Improper grazing, recreation. *Factor C:* Nonnative species, prey base reduction.
Lower Colorado River from Davis Dam to International Border (Arizona).	Extirpated	*Factor A:* Recreation, development, road construction and use, borderland security and undocumented immigration, intentional harm, dams. *Factor C:* Nonnative species, prey base reduction.
San Pedro River in United States (Arizona).	Extirpated	*Factor A:* Improper grazing, groundwater pumping, road construction and use, borderland security and undocumented immigration, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Santa Cruz River downstream of the Nogales area of the International Border (Arizona).	Extirpated	*Factor A:* Improper grazing, development, groundwater pumping, water diversions, channelization, road construction and use, borderland security and undocumented immigration, intentional harm, contaminants. *Factor C:* Nonnative species, prey base reduction.
Salt River (Arizona)	Extirpated	*Factor A:* Improper grazing, recreation, development, water diversions, wildfire, channelization, road construction/use, intentional harm, dams. *Factor C:* Nonnative species, prey base reduction.
Rio San Bernardino from International Border to headwaters at Astin Spring (San Bernardino National Wildlife Refuge, Arizona).	Extirpated	*Factor A:* Borderland security and undocumented immigration, intentional harm. *Factor C:* Nonnative species, prey base reduction. *Factor E:* Competition with Marcy's checkered gartersnake.
Agua Fria River (Arizona)	Extirpated	*Factor A:* Improper grazing, development, recreation, dams, road construction and use, wildfire, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Verde River upstream of Clarkdale (Arizona).	Extirpated	*Factor A:* Improper grazing, recreation, development, groundwater pumping, water diversions, channelization, road construction and use, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Verde River from the confluence with the Salt upstream to Fossil Creek (Arizona).	Extirpated	*Factor A:* Improper grazing, recreation, groundwater pumping, water diversions, channelization, road construction and use, wildfire, development, intentional harm, dams. *Factor C:* Nonnative species, prey base reduction.
Potrero Canyon/Springs (Arizona)	Extirpated	*Factor A:* Improper grazing. *Factor C:* Nonnative species, prey base reduction.
Tanque Verde Creek in Tucson (Arizona)	Extirpated	*Factor A:* Improper grazing, recreation, development, groundwater pumping, road construction and use, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Rillito Creek in Tucson (Arizona)	Extirpated	*Factor A:* Improper grazing, recreation, development, groundwater pumping, road construction and use, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Agua Caliente Spring in Tucson (Arizona).	Extirpated	*Factor A:* Improper grazing, recreation, development, groundwater pumping, road construction and use, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Babocamari Cienega (Arizona)	Extirpated	*Factor A:* Improper grazing. *Factor C:* Nonnative species, prey base reduction.
Barchas Ranch, Huachuca Mountain bajada (Arizona).	Extirpated	*Factor A:* Improper grazing, borderland security and undocumented immigration, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Parker Canyon Lake and tributaries in the Canelo Hills (Arizona).	Extirpated	*Factor A:* Improper grazing, recreation, road construction and use, borderland security and undocumented immigration, intentional harm, dams. *Factor C:* Nonnative species, prey base reduction.
Oak Creek at Midgley Bridge (Arizona)	Extirpated	*Factor A:* Improper grazing, recreation, development, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Santa Cruz River/Lower San Rafael Valley (headwaters downstream to International Border) (Arizona).	Extant	*Factor A:* Improper grazing, borderland security and undocumented immigration, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Verde River from the confluence with Fossil Creek upstream to Clarkdale (Arizona).	Extant	*Factor A:* Improper grazing, recreation, development, groundwater pumping, water diversions, channelization, road construction and use, intentional harm, dams. *Factor C:* Nonnative species, prey base reduction.
Oak Creek at Page Springs (Arizona)	Extant	*Factor A:* Development, construction, vehicle mortality. *Factor C:* Nonnative species, prey base reduction, domestic cat predation, parasites.
Tonto Creek from mouth of Houston Creek downstream to Roosevelt Lake (Arizona).	Extant	*Factor A:* Improper grazing, recreation, development, water diversions, channelization, road construction and use, wildfire, intentional harm, dams, flood control. *Factor C:* Nonnative species, prey base reduction.
Cienega Creek from headwaters downstream to the "Narrows" just downstream of Apache Canyon (Arizona).	Extant	*Factor A:* Improper grazing. *Factor C:* Nonnative species, prey base reduction.

Population locality	Current status	Regional historical or current threats
Pantano Wash (Cienega Creek) from Pantano downstream to Vail (Arizona).	Extant	*Factor A:* Improper grazing, development, wildfire. *Factor C:* Nonnative species, prey base reduction.
Appleton-Whittell Research Ranch and vicinity near Elgin (Arizona).	Extant	*Factor A:* Improper grazing. *Factor C:* Nonnative species, prey base reduction.
Upper Scotia Canyon in the Huachuca Mountains (Arizona).	Unknown	*Factor A:* Wildfire. *Factor C:* Nonnative species, prey base reduction.
Downstream portion of the Black River drainage from the Paddy Creek confluence (Arizona).	Unknown	*Factor A:* Improper grazing, recreation, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Downstream portion of the White River drainage from the confluence of the East/North (Arizona).	Unknown	*Factor A:* Improper grazing, recreation, road construction and use, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Big Bonito Creek (Arizona)	Unknown	*Factor A:* Improper grazing. *Factor C:* Nonnative species, prey base reductions.
Lake O' Woods (Lakeside, Arizona)	Unknown	*Factor A:* recreation, development, road construction/use, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Spring Creek above confluence with Oak Creek (Arizona).	Unknown	*Factor A:* Development. *Factor C:* Nonnative species, prey base reduction.
Bog Hole Wildlife Area (Arizona)	Unknown	*Factor C:* Nonnative species, prey base reduction.
Upper 13 Tank, Patagonia Mountains bajada (Arizona).	Unknown	*Factor A:* Improper grazing. *Factor C:* Nonnative species, prey base reduction.
Babocamari River (Arizona)	Unknown	*Factor A:* Improper grazing. *Factor C:* Nonnative species, prey base reduction.
Arivaca Cienega (Arizona)	Unknown	*Factor A:* Improper grazing, borderland security and undocumented immigration, intentional harm. *Factor C:* Nonnative species, prey base reduction.
Gila River at Highway 180 (New Mexico)	Unknown	*Factor A:* Improper grazing, recreation, development, groundwater pumping, water diversions, channelization, dewatering, road construction/use, wildfire, intentional harm, dams. *Factor C:* Nonnative species, prey base reduction.

References: For each of the population localities discussed in Table 1, a detailed textual discussion of the identified threats, including applicable reference citations, is found in subsequent sections of this finding related to each of the five listing factors. Site-specific information from locations in Mexico is limited and, therefore, locations in Mexico are not included in this table. Where available, the information from Mexico is presented and cited in our discussion of the five listing factors below.

In the discussions of Factors A through E below, we describe the known factors that have contributed to the current status of the northern Mexican gartersnake. For populations within the United States, our analysis benefitted from the availability of specific research, monitoring, and other studies. The discussion of these factors that pertain to the status and threats to the northern Mexican gartersnake in Mexico are mainly regional, or statewide, in scope because, in many cases, there was limited specific information available. In some instances, we do include discussion on more refined geographic areas of Mexico when supported by the literature. It is important to understand, however, that many of the threats that affect the northern Mexican gartersnake in the United States are also likely present in Mexico, as further discussed below, despite the lack of formal documentation. Thus, we expect impacts to the habitat and the species to be similar in the United States and Mexico.

A. The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range

Various threats that have affected and continue to affect riparian and aquatic communities that provide habitat for the northern Mexican garter snake include dams, water diversions, groundwater pumping, introduction of nonnative species (vertebrates, plants, and crayfish), woodcutting, recreation, mining, contaminants, urban and agricultural development, road construction, improper livestock grazing, wildfires, and undocumented immigration (Hendrickson and Minckley 1984, p. 161; Ohmart *et al.* 1988, p. 150; Bahre 1995, pp. 240–252; Medina 1990, p. 351; Sullivan and Richardson 1993, pp. 35–42; Fleischner 1994, pp. 630–631; Hadley and Sheridan 1995; Hale *et al.* 1995, pp. 138–140; DeBano and Neary 1996, pp. 73–75; Rinne and Neary 1996, p. 135; Stromberg *et al.* 1996, pp. 124–127; Girmendock and Young 1997, pp. 45–52; Rinne *et al.* 1998, pp. 7–11; Belsky *et al.* 1999, pp. 8–12; Esque and Schwalbe 2002, pp. 165, 190; Hancock 2002, p. 765; Voeltz 2002, pp. 87–88; Webb and Leake 2005, pp. 305–308; Holycross *et al.* 2006, pp. 52–61; McKinnon 2006a, 2006b, 2006c, 2006d, 2006e; Paradzick *et al.* 2006, pp. 88–93; Segee and Neeley 1996, Executive Summary, pp. 10–12, 21–23; Burger 2008, USFS 2008; USFWS 2007, pp. 25, 35–39; Gila County Board of Supervisors 2008, pp. 1–2; Kimmel 2008; Trammell 2008; Sanchez 2008; Lyons and Navarro-Perez 1990, p. 37; Minckley *et al.* 2002, pp. 696; Nijhuis 2007, pp. 1–7; Ouren *et al.* 2007, pp. 16–22; Rorabaugh 2008, pp. 25–26). Threats to northern Mexican gartersnake habitat in Mexico include the intentional and unintentional introductions of nonnative species, improper livestock grazing, urbanization and development, water diversions and groundwater pumping, loss of vegetation cover and deforestation, erosion, and pollution, as well as impoundments and dams that have modified or destroyed riparian and aquatic communities within Mexico in areas where the species occurred historically (Conant 1974, p. 471; Lyons and Navarro-Perez 1990, p. 37; Contreras Balderas and Lozano 1994, p.

384; va Landa *et al.* 1997, p. 316; Jiménez-Ruiz *et al.* 2002, p. 458; Minckley *et al.* 2002, pp. 696; Miller *et al.* 2005, pp. 60–61; Abarca 2006; Burger 2008; Luja and Rodríguez-Estrella 2008, pp. 17–22; Rorabaugh 2008, pp. 25–26; Manjarrez 2008).

Rorabaugh (2008, pp. 25–26) noted threats to northern Mexican gartersnakes and their native amphibian prey base in Sonora, which included disease, pollution, improper livestock grazing, conversion of land for agriculture, nonnative plant invasions, and logging. Ramirez Bautista and Arizmendi (2004, p. 3) stated that the principal threats to northern Mexican gartersnake habitat in Mexico include the drying of wetlands, improper livestock grazing, deforestation, wildfires, and urbanization. In addition, nonnative species, such as bullfrogs and sport and bait 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).

The activities outlined above for both the United States and Mexico and their effects on the northern Mexican gartersnake are discussed in further detail below. It is important to recognize that in most areas where northern Mexican gartersnakes historically or currently occur, two or more threats may be acting in combination in their influence on the suitability of those habitats or on the northern Mexican gartersnake itself. In our assessment of the status of these habitats, discussion of the role that nonnative species introductions have had on habitat suitability is critical. However, we provide that discussion under ‘‘Factor C. Disease and Predation’’ due to the intricate and complex relationship nonnative species have with respect to direct and indirect pressures applied to the northern Mexican gartersnake and to its native prey base.

Destruction and Modification of Riparian and Aquatic Biological Communities

The modification and destruction of aquatic and riparian communities in the post-settlement arid southwestern United States is well documented (Medina 1990, p. 351; Sullivan and Richardson 1993, pp. 35–42; Fleischner 1994, pp. 630–631; Stromberg *et al.* 1996, pp. 113, 123–128; Girmendock and Young 1997, pp. 45–52; Belsky *et al.* 1999, pp. 8–12; Webb and Leake 2005, pp. 305–310; Holycross *et al.* 2006, pp. 52–61; Nijhuis 2007, pp. 1–7; Ouren *et al.* 2007, pp. 16–22). Several threats have been identified in the decline of many native riparian flora and fauna species through habitat modification and destruction, as well as nonnative species introductions. Researchers agree that the period from 1850 to 1940 marked the greatest loss and degradation of riparian and aquatic communities in Arizona, which were caused by anthropogenic (human-caused) land uses and the primary and secondary effects of those uses (Stromberg *et al.* 1996, p. 114; Webb and Leake 2005, pp. 305–310). Many of these land activities continue today and are discussed in detail below. An estimated one-third of Arizona's pre-settlement wetlands have dried or have been rendered ecologically dysfunctional (Yuhas 1996).

Modification and Loss of Cienegas. Cienegas are particularly important habitat for the northern Mexican gartersnake and are considered ideal for the species (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, improper 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.

Nonnative shrub species in the genus *Tamarix,* such as salt cedar, have been widely introduced throughout the western States and appear to thrive in regulated river systems (Stromberg and Chew 2002, pp. 210–213). Tamarix invasions may result in habitat alteration from potential effects to water tables, changes to canopy and ground vegetation structures, and increased fire risk, which hasten the loss of native cottonwood and willow communities and affect the suitability of the vegetation component to northern Mexican gartersnake habitat (Stromberg and Chew 2002, pp. 211–212; USFWS 2002b, p. H–9).

Many sub-basins, where cienegas have been severely modified or lost entirely, wholly or partially overlap the historical distribution of the northern Mexican gartersnake, including the San Simon, Sulphur Springs, San Pedro, and Santa Cruz valleys of southeastern and south-central Arizona. The San Simon Valley in Arizona possessed several natural cienegas with luxuriant vegetation prior to 1885, and was used as a watering stop for pioneers, military, and surveying expeditions (Hendrickson and Minckley 1984, pp. 139–140). In the subsequent decades, the disappearance of grasses and commencement of severe erosion were the result of heavy grazing pressure by large herds of cattle, as well as the effects from wagon trails that paralleled arroyos, occasionally crossed them, and often required stream bank modification (Hendrickson and Minckley 1984, p. 140). Today, only the artificially maintained San Simon Cienega exists in this valley. Similar accounts of past conditions, adverse effects from historical anthropogenic activities, and subsequent reduction in the extent and quality of cienega habitats in the remaining valleys are also provided in Hendrickson and Minckley (1984, pp. 138–160).

Urban and Rural Development. 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). Riparian communities are sensitive to even low levels (less than 10 percent) of urban development within a watershed (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) and, within occupied habitat, the northern Mexican gartersnake. Medina (1990, pp. 358–359) concluded that perennial streams had greater tree densities in all diameter size classes of *Alnus oblongifolius* (Arizona alder) and *Acer negundo* (box elder) as compared to ephemeral reaches where small-diameter trees were absent. Small-diameter trees assist the northern Mexican gartersnake by providing additional habitat complexity and cover needed to reduce predation risk and enhance the usefulness of areas for maintaining optimal body temperature.

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, Gila, and 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 areas.

Urbanization on smaller scales can also impact habitat suitability and the prey base for the northern Mexican gartersnake. Regional development and subsequent land use changes, spurred by increasing populations, along lower Tonto Creek and within the Verde Valley where northern Mexican gartersnakes occur, continue to threaten this snake's habitat and affect the habitat's suitability for the northern Mexican gartersnake and its prey species (Girmendock and Young 1997, pp. 45–52; Voeltz 2002, pp. 58–59, 69–71; Paradzick *et al.* 2006, pp. 89–90). Holycross *et al.* (2006, pp. 53, 56) recently documented the damage and removal of northern Mexican gartersnake streamside habitat from development in the vicinity of Rock Springs along the Agua Fria River and also within the Verde Valley along the Verde River.

Ongoing small-scale development projects within the Page Springs and Bubbling Ponds fish hatcheries along Oak Creek, upstream of its confluence with the Verde River, occur within potentially the most robust remaining population of northern Mexican gartersnakes in the United States (AGFD 1997a, pp. 1–13; 1997b, pp. 1–12). The Page Springs trout hatchery is an 82-acre (ac) (33-hectare (ha)) facility located within a semi-desert grassland vegetative community (AGFD 1997a, p. 3). It is the largest State-run hatchery and was renovated in 1993, resulting in construction-related impacts such as the removal of riparian vegetation and other earth-moving activities to occupied snake habitat (AGFD 1997a, p.1). Current and future management and maintenance of Page Springs include a variety of activities that would potentially affect occupied snake habitat, such as the maintenance of roads, buildings, fences, equipment, as well as development (residences, storage facilities, asphalt, resurfacing, etc.) and both human- and habitat-based enhancement projects (AGFD 1997a, p. 8). Implementation of such projects is expected to result in the damage or removal of habitat or potentially the contamination of habitat from the use of industrial products and chemicals. These projects may adversely affect the northern Mexican gartersnake directly through physical harm or injury or indirectly from effects to its habitat or prey base.

The Bubbling Ponds hatchery, which raises nonnative and native fish (largemouth bass, smallmouth bass, and bluegill, Colorado River pikeminnow, razorback sucker), is located on Oak Creek, just north of the Page Springs hatchery, and comprises 2 parcels approximately 117 ac (47 ha) in size (AGFD 1997b, p. 2). The hatchery consists of 11 earthen ponds and 6 lined ponds totaling 10 surface acres (4 surface hectares), 3 residential structures, and the hatchery building (AGFD 1997b, p. 2). Hatchery operations are confined to 17 of the 117 ac (7 of 47 ha) and have been modified extensively (AGFD 1997b, p. 4). The remaining 100 ac (40 ha) support riparian woodland and forest along Oak Creek (AGFD 1997b, p. 4). Northern Mexican gartersnakes are presumed to occur throughout this property; using the earthen ponds for foraging on young bullfrogs, their tadpoles, and fish, and using areas near or adjacent to structures on the property. Current and future management and maintenance of Bubbling Ponds include a variety of activities that would potentially affect snake habitat, such as the maintenance of roads, buildings, fences, equipment, as well as development (residences, storage facilities, asphalt, resurfacing, etc.) and both human- and habitat-based enhancement projects (AGFD 1997b, pp. 8–9; Wilson and Company 1991, pp. 1–40; 1992, pp. 1–99). Implementation of such projects is expected to result in the damage or removal of habitat or potentially the contamination of habitat from the use of industrial products and chemicals. The small-scale development projects at these hatcheries may injure or kill northern Mexican gartersnakes or their prey base, and may also temporarily damage or remove occupied habitat. The Arizona Game and Fish Department is a long-standing partner in research and survey efforts related to the northern Mexican gartersnake, and there is an ongoing population study at the hatcheries. Adaptive management in relation to activities at the hatcheries, as informed by the population study, will help reduce the overall effects to gartersnakes and their habitat at the hatcheries.

The effects of urban and rural development are expected to increase as human populations increase. Consumer interest in second home and/or retirement real estate investments has increased significantly in recent times within the southwestern United States. Medina (1990, p. 351) points out that many real estate investors are looking for aesthetically scenic, mild climes to enjoy seasonally or year-round and hence choose to develop pre- or post-retirement properties that are within or adjacent to riparian areas due to their aesthetic appeal and available water, especially in the southwestern United States. Arizona increased its population by 394 percent from 1960 to 2000, 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 the same time period, population growth rates in Arizona counties where the northern Mexican gartersnake historically occurred or may still occur 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 (2004 percent) (SSDAR 2000).

Population growth trends in Arizona, Maricopa County in particular, are expected to continue into the future. The Phoenix metropolitan area, founded in part due to its location at the junction of the Salt and Gila rivers, is a population center of 3.63 million people. The Phoenix metropolitan area is the sixth largest in the United States and resides in the fastest growing county in the United States since the 2000 census (Arizona Republic 2006). Given the large amount of perennial habitat at the confluence of two large, flowing rivers that was historically present in this area prior to settlement, northern Mexican gartersnakes likely maintained dense populations in this region of Arizona. However, with the burgeoning population growth and associated urbanization and development that have occurred since, any remaining habitat for the northern Mexican gartersnake has been rendered unsuitable and the subspecies is now likely extirpated from this area and its recovery is unlikely.

Massive growth predictions have been made for traditionally rural portions of Arizona. The populations of developing cities and towns of the Verde watershed are expected to more than double in the next 50 years, which may pose exceptional threats to riparian and aquatic communities of the Verde Valley where northern Mexican gartersnakes occur (Girmendock and Young 1993, p. 47; American Rivers 2006; Paradzick *et al.* 2006, p. 89). Communities in Yavapai and Gila counties such as the Prescott-Chino Valley, Strawberry, Pine, and Payson have all seen rapid population growth in recent years. For example, the population in the town of Chino Valley, at the headwaters of the Verde River, has grown by 22 percent between 2000 and 2004; Gila County, which includes reaches of the Salt, White, and Black rivers and Tonto Creek, grew by 20 percent between 2000 and 2003 (*http://www.census.gov*). The upper San Pedro River is also the location of rapid population growth in the Sierra Vista-Huachuca City-Tombstone-Benson area (*http://www.census.gov*). All of these communities are near or within the vicinity of historical or current northern Mexican gartersnake populations.

In Mexico, the magnitude and significance of adverse effects to riparian communities related to development lags somewhat behind that experienced in the United States due to slower population and economic growth, but it is reported that threats to riparian and aquatic communities that have been observed in Arizona are currently occurring with increasing significance in Mexico (Conant 1974, pp. 471, 487–489; Contreras Balderas and Lozano 1994, pp. 379–381; va Landa *et al.* 1997, p. 316; Miller *et al.* 2005, p. 60–61; Abarca 2006; Rosen 2006).

Ortega-Huerta and Kral (2007, p. 1) found that land legislation within Mexico has changed considerably over recent years to integrate free market policies into local agricultural production methods that may result in the loss of land management practices that protect the natural environment. Community-based lands generally presented higher instance of habitat conservation in terms of natural vegetation, higher species aggregations, more evenly distributed cover types, and greater species richness (Ortega-Huerta and Kral 2007, p. 1). These correlations between land ownership and bird and mammal species richness can be generally extrapolated to other aspects of biotic communities, including the aquatic and semi-aquatic communities within areas. A shift away from traditional land management in Mexico presents threats to riparian and aquatic habitats occupied by the northern Mexican gartersnake.

Collectively, development impacts of all types in Mexico are expected to continue as a result of Mexico's expanding role as an economical labor force for international manufacturing under the North American Free Trade Agreement (NAFTA) and the subsequent increase in population size, economic growth and development, and infrastructure. The threats to northern Mexican gartersnake habitat in riparian and aquatic communities in Mexico vary in their significance, based on geographical distribution of land management activities and urban centers, but are expected to continue into the future.

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). As of 1992, Mexico had the second highest gross domestic product in Latin America at 5.8 percent, following Brazil (DeGregorio 1992, p. 60). As a result of NAFTA, the number of maquiladoras (export assembly plants) is expected to increase by as many as 3,000 to 4,000 (Contreras Balderas and Lozano 1994, p. 384). To accommodate Mexico's increasing human population, rural areas are largely devoted to food production based on traditional methods, which has led to serious losses in vegetative cover and soil erosion (va Landa *et al.* 1997, p. 316).

Road Construction, Use, and Maintenance. Roads cover approximately 1 percent of the land area in the United States, but negatively affect 20 percent of the habitat and biota in the United States (Angermeier *et al.* 2004, p. 19). Roads pose unique threats to herpetofauna and specifically to species like the northern Mexican gartersnake, its prey base, and the habitat where it occurs through: (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; and (8) population sinks (a factor resulting in unnaturally high death rates that exceed birth rates within a population) through direct mortality (Rosen and Lowe 1994, pp. 146–148; Waters 1995, p. 42; 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).

Construction and maintenance of roads and highways near riparian areas can be a source of sediment and pollutants (Waters 1995, p. 42; Wheeler *et al.* 2005, pp. 145, 148–149). Sediment can adversely affect fish populations used as prey by the northern Mexican gartersnake by (1) interfering with respiration; (2) reducing the effectiveness of fish's visually-based hunting behaviors; and (3) filling in interstitial spaces 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. Fine sediment pollution in streams impacted by highway construction without the use of sediment control structures was 5 to 12 times greater than control streams (Wheeler *et al.* 2005, p. 144). As stated above, sediment can lead to several effects in resident fish species used by northern Mexican gartersnakes as prey, which can ultimately cause increased direct mortality, reduced reproductive success, lower overall abundance of the northern Mexican gartersnake, lower species diversity of prey, and reductions in food base as documented by Wheeler *et al.* (2005, p. 145). The underwater foraging ability of northern Mexican gartersnakes is also directly compromised by excessive turbidity caused by sedimentation of water bodies, because this snake locates its prey visually.

Metal contaminants, including iron, zinc, lead, cadmium, nickel, copper, and chromium, are associated with highway construction and use (Foreman and Alexander 1998, p. 220; Hopkins *et al.* 1999, p. 1260; Campbell *et al.* 2005, p. 241; Wheeler *et al.* 2005, pp. 146–149) and are bioaccumulative. 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. Several studies have addressed the effects of bioaccumulative substances on watersnakes. We find these studies relevant because watersnakes and gartersnakes have very similar life histories and prey bases and, therefore, the effects from contamination of their habitat from bioaccumulative agents are expected to be similar. 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 food item, the central stoneroller (fish) (*Campostoma anomalum*). Metals, in trace amounts, affect the structure and function of the liver and kidneys of vertebrates and may also act as neurotoxins, affecting nervous system function (Rainwater *et al.* 2005, p. 670). Metals may also be sequestered in the skin of reptiles, but this effect is tempered somewhat by ecdysis (the regular shedding or molting of the skin) (Burger 1999, p. 212). Hopkins *et al.* (1999, p. 1261) found that metals may even interfere with metabolic rates of banded watersnakes (*Nerodia fasciata*), altering the allocation of energy between maintenance and reproduction, reducing the efficiency of energy stores, and forcing individuals to forage more often, which increases activity costs (the energy expended in hunting, which affects the net nutritional intake of an organism) and predation risk.

Snakes of all species are particularly vulnerable to mortality when they attempt to cross roads. Snakes are animals that derive heat from warm surfaces, which often compels them to slow down or even stop and rest on road surfaces that have been warmed by the sun as they attempt to cross (Rosen and Lowe 1994, p. 143). Gartersnakes are generally diurnal (active during daylight hours) and are often active when traffic densities are greatest (Rosen and Lowe 1994, p. 147). Mortality data have been collected at the Bubbling Ponds Hatchery since 2006. Of the eight dead specimens, half were struck by vehicles on roads adjacent to the hatchery ponds that are crossed by northern Mexican gartersnakes in traveling between ponds to forage (Boyarski 2008a). 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. Perhaps the most common factor in road mortality of snakes is the propensity for drivers to intentionally run over snakes, which generally make easy targets because they usually cross roads at a perpendicular angle (Klauber 1956, p. 1026; Langley *et al.* 1989, p. 47; Shine *et al.* 2004, p. 11). This driving behavior is exacerbated by the general animosity that humans have toward snakes (Ernst and Zug 1996, p. 75; Green 1997 pp. 285–286). In fact, Langley *et al.* (1989, p. 47) conducted an experiment on the propensity for drivers to hit reptiles on the road using turtle and snake models and found that many people have a greater desire to hit a snake on the road than any other animal; several drivers actually stopped and backed-over the snake mimic to ensure it was dead. Roe *et al.* (2006, p. 161) conclude that mortality rates due to roads are higher in vagile (mobile) species, such as gartersnakes (active hunters), than those of more sedentary species, which more commonly employ sit-and-wait foraging strategies. Roads that bisect wetland communities also act as mortality sinks in the dispersal or migratory movements of snakes (Roe *et al.* 2006, p. 161). The effect of road mortality of snakes becomes most significant in the case of small, highly fragmented populations where the chance removal of mature females from the population may appreciably degrade the viability of a population.

Even lightly used roads may also lead to mortality of northern Mexican gartersnakes. For example, gravel roads that surround the hatchery ponds that are traveled by hatchery, research lab, and resident vehicles at the Bubbling Ponds fish hatchery have resulted in four documented northern Mexican gartersnake mortalities since mortality data began being collected in 2006 (Boyarski 2008a, pp. 1–4). These vehicle mortalities represent 50 percent of the mortalities documented at the hatcheries. Of note is the fact that these vehicles are likely traveling at slow speeds, which indicates that even slow-moving vehicles pose a hazard to crossing and basking snakes. Wallace *et al.* (2008, pp. 243–244) documented a vehicle-related mortality of a northern Mexican gartersnake on Arizona State Route 188 near Tonto Creek that occurred in 1995. As shown in the above examples, vehicle-related mortalities of northern Mexican gartersnakes likely occur routinely along roads or trails adjacent to occupied habitat throughout the range of the subspecies but are generally difficult to document.

Off-highway vehicle (OHV) use has grown considerably in Arizona. For example, as of 2007, 385,000 OHVs were registered in Arizona (a 350 percent increase since 1998) and 1.7 million people (29 percent of the Arizona's public) engaged in off-road activity from 2005–2007 (Sacco 2007). Over half of OHV users reported that merely driving off-road was their primary activity, versus using the OHV for the purpose of hunting, fishing, or hiking (Sacco 2007). Given the pervasive use of OHV's on the landscape, OHV-related mortalities are likely a threat to northern Mexican gartersnakes. Ouren *et al.* (2007, pp. 16–22) provide additional data on the effects of OHV use on wildlife. Specifically, OHV use may cause mortality or injury to species, such as northern Mexican gartersnakes, that attempt to cross trails created through occupied habitat and may even lead to depressed populations of snakes depending on the rate of use and number of trails within a given area (Ouren *et al.* 2007, pp. 20–21). This threat may be even more extensive from OHVs than from conventional vehicles because OHV trails often travel through undeveloped habitat and often cross directly through waterbodies. OHV use may also affect northern Mexican gartersnake habitat by reducing vegetation cover and plant species diversity, reducing infiltration rates, increasing erosion, and reducing habitat connectivity (Ouren *et al.* 2007, pp. 6–7, 11, 16).

Roads create access to areas that were previously visited only infrequently or were inaccessible to humans, increasing the frequency and significance of anthropogenic threats to riparian areas and fragmenting the landscape, which in addition to direct effects to snakes and habitat, may genetically isolate herpetofaunal populations (Rosen and Lowe 1994, pp. 146–148; Andrews and Gibbons 2005, p. 772).

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 species 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.

While snakes of all species may suffer direct mortality as a result of attempting to cross roads, Andrews and Gibbons (2005, pp. 777–779) found that many individuals of small, diurnal snake species avoid open areas (e.g., roads) instinctively in order to lower predation rates, which represents a different type of threat from roads. Shine *et al.* (2004, p. 9) found that the common gartersnake typically changed direction when encountering a road. These avoidance behaviors by individuals aversive to crossing roads affect movement patterns and may ultimately affect reproductive output within populations (Shine *et al.* 2004, pp. 9, 17–19). Not crossing roads can reduce the amount of habitat available for individual snakes to find prey, mates, etc. This avoidance behavior has been observed in the common gartersnake (*Thamnophis sirtalis*), a sister taxon to the Mexican gartersnake with similar life histories and behavior (Shine *et al.* 2004, p. 9). In our discussion and as evidenced by the literature we reviewed on the effect of roads on snake movements, we acknowledge the individuality of snakes in their behaviors towards road crossings.

In addition to altering the movement patterns of some snakes, roads interfere with the male gartersnake's olfactory-driven ability to follow the pheromone trails left by receptive females (Shine *et al.* 2004, pp. 17–18). This effect to the male's ability to efficiently trail females may exacerbate the effects of low population density and fragmentation that affect several species of snakes, including the northern Mexican gartersnake. Because the male gartersnake's ability to trail females is hampered by roads, the extra time and distance traveled by male snakes seeking receptive females increases exposure to predation and subsequently increases mortality rates (Shine *et al.* 2004, pp. 18–19). Although the northern Mexican gartersnake was not the subject of the 2004 Shine *et al.* study, similar responses can be expected in the northern Mexican gartersnake because its life history is similar to the study's subject species (i.e., the common gartersnake).

Roads also affect prey availability for northern Mexican garter snakes. Roads tend to adversely affect aquatic breeding anuran populations more so than other species due to their activity patterns (mass movements of individuals), population structures (large cohorts of similarly aged individuals within a population), and preferred habitats which are often adjacent to roads and usually constrained to aquatic or semiaquatic areas (Hels and Buchwald 2001, p. 331). Carr and Fahrig (2001, pp. 1074–1076) found that populations of highly mobile anuran species such as leopard frogs (*Rana pipiens*) were run over more frequently than more sedentary species and that population persistence can be at risk depending on traffic densities, which may adversely affect the prey base for northern Mexican gartersnakes because leopard frogs are a primary prey species.

Recreation. As discussed above, population growth trends are expected to continue into the future. Expanding population growth leads to higher recreational use of riparian areas, as evidenced along reaches of the Salt and Verde rivers in proximity to the Phoenix metropolitan area. Riparian areas located near urban areas are vulnerable to the effects of increased recreation with predictable changes in the type and intensity of land use following residential development. An example of such an area within the existing distribution of the northern Mexican 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 human-gartersnake interactions, 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, p. 39). Recreational activities in the Southwest are often tied to water bodies and riparian areas. Increased recreational impacts on the quantity and quality of water, as well as the adjacent vegetation, are threats to local populations of the northern Mexican gartersnake.

Groundwater Pumping, Surface Water Diversions, and Flood Control. Increased urbanization and population growth results in an increase in the demand for water and, therefore, water development projects. Collier *et al.* (1996, p. 16) mention that water development projects are one of two main causes of decline of native fish in the Salt and Gila rivers of Arizona. Municipal water use in central Arizona has increased by 39 percent in the last 8 years (American Rivers 2006). 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. The hydrologic connection between groundwater and surface flow of intermittent and perennial streams is becoming better understood. 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. This situation has been created by groundwater use by the community of Sierra Vista in Cochise County, which continues to threaten the riparian community along the upper San Pedro River where the northern Mexican gartersnake historically occurred. 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). Finally, complete disconnection of the aquifer and the stream results in strong negative effects to riparian vegetation (Webb and Leake 2005, p. 309). If complete disconnection occurs, the hyporheic zone could be adversely affected. The hyporheic zone can promote ''hot spots'' of productivity where groundwater upwelling produces nitrates that can enhance the growth of vegetation, but its significance is contingent upon its activity and extent of connection with the groundwater (Boulton *et al.* 1998, p. 67; Boulton and Hancock 2006, pp. 135, 138). Such ''hot spots'' can enhance the quality of northern Mexican gartersnake habitat. Conversely, changes to the duration and timing of upwelling can potentially lead to localized extinctions in biota (Boulton and Hancock 2006, p. 139), reducing gartersnake habitat suitability.

The effects of groundwater pumping on surface water flow and riparian communities have been observed in the Santa Cruz, San Pedro, and Verde rivers as a result of groundwater demands of Tucson, Sierra Vista, and the rapidly growing Prescott Valley, respectively (Stromberg *et al.* 1996, pp. 113, 124–128; Rinne *et al.* 1998, p. 9; Voeltz 2002, pp. 45–47, 69–71). 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 more tolerant of declining water tables due to their associated deeper rooting depths.

The full effects of large-scale groundwater pumping associated with the proposed Big Chino Water Ranch Project and its associated 30-mile (48-km), 36-in (91-cm) diameter pipeline have yet to be realized in the Verde River (McKinnon 2006c). This groundwater pumping and inter-basin transfer project is projected to deliver

2.8 billion gallons of groundwater annually from the Big Chino sub-basin aquifer to the rapidly growing area of Prescott Valley for municipal use (McKinnon 2006c). The Big Chino sub-basin provides 86 percent of the baseflow to the upper Verde River (American Rivers 2006; McKinnon 2006a). The potential for this project to obtain funding and approval for implementation has placed the Verde River on American River's 2006 ''Ten Most Endangered Rivers List'' (American Rivers 2006). This potential reduction or loss of baseflow in the Verde River could seasonally dry up large reaches or adversely affect the riparian community and the suitability of the habitat for remaining populations of the northern Mexican gartersnake and its prey species in that area.

Within the Verde River watershed, and particularly within the Verde Valley where the northern Mexican gartersnake is believed to currently remain, several other activities continue to threaten surface flows (Rinne *et al.* 1998, p. 9; 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, which may have supported the northern Mexican gartersnake (Girmendock and Young 1993, pp. 45–47; Sullivan and Richardson 1993, pp. 38–39; Paradzick *et al.* 2006, pp. 104–110). Groundwater pumping in the Tonto Creek drainage regularly eliminates surface flows during parts of the year (Abarca and Weedman 1993, p. 2). The upper Gila River is also threatened by water diversions and water allocations. In New Mexico, a proposed water project that resulted from a landmark Gila River water settlement in 2004 allows New Mexico the right to withhold 4.5 billion gallons of surface water every year (McKinnon 2006d). If this proposed water diversion project is implemented, in dry years, currently perennial reaches of the upper Gila River will dry completely, which removes all suitability of this habitat for the northern Mexican gartersnakes and a host of other riparian and aquatic species (McKinnon 2006d).

The Arizona Department of Water Resources (ADWR) manages water supplies in Arizona and has established five Active Management Areas (AMA) across the State (ADWR 2006). 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 that precipitation can recharge the aquifer, which leads to conditions described above. Geographically, all five AMAs overlap the historical distribution of the northern Mexican gartersnake in Arizona. The declaration of these AMAs further illustrates the condition and future threats to riparian habitat in these areas and are a cause of concern for the long-term maintenance of historical and occupied northern Mexican gartersnake habitat. Such overdrafts reduce surface water flow of streams that are hydrologically connected to the aquifer under stress, which can be further exacerbated by the surface water diversions.

To accommodate the needs of rapidly growing rural and urban populations, surface water is commonly diverted to serve many industrial and municipal uses. These water diversions have dewatered large reaches of once perennial or intermittent streams, adversely affecting northern Mexican gartersnake habitat throughout its range in Arizona and New Mexico. Many tributaries of the Verde River are permanently or seasonally dewatered by water diversions for agriculture (Paradzick *et al.* 2006, pp. 104–110).

Effects from flood control projects threaten riparian and aquatic habitat, as well as threaten the northern Mexican gartersnake directly. Kimmell (2008), Gila County Board of Supervisors (2008), Trammell (2008), and Sanchez (2008) 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). The only known remaining population of northern Mexican gartersnakes within the large Salt River watershed occurs on Tonto Creek. The status of the northern Mexican gartersnake on tribal lands within the Salt River watershed remains unknown. In Resolution No. 08–06–02, the Gila County Board of Supervisors has 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). 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, Trammell 2008). 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 of 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.

In Mexico, Conant (2003, p. 4) noted human-caused threats to seven fragmented, highly localized subspecies of Mexican gartersnake in the Transvolcanic Belt Region of southern Mexico, which extends from southern Jalisco eastward through the State of Mexico to central Veracruz. Although this is a relatively small area, rural land uses are widespread in the region and these threats can be extrapolated to other areas of that region within the distribution of the northern Mexican gartersnake in Mexico. Some of these threats included water diversions, pollution (e.g., discharge of raw sewage), sedimentation of aquatic habitats, and increased dissolved nutrients, resulting in decreased dissolved oxygen, in still-water habitats. Conant (2003, p. 4) stated that many of these threats were evident during his field work in the 1960s, but that they are ''continuing with increased velocity.''

Water pollution, dams, groundwater pumping, and impoundments were identified by Miller *et al.* (2005, pp. 60–61) as significant threats to aquatic biota in Mexico. 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 where the northern Mexican gartersnake is distributed, 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.'' 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. 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) provides an excerpt from Soto Galera et al. (1999) addressing the threats to the Río Lerma, Mexico's longest river, and 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.''

Several rivers within the historical range of the northern Mexican gartersnake have been impounded and dammed throughout Mexico, resulting in habitat modification and the dispersal and establishment of nonnative species. 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). Nonnative species continue to pose significant threats in the decline of native, often highly localized, prey species of the northern Mexican gartersnake, as discussed further in Factor C below (Miller *et al.* 2005, p. 60).

Miller *et al.* (2005) provide information on threats to freshwater fishes, and riparian and aquatic communities in specific waterbodies throughout Mexico that are within the historical range of the northern Mexican gartersnake: The Río Grande (dam construction, p. 78 and extirpations of freshwater fish species, pp. 82, 112); headwaters of the Río Lerma (extirpation of freshwater fish species, nonnative species, pollution, dewatering, pp. 60, 105, 197); Lago de Chapala and its outlet to the Río Grande de Santiago (major declines in freshwater fish species, p. 106); medium-sized streams throughout the Sierra Madre Occidental (localized extirpations, logging, dewatering, pp. 109, 177, 247); the Rio 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 (nonnative species, pp. 148, Plate 61); 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); lagos de Zacapu and Yuriria (habitat destruction, p. 282); and the Río Pánuco Basin (nonnative species, p. 295).

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. We discuss the threats from nonnative species introductions below in our discussion of Factor C.

Clearly, water quality and quantity are being affected by ongoing activities in the United States and Mexico. Due to the reliance of the northern Mexican gartersnake on ecosystems and communities supported by permanent water sources, these threats are significant to the survival and viability of existing and future northern Mexican gartersnake populations.

Improper Livestock Grazing and Agricultural Uses. In a number of ways described below, poorly managed 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; 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 poorly managed cattle to remain within or adjacent to riparian communities. Trimble and Mendel (1995, p. 243) stated that ''Cows, unlike sheep, appear to love water and spend an inordinate amount of time together lounging in streams and ponds, especially in summer (surface-active season for reptiles and amphibians), sometimes going in and coming out several times in the course of a day.'' Expectedly, this behavior is more pronounced in more arid regions (Trimble and Mendel 1995, p. 243). 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 (Trimble and Mendel 1995, p. 243). Another study reported that grazing rates were 5 to 30 times higher in riparian areas than on the uplands, which may be due in part to several factors: (1) Higher forage volume and palatability of species in riparian areas; (2) water availability; (3) the close proximity of riparian areas to the best upland grazing sites; and (4) microclimatic features such as cooler temperatures and shade (Trimble and Mendel 1995, p. 244).

Effects of improper livestock management on riparian and aquatic communities have spanned from early settlement to modern day. Some historical accounts of riparian area conditions in Arizona clarify early effects of poor livestock management. Cheney *et al.* (1990, pp. 5, 10) provide historical accounts of the early adverse effects of improper livestock management in the riparian zones and adjacent uplands of the Tonto National Forest and in south-central Arizona. These accounts describe the removal of riparian trees for preparation of livestock use and substantial changes to flow regimes accentuated by observed increases in runoff and erosion rates. Such accounts of riparian conditions within the historical distribution of the northern Mexican gartersnake in Arizona contribute to the understanding of when declines in abundance and distribution may have occurred and the contributions of this factor to the subsequent fragmentation of populations and widespread extirpations.

Poor livestock management causes a decline in diversity, abundance, and species composition of riparian herpetofauna communities from direct or indirect threats to the prey base, the habitat, or to the northern Mexican gartersnake. These effects 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; and (5) a rise in water temperatures to levels lethal to larval stages of amphibian and fish development (Szaro *et al.* 1985, p. 362; Schulz and Leininger 1990, p. 295; Belsky *et al.* 1999, pp. 8–11). Improper livestock grazing may also lead to desertification (the process of becoming arid land or desert as a result of land mismanagement or climate change) due to a loss in soil fertility from erosion and gaseous emissions spurred by a reduction in vegetative ground cover (Schlesinger *et al.* 1990, p. 1043).

Szaro *et al.* (1985, p. 360) assessed the effects of improper livestock management on a sister taxon. They 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.

Watersheds where improper grazing has been documented as a contributing factor of northern Mexican 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; Girmendock and Young 1997, p. 47; Voeltz 2002, pp. 45–81; Krueper *et al.* 2003, pp. 607, 613–614; Holycross *et al.* 2006, pp. 52–61; McKinnon 2006d, 2006e; Paradzick *et al.* 2006, pp. 90–92; USFS 2008). Holycross *et al.* (2006, pp. 53–55, 58) recently documented adverse effects from improper livestock grazing on northern Mexican gartersnake habitat along the Agua Fria from EZ Ranch to Bloody Basin Road, along Dry Creek from Dugas Road to Little Ash Creek, along Little Ash Creek from Brown Spring to Dry Creek, along Sycamore Creek in the vicinity of its confluence with the Verde River, and on potential northern Mexican gartersnake habitat along Pinto Creek at the confluence with the West Fork of Pinto Creek. In southeastern Arizona, there have been observations of effects to the vegetative community suggesting that livestock grazing activities continue to adversely affect remaining populations of northern Mexican gartersnakes by reducing or eliminating cover required by the northern Mexican gartersnake for thermoregulation, protection from predation, and foraging (Hale 2001, pp. 32–34, 50, 56).

To increase forage and stocking rates for livestock production in the arid lowlands of northern Mexico, African buffelgrass was widely introduced in Mexico and has subsequently spread via its own natural means of dispersal (Búrquez-Montijo *et al.* 2002, p. 131; Nijhuis 2007, pp. 1–7). Buffelgrass invasions pose a serious threat to native arid ecosystems because buffelgrass prevents germination of native plant species, competes for water, crowds out native vegetation, and creates fine fuels in vegetation communities not adapted to fire. In such native arid ecosystems, buffelgrass has caused many changes, including severe soil erosion resulting from an increase in the number and severity of fires (Búrquez-Montijo *et al.* 2002, pp. 135, 138). Erosion affects the suitability of habitat for northern Mexican gartersnakes and their prey species by increasing the turbidity of streams and filling in important pool habitat, which increases the water temperature of pools, lowers the dissolved oxygen content of the water, and reduces their permanency. 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) (va Landa *et al.* 1997, p. 317), the states in which the northern Mexican gartersnake occurs.

The effects of stock tanks associated with livestock grazing 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 that can be affected if the impoundment is poorly managed, which may lead to trampling or overgrazing of the bankside vegetation. Alternatively, well-managed stock tanks can provide habitat suitable for northern Mexican gartersnakes both structurally and in terms of prey base, especially when the tank remains devoid of nonnative species while supporting native prey species; provides adequate vegetation cover; and provides reliable water sources in periods of prolonged drought. Given these benefits of well-managed stock tanks, we believe well-managed stock tanks may be an important component to northern Mexican gartersnake conservation.

Direct mortality of amphibian species, in all life stages, from being trampled by livestock has been documented in the literature (Bartelt 1998, p. 96; Ross *et al.* 1999, p. 163). The resultant extirpation risk of amphibian populations as a prey base for northern Mexican gartersnakes by direct mortality is governed by the relative isolation of the amphibian population, the viability of that population, and the propensity for stochastic events such as wildfires. Livestock grazing within habitat occupied by northern Mexican gartersnakes can result in direct mortality of individual gartersnakes as observed in a closely related taxon on the Apache-Sitgreaves National Forest. In that instance, a black-necked gartersnake (*Thamnophis cyrtopsis cyrtopsis*) had apparently been killed by trampling by cattle along the shore of a stock tank within an actively grazed allotment (Chapman 2005). This event was not observed first-hand, but was supported by postmortem photographic documentation of the physical injuries to the specimen and the location of the carcass among a dense cluster of hoof tracks along the shoreline of the stock tank. It is also unlikely that a predator would kill the snake and leave it uneaten. While this type of direct mortality of gartersnakes has long been suspected by agency biologists and academia, this may be the first recorded observation of direct mortality of a gartersnake due to livestock trampling. We expect this type of direct mortality to be uncommon but significant in the instance of a fragmented population with a skewed age-class distribution (large adults), without a neighboring source population to assist with recolonization, and low to no recruitment as currently observed in many northern Mexican gartersnake populations in the United States. In these circumstances, the loss of one or more adults, most notably reproductive females, may lead directly to extirpation of the species from a given site with no expectation of recolonization.

Poor forestry and agricultural practices were cited as the largest and most widespread threats to the native fisheries of the Jalisco and Colima area in Mexico investigated by Lyons and Navarro-Perez (1990, p. 37), affecting prey availability for northern Mexican gartersnakes in areas where they occur. Lyons and Navarro-Perez (1990, p. 37) indicated that in high-elevation areas, clear-cutting of trees and unrestricted livestock grazing have increased erosion and sedimentation. They suspected impacts on fish and invertebrate populations had occurred. In lowland areas, Lyons and Navarro-Perez (1990, p. 37) cited diversion of water for irrigation, runoff from cultivated fields, and runoff from small towns and villages as causing additional environmental degradation. Lyons and Navarro-Perez (1990, p. 37) found that the tolerance of several fish species to degradation depended on the form of degradation.

Minckley *et al.* (2002, pp. 687–705) described three new species of pupfish and provided a summary of threats (p. 696) to these species and their habitat in Chihuahua, Mexico, within the distribution of the northern Mexican gartersnake. 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).

Our analysis of the best available scientific and commercial information available indicates that adverse effects from improper livestock management on the northern Mexican gartersnake, its habitat, and its prey base can be significant, especially when combined with other threats, most notably nonnative species (discussed below under Factor C). Preliminary gartersnake survey data from Burger (2008) from the States of Durango and southern Chihuahua, Mexico, indicate that the northern Mexican gartersnake is less susceptible to population impacts associated with physical disturbances to its habitat, such as livestock grazing, when the biotic community is comprised of wholly native species. However, even modest alterations in the physical habitat of the northern Mexican gartersnake may lead to population declines, or even extirpations, when these adverse effects act in combination with the adverse effects of nonnative species. In Mexico, livestock grazing, often in association with deforestation and crop cultivation, are also having adverse affects on the northern Mexican gartersnake. We recognize that well-managed grazing can occur with limited effects to this species when the presence or absence of nonnative species is considered, and management emphasis is directed towards limiting some access to riparian and aquatic habitats within occupied habitat. These actions, combined with management that disperses livestock away from riparian areas, reduce the threats of livestock grazing on northern Mexican gartersnakes and their habitats. As previously stated, we also recognize well-managed stock tanks as a valuable tool in the conservation of northern Mexican gartersnakes.

Additional information on the effects of improper livestock grazing to the northern Mexican gartersnake and its habitat can be found in our 2006, 12-month finding for this species (71 FR 56227) and in Sartz and Tolsted (1974, p. 354); Szaro *et al.* (1985, pp. 360, 362, 364); Weltz and Wood (1986, pp. 367–368); Rosen and Schwalbe (1988, pp. 32–33, 47); Clary and Webster (1989, p. 1); Clary and Medin (1990, p. 1); Schulz and Leininger (1990, p. 295); Schlesinger *et al.* (1990, p. 1043); Orodho *et al.* (1990, p. 9); Fleischner (1994, pp. 629, 631–632); Trimble and Mendel (1995, pp. 235–236, 243–244); Pearce *et al.* (1998, p. 302); Belsky *et al.* (1999, pp. 8–11); Stromberg and Chew (2002, p. 198); and Krueper *et al.* (2003, pp. 607, 613–614).

High-Intensity Wildfires. Low-intensity fire has been a natural disturbance factor in forested landscapes for centuries, and low-intensity fires were common in southwestern forests prior to European settlement (Rinne and Neary 1996, pp. 135–136). Rinne and Neary (1996, p. 143) discuss the current effects of fire management policies on aquatic communities in Madrean Oak Woodland biotic communities in the southwestern United States. They 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 devastating wildfires. The effects of these catastrophic wildfires include the removal of vegetation, the degradation of watershed 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 decimated some fish populations in Dude Creek and the East Verde River (Voeltz 2002, p. 77), which, ultimately, affects habitat suitability for the gartersnake. These effects can significantly reduce the prey base for northern Mexican gartersnakes and could lead to direct mortality in the case of high-intensity fires that are within occupied habitat. 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 2008, pp. 38–39).

Fire has also become an increasingly significant threat in lower elevation communities as well. Esque and Schwalbe (2002, pp. 180–190) discuss the effect of wildfires in the upper and lower subdivisions of Sonoran desertscrub where the northern Mexican gartersnake historically occurred. The widespread invasion of nonnative annual grasses, such as brome species (*Bromus sp.*) and Mediterranean grasses (*Schismus sp.*), appear to be largely responsible for altered fire regimes that have been observed in these communities, which are not adapted to fire (Esque and Schwalbe 2002, p. 165). African buffelgrass (*Pennisetum ciliare*) is recognized as another invading nonnative plant species throughout the lower elevations of northern Mexico and Arizona. Nijhuis (2007, pp. 1–7) discuss the spread of nonnative buffelgrass within the Sonoran Desert of Arizona and adjoining Mexico, citing the grass' ability to out compete native vegetation and present significant risks of fire in an ecosystem that is not adapted to fire. In areas comprised entirely of native species, ground vegetation density is mediated by barren spaces that do not allow fire to carry itself across the landscape. However, in areas where nonnative grasses have become established, the fine fuel load is continuous, and fire is capable of spreading quickly and efficiently (Esque and Schwalbe 2002, p. 175).

After disturbances such as fire, nonnative grasses may exhibit dramatic population explosions, which hasten their effect on native vegetative communities. Additionally, with increased fire frequency, these population explosions ultimately lead to a type-conversion of the vegetative community from desertscrub to grassland (Esque and Schwalbe 2002, pp. 175–176). Fires carried by the fine fuel loads created by nonnative grasses often burn at unnaturally high temperatures, which may result in soils becoming hydrophobic (water repelling), exacerbate sheet erosion, and contribute large amounts of sediment to receiving water bodies, thereby affecting the health of the riparian community (Esque and Schwalbe 2002, pp. 177–178). The siltation of isolated, remnant pools in intermittent streams significantly affects lower elevation species by increasing the water temperature, reducing dissolved oxygen, and reducing or eliminating the permanency of pools, as observed in pools occupied by lowland leopard frogs and native fish, important prey species for northern Mexican gartersnakes (Esque and Schwalbe 2002, p. 190).

Undocumented Immigration and International Border Enforcement and Management. Undocumented immigrants and smugglers attempt to cross the International border from Mexico into the United States in areas historically and currently occupied by the northern Mexican gartersnake. These illegal border crossings and the corresponding efforts to enforce U.S. border laws and policies have been occurring for many decades with increasing intensity and have resulted in unintended adverse effects to biotic communities in the border region. During the warmest months of the year, many attempted border crossings occur in riparian areas that serve to provide shade, water, and cover. Increased U.S. border enforcement efforts that began in the early 1990s in California and Texas have resulted in a shift in crossing patterns and increasingly concentrated levels of attempted illegal border crossings into Arizona (Segee and Neeley 2006, p. 6).

Riparian habitats that historically supported or may currently support northern Mexican gartersnakes in the San Bernardino National Wildlife Refuge, the San Pedro River corridor, the Santa Cruz River corridor, the lower Colorado River corridor, and along many smaller streamside and canyon bottom areas within Cochise, Santa Cruz, and Pima counties have high levels of undocumented immigrant traffic (Segee and Neeley 2006, Executive Summary, pp. 10–12, 21–23).

Traffic on new roads and trails from illegal border crossing and enforcement activities, as well as the construction, use, and maintenance of enforcement infrastructure (*i.e.*, fences, walls, and lighting systems), leads to compaction of streamside soils, and the destruction and removal of riparian vegetation necessary as cover for the northern Mexican gartersnake. Current border infrastructure projects, including vehicle barriers and pedestrian fences, are located specifically in valley bottoms and have resulted in direct impacts to water courses and altered drainage patterns affecting northern Mexican gartersnake habitat (USFWS 2008, p. 4). These activities also produce sediment in streams, which affects their suitability as habitat for prey species of the northern Mexican gartersnake by reducing their permanency and altering their physical and chemical parameters. Riparian areas along the upper San Pedro River have been impacted by abandoned fires that undocumented immigrants started to keep warm or prepare food (Segee and Neeley 2006, p. 23). There is also the threat of pursuit, capture, and death of northern Mexican gartersnakes when they are encountered by illegal border crossers and border enforcement personnel in high-use areas due to the snake's stigma in society (Rosen and Schwalbe 1988, p. 43; Ernst and Zug 1996, p. 75; Green 1997, pp. 285–286; Nowak and Santana-Bendix 2002, p. 39).

The wetland habitat within the San Bernardino National Wildlife Refuge provides habitat for the northern Mexican gartersnake, where it is now likely extirpated, and has been adversely affected by undocumented immigration. It is estimated that approximately 1,000 undocumented immigrants per month use these important wetlands for bathing, drinking, and other uses during their journey northward (Segee and Neeley 2006, pp. 21–22). These activities occur in other border areas, such as the Santa Cruz River, where the northern Mexican gartersnake occurs, although they have not been quantified (Segee and Neeley 2006, pp. 21–22). They can contaminate the water quality of the wetlands and lead to reductions in the prey base for the northern Mexican gartersnake, as well as increase exposure of the snake to humans, and thereby increase direct mortality rates (Rosen and Schwalbe 1988, p. 43; Ernst and Zug 1996, p. 75; Green 1997, pp. 285–286; Nowak and Santana-Bendix 2002, p. 39; Segee and Neeley 2006, pp. 21–22). In addition, numerous observations of littering and destruction of vegetation and wildlife occur annually throughout the San Bernardino National Wildlife Refuge, which adversely affect the quality and quantity of vegetation as habitat for the northern Mexican gartersnake (USFWS 2006, p. 95). Due to the immediate proximity of the upper Santa Cruz River to the international border and the effect of border control operations that funnel undocumented immigrants into rural environments, we conclude that these adverse effects likely occur in this area, which is occupied by the northern Mexican gartersnake.

Threats from illegal border crossers appear to have increased in recent years within the Coronado National Forest of southern Arizona (USFS 2008). Reports of significant water pollution from bathing activities by undocumented immigrants in habitat occupied by northern Mexican gartersnakes have been received (USFS 2008). Of particular concern to USFS (2008), was the concentrated use of pools by undocumented immigrants during the warmest months before summer rains commence, when the habitat is also critical to the northern Mexican gartersnake and its prey. The amount of surface water is generally considered the lowest during the early summer, pre-monsoon months in Arizona, which compounds the effects of the use of pools for bathing by concentrating water contamination in the limited habitat available to northern Mexican gartersnakes and their prey species. Because of the limited amount of alternative habitat, illegal border crossers and gartersnakes are concentrated in the same areas, increasing encounter rates and the potential threats to northern Mexican gartersnakes.

Summary of Factor A. Riparian and aquatic habitats that are essential for the survival of the northern Mexican gartersnake are being negatively impacted throughout the subspecies' range. Threats including water diversions, groundwater pumping, dams, channelization, and erosion-related effects are occurring in both the United States and Mexico that affect the amount of water within occupied northern Mexican gartersnake habitat, directly affecting its suitability for northern Mexican gartersnakes. Threats from development, roads, flood control and water diversion, improper livestock grazing, high-intensity wildfire, and undocumented immigration that alter the vegetation of occupied northern Mexican gartersnake habitat are documented throughout its range and reduce the habitat's suitability as cover for protection from predators, as a foraging area, and as an effective thermoregulatory site. However, Rorabaugh (2008, p. 26) suggests that an increased awareness of the potential for ecotourism to provide rural economic growth is occurring in many areas within Sonora, Mexico, which may provide enhanced opportunities for conservation of biologically rich ecosystems in the future.

Nonnative plant species, in particular shrubs (genus *Tamarix*) and buffelgrass, are increasing their distribution in both the United States and Mexico and adversely affect habitat suitability and availability for the northern Mexican gartersnake.

B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The northern Mexican gartersnake may not be collected in the United States without special authorization by the Arizona Game and Fish Department or the New Mexico Department of Game and Fish. We have found no evidence that current or historical levels of lawful or unlawful field collecting of northern Mexican gartersnakes has played a significant role in the decline of this species. The Arizona Game and Fish Department recently produced identification cards for distribution that provide information to assist with the field identification of each of Arizona's five native gartersnake species, as well as guidance on submitting photographic vouchers for university museum collections. Additionally, Arizona State University and the University of Arizona recently began to accept photographic vouchers, versus physical specimens, in their respective museum collections, which will reduce the amount of collection. We believe these measures reduce the necessity for field biologists to collect physical specimens (unless discovered postmortem) for locality voucher purposes and, therefore, further reduce impacts to vulnerable populations of the northern Mexican gartersnake. We were unable to obtain information about the effect of overutilization for commercial, recreational, scientific, or educational purposes in Mexico. Specific discussion of the regulatory protections for the northern Mexican gartersnake is provided under Factor D ''Inadequacy of Existing Regulatory Mechanisms'' below.

C. Disease or Predation

Disease. Disease in northern Mexican gartersnakes has not yet been documented as a specific threat in the United States or Mexico. However, because little is known about disease in wild snakes, it is premature to conclude that there is no disease threat that could directly affect remaining northern Mexican gartersnake populations (Rosen 2006).

Disease and nonnative parasites have been implicated in the decline in the prey base of the northern Mexican gartersnake. Particularly, the outbreak of chytridiomycosis or ''Bd,'' a skin fungus (*Batrachochytrium dendrobatidis*), has been identified as a chief causative agent in the significant declines of many of the native ranid frogs and other amphibian species, and regional concerns exist for the native fish community due to nonnative parasites such as the Asian tapeworm (*Bothriocephalus achelognathi*) in southeastern Arizona (Rosen and Schwalbe 1997, pp. 14–15; 2002c, pp. 1–19; Morell 1999, pp. 728–732; Sredl and Caldwell 2000, p. 1; Hale 2001, pp. 32–37; Bradley *et al.* 2002, p. 206). 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 northern Mexican gartersnake native prey species 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 2002a, pp. 40802–40804; USFWS 2007, 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 and likely in Mexico (Morell 1999, pp. 731–732; Sredl and Caldwell 2000, p. 1; Hale 2001, pp. 32–37; Bradley *et al.* 2002, p. 207; USFWS 2002a, pp. 40802–40804; USFWS 2007, pp. 26, 29–32).

Research shows that, in a pure culture, the fungus *Batrachochytrium* can grow on boiled snakeskin (keratin), which indicates the potential for the fungus to live on gartersnake skin in the wild, if other components of the ecosystem are favorable (Longcore *et al.* 1999, p. 227). Despite the demonstrated potential, no reports of the organism on reptilian hosts in the wild have been documented. We, as well as other researchers, will monitor the incidence of this disease in gartersnakes in the wild for early detection purposes and to determine the status of this potential threat.

Parasites have been observed in northern Mexican gartersnakes. Boyarski (2008b, pp. 5–6) recorded several snakes within the population at the Page Springs and Bubbling Ponds fish hatcheries with interior bumps or bulges along the anterior one-third of the body although the cause of these bumps was not identified or speculated upon, nor were there any signs of trauma to their body in these areas. Dr. Jim Jarchow, a veterinarian with herpetological expertise, reviewed photographs of affected specimens and suggested the bumps may likely contain plerocercoid larvae of a pseudophyllidean tapeworm (possibly *Spirometra* spp.), which are common in fish- and frog-eating gartersnakes. This may not be detrimental to their health provided the bumps do not grow large enough to impair movement or other bodily functions (Boyarski 2008b, p. 8). However, Gúzman (2008, p. 102) documented the first observation of mortality of a Mexican gartersnake from a larval *Eustrongylides* sp. (endoparasitic nematode) which ''raises the possibility that infection of Mexican gartersnakes by *Eustrongylides* sp. larvae might cause mortality in some wild populations,'' especially in the presence of other threats.

Nonnative Species Interactions. A host of native predators prey upon northern Mexican gartersnakes including birds of prey, other snakes [kingsnakes (*Lampropeltis* sp.), whipsnakes (*Masticophis* sp.), etc.], wading birds, raccoons (*Procyon lotor*), skunks (*Mephitis* sp.), and coyotes (*Canis latrans*) (Rosen and Schwalbe 1988, p. 18). Historically, large, highly predatory native fish species such as Colorado pikeminnow may have preyed upon northern Mexican gartersnakes where the two species co-occurred. However, nonnative species represent the most serious threat to the northern Mexican gartersnake through direct predation and predation on northern Mexican gartersnake prey (competition). Nonnative species, such as the bullfrog, the northern (virile) crayfish (*Orconectes virilis*) and red swamp (*Procambarus clarki*) crayfish, and numerous species of nonnative sport and bait fish species continue to be the most significant threat to the northern Mexican gartersnake and to its prey base from direct predation, competition, and modification of habitat (Meffe 1985, pp. 179–185; Rosen and Schwalbe 1988, pp. 28, 32; 1997, p. 1; Bestgen and Propst 1989, pp. 409–410; Clarkson and Rorabaugh 1989, pp. 531, 535; Marsh and Minckley 1990, p. 265; Stefferud and Stefferud 1994, p. 364; Douglas *et al.* 1994, pp. 9–19; Rosen *et al.* 1995, pp. 257–258; 1996b, pp. 2, 11–13; 2001, p. 2; Degenhardt *et al.* 1996, p. 319; Fernandez and Rosen 1996, pp. 8, 23–27; Richter *et al.* 1997, pp. 1089, 1092; Weedman and Young 1997, p. 1, Appendices B, C; Inman *et al.* 1998, p. 17; Rinne *et al.* 1998, pp. 4–6; Minckley *et al.* 2002, p. 696; DFT 2003, p. 1; Clarkson *et al.* 2005, p. 20; Fagan *et al.* 2005, pp. 34, 34–41; Olden and Poff 2005, pp. 82–87; Turner 2006, p. 10; Holycross *et al.* 2006, pp. 13–15; Brennan and Holycross 2006, p. 123; USFWS 2007, pp. 22–23; Caldwell 2008a, 2008b; Jones 2008b; d'Orgeix 2008; Haney *et al.* 2008, p. 59; Luja and Rodríguez-Estrella 2008, pp.. 17–22; Rorabaugh 2008, p. 25; USFS 2008; Wallace *et al.* 2008, pp. 243–244; Witte *et al.* 2008, p. 1).

Riparian and aquatic communities in both the United States and Mexico have been dramatically impacted by a shift in species' composition, from being historically dominated by native fauna to being increasingly occupied by an expanding assemblage of nonnative animal species that have been intentionally or accidentally introduced, such as crayfish, bullfrogs, sportfish, and domestic pets. For example, in two of eight cases of northern Mexican gartersnake mortality collected at Bubbling Ponds Hatchery since 2006, the cause of death was considered to be from domestic cats (Boyarski 2008a).

The population of northern Mexican gartersnakes at the hatcheries occurs with potential and known nonnative predators including rainbow and brown trout, largemouth and smallmouth bass, bluegill, crayfish (in Oak Creek), and bullfrogs (Boyarski 2008b, pp. 3–4, 8). Seven snakes (11 percent of those captured) were observed as having some level of tail damage, presumably from bullfrog predation attempts and were noted as having a lower body condition index (an indicator of overall health based on a set of pre-determined variables) (Boyarski 2008b, pp. 5, 8). The relatively low occurrence of tail damage, as compared to the 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 bullfrog predation attempts; (2) a relatively low density population of bullfrogs occurs at the site (bullfrog population density data were not collected); (3) gartersnakes may not need to move significant distances to achieve foraging success, which might have reduced the potential for encounters with bullfrogs; or, (4) that gartersnakes infrequently escape bullfrog predation attempts, were removed from the population, and were consequently not detected by surveys. Additional information on tail damage as an indicator of predation is found in our discussion of Factor C below.

Stock tanks associated with livestock grazing may facilitate the spread of nonnative species when nonnative species of fish, amphibians, and crayfish 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. 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 northern Mexican gartersnake appears to be particularly vulnerable to a loss in native prey species (Rosen and Schwalbe 1988, p. 20). Rosen *et al.* (2001, pp. 10, 13, 19) examined this issue in detail and proposed two reasons for the decline in northern Mexican gartersnakes following the loss or decline in the native prey base: (1) The species is unlikely to increase foraging efforts at the risk of increased predation; and (2) the species needs substantial food regularly 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) concluded that the presence and expansion of nonnative predators (mainly bullfrogs, crayfish, and green sunfish) are the primary causes of decline in northern Mexican gartersnakes and their prey in southeastern Arizona.

The decline of the northern Mexican gartersnake within its historical and currently occurring distribution was subsequent to the declines in its prey base (native amphibian and fish populations) from predation following introductions of nonnative bullfrogs, crayfish, and numerous species of exotic sport and bait fish as documented in an extensive body of literature (Nickerson and Mays 1970, p. 495; Hulse 1973, p. 278; Vitt and Ohmart 1978, p. 44; Meffe 1985, pp. 179–185; Ohmart *et al.* 1988, pp. 143–147; Rosen and Schwalbe 1988, pp. 28–31; 1997, pp. 8–16; Bestgen and Propst 1989, pp. 409–410; Clarkson and Rorabaugh 1989, pp. 531–538; Marsh and Minckley 1990, p. 265; Sublette *et al.* 1990, pp. 112, 243, 246, 304, 313, 318; Stefferud and Stefferud 1994, p. 364; Holm and Lowe 1995, p. 5; Rosen *et al.* 1995, pp. 251, 257–258; 1996a, pp. 2–3; 1996b, p. 2; 2001, p. 2; Sredl *et al.* 1995a, pp. 7–8; 1995b, pp. 8–9; 1995c, pp. 7–8; 2000, p. 10; Degenhardt *et al.* 1996, p. 319; Fernandez and Rosen 1996, pp. 8–27; Drost and Nowak 1997, p. 11; Weedman and Young 1997, p. 1, Appendices B, C; Inman *et al.* 1998, p. 17; Rinne *et al.* 1998, pp. 4–6; Turner *et al.* 1999, p. 11; Nowak and Spille 2001, p. 11; Bonar *et al.* 2004, p. 3; Fagan *et al.* 2005, pp. 34, 34–41; Olden and Poff 2005, pp. 82–87; Holycross *et al.* 2006, pp. 13–15, 52–61; Brennan and Holycross 2006, p. 123; USFWS 2007, pp. 22–23; Caldwell 2008a, 2008b; Jones 2008b; d'Orgeix 2008; Haney *et al.* 2008, p. 59; Luja and Rodríguez-Estrella 2008, pp. 17–22; Rorabaugh 2008, p. 25; USFS 2008; Wallace *et al.* 2008, pp. 243–244; Witte *et al.* 2008, p. 1).

Declines in the Northern Mexican Gartersnake Anuran Prey Base. Declines in the native leopard frog populations in Arizona have contributed to declines in the northern Mexican gartersnake as a primary native predator. Native ranid frog species such as lowland leopard frogs, northern leopard frogs, and federally threatened Chiricahua leopard frogs have all experienced significant declines throughout their distribution in the Southwest, partially 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 and without corrective action, predicted that the Chiricahua leopard frog will be extirpated from this region. 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 community and that native frog populations in another 19 sites (33 percent) had been completely displaced by invading bullfrogs.

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 apparently 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 remaining through the early 1990s (Holm and Lowe 1995, pp. 27–35). Surveys documented further decline 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 has also experienced a correlative decline of leopard frog and northern Mexican gartersnake populations, at least in part related to illegal immigration and smuggling activities in riparian and aquatic habitats as discussed in Factor A above (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 chytridiomycosis disease, and habitat modification and destruction, have occurred throughout much of the U.S. distribution of the northern Mexican gartersnake (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). Specifically, Holycross *et al.* (2006, pp. 53–57, 59) recently documented extirpations of the northern Mexican gartersnake's native leopard frog prey base at several currently, 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 watershed) in the vicinity of the Forest Service Cabin, at the Page Springs and Bubbling Ponds fish hatchery along Oak Creek, Sycamore Creek (Verde River watershed) 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.* (2001, p. 22) identified the expansion of bullfrogs into the Sonoita grasslands, which border occupied northern Mexican gartersnake habitat, and the introduction of crayfish into Lewis Springs as being of particular concern in terms of future recovery efforts for the northern Mexican gartersnake. Rosen *et al.* (1995, pp. 252–253) sampled 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 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).

Native ranid frogs (particularly lowland and Chiricahua leopard frogs), which are a primary prey species for northern Mexican gartersnakes, are one of the most imperiled taxa of Sonora, Mexico, due primarily to threats from nonnative species (bullfrogs, crayfish, and sport fish) (Rorabaugh 2008, p. 25).

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.

Declines in the Northern Mexican Gartersnake Native Fish Prey Base. Native fish species such as the federally endangered Gila chub, roundtail chub (a species petitioned for Federal listing), and federally endangered Gila topminnow historically were among the primary prey species for the northern Mexican gartersnake (Rosen and Schwalbe 1988, p. 18). Northern Mexican gartersnakes depend on native fish as a principle part of their prey base, although nonnative mosquitofish may also be taken as prey (Holycross *et al.* 2006, p. 23). Both nonnative sport and bait fish compete with the northern Mexican gartersnake in terms of its native fish and native anuran prey base. 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 gartersnakes). Holycross *et al.* (2006, pp. 53–55) recently documented significantly depressed or extirpated native fish prey bases for the northern Mexican gartersnake along the Agua Fria in the vicinity of Table Mesa Road and the Little Grand Canyon Ranch, along Dry Creek from Dugas Road to Little Ash Creek, along Little Ash Creek from Brown Spring to Dry Creek, along Sycamore Creek (Agua Fria watershed) in the vicinity of the Forest Service Cabin, and along Sycamore Creek (Verde River watershed) in the vicinity of its confluence with the Verde River north of Clarkdale. 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.

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 captured in the listing rules of 13 native species listed under the Act whose historical ranges overlap with the historical distribution of the northern Mexican gartersnake. Native fish species that were likely prey species for the northern Mexican gartersnake, including bonytail chub (*Gila elegans,* 45 FR 27710, April 23, 1980), Yaqui catfish (*Ictalurus pricei,* 49 FR 34490, August 31, 1984), 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), humpback chub (*Gila cypha,* 32 FR 4001, March 11, 1967), Gila chub (*Gila intermedia,* 70 FR 66663, November 2, 2005), Colorado pikeminnow (*Ptychocheilus lucius,* 32 FR 4001, March 11, 1967), spikedace (*Meda fulgida,* 51 FR 23769, July 1, 1986) loach minnow (*Tiaroga cobitis,* 51 FR 39468, October 28, 1986), razorback sucker (*Xyrauchen texanus,* 56 FR 54957, October 23, 1991), desert pupfish (*Cyprinodon macularius,* 51 FR 10842, March 31, 1986), and Gila topminnow (*Poeciliopsis occidentalis occidentalis,* 32 FR 4001, March 11, 1967). In total within Arizona, 19 of 31 (61 percent) of 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, Stein 2002, p. 21; Warren and Burr 1994, pp. 6–18).

There are significant ongoing threats from nonnative species to the snake in Mexico. Lyons and Navarro-Perez (1990, pp. 32–46) investigated the fish communities of 17 streams in and adjacent to the Sierra de Manantlán Biosphere Reserve in Jalisco and Colima, Mexico. They noted the exceptionally high number of native fish species with small, localized distributions, which makes them more susceptible to threats and subsequent extirpation, stating that degradation of just a few streams could result in the elimination of many species of fish and, thus, prey availability for the northern Mexican gartersnake.

In an evolutionary context, native fishes co-evolved with very few predatory fish species, whereas many of the nonnative species co-evolved with many predatory species (Clarkson *et al.* 2005, p. 21). A contributing factor to the decline of native fish species cited by Clarkson *et al.* (2005, p. 21) is that most of the nonnative species evolved behaviors, such as nest guarding, to protect their offspring from these many predators, while native species are generally broadcast spawners that provide no parental care. In the presence of nonnative species, the reproductive behaviors of native fish fail to allow them to compete effectively with the nonnative species and, as a result, the viability of native fish populations is reduced.

Olden and Poff (2005, p. 75) stated that environmental degradation and the proliferation of nonnative fish species threaten the highly localized and unique fish faunas of the American Southwest. The fastest expanding nonnative species are red shiner (*Cyprinella lutrensis*), fathead minnow (*Pimephales promelas*), green sunfish (*Lepomis cyanellus*), largemouth bass (*Micropterus salmoides*), western mosquitofish, and channel catfish (*Ictalurus punctatus*). 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 (*Micropterus dolomieue*), have been introduced into formerly and currently occupied northern Mexican gartersnake habitat and are predators on northern Mexican gartersnakes 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).

Several authors have identified both the presence of nonnative fish as well as their deleterious effects on native species within Arizona. 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. Surveys in the Salt River above Lake Roosevelt indicate a decline of roundtail chub and other natives 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 roundtail chub populations (Voeltz 2002, p. 40). Douglas *et al.* (1994, pp. 9–19) provide data indicating that the nonnative red shiner may be competitively displacing spikedace (a potential prey item of the northern Mexican gartersnake) in Arizona and New Mexico within the historical or current distribution of the northern Mexican gartersnake.

In a comprehensive and thorough 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.

Haney *et al.* (2008, p. 61) declared the northern Mexican gartersnake as nearly lost from the Verde River and suggested that diminished river flow may be an important factor. Differing river flows may provide both advantages and disadvantages to aquatic species. The timing, duration, intensity, and frequency of flood events has been altered to varying degrees by the presence of dams along the Verde River, which has an effect on fish communities. Specifically, Haney *et al.* (2008, p. 61) suggested that flood pulses may help to reduce populations of nonnative species (see discussion below) and efforts to increase the baseflows may assist in sustaining native prey species for the northern Mexican gartersnake. However, the investigators also suggest that, because the northern Mexican gartersnake preys on both fish and frogs, it may be less affected by reductions in baseflow but might incur greater risks from concentrating nonnative predators and higher water-borne disease rates (Haney *et al.* 2008, pp. 82, 93).

The Desert Fishes Team (DFT) is an ''independent group of biologists and parties interested in protecting and conserving native fishes of the Colorado River basin'' and includes personnel from the U.S. Forest Service, U.S. Bureau of Reclamation, U.S. Bureau of Land Management, University of Arizona, Arizona State University, the Nature Conservancy, and independent experts (DFT 2003, p. 1). DFT (2003, p. 1) declared the native fish fauna of the Gila River basin to be critically imperiled, cite habitat destruction and nonnative species as the primary factors for the declines, and call for the control and removal of nonnative fish as an overriding need to prevent the decline and ultimate extinction of native fish species within the basin.

Northern Mexican gartersnakes can successfully use some nonnative species, such as mosquitofish and red shiner, as prey species. However, all other nonnative species, most notably the spiny-rayed fish, are not considered prey species for the northern Mexican gartersnake. These nonnative species can be difficult to swallow due to their body shape and spiny dorsal fins. They are predatory on juvenile gartersnakes and reduce the abundance of or completely eliminate native fish populations. This is particularly important in the wake of random, high-intensity events, such as flooding, extreme water temperatures, or excessive turbidity. Native fish are adapted to the dramatic fluctuations in water conditions and flow regimes, and generally persist in the wake of stochastic events and continue to provide a prey base for the northern Mexican gartersnake. Nonnative fish, even species that may be used as prey by the northern Mexican gartersnake, generally are ill-adapted to these conditions and may be removed from the area temporarily or permanently, depending on the hydrologic connectivity to current populations. If an area is solely comprised of nonnative fish, the northern Mexican gartersnake may be faced with nutritional stress or starvation because only a few small-bodied, soft-rayed fish species are taken as prey and significant effort may be required to obtain these species.

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 fauna as imperiled. The investigators cite nonnative species as the most consequential factor that has led to rangewide declines that prevents or negates species' recovery efforts from being implemented or being successful (Clarkson *et al.* 2005, p. 20). Clarkson *et al.* (2005, p. 20) note that over 50 nonnative species have been introduced into the Southwest as either sportfish or baitfish and are still being actively stocked, managed for, and promoted by both Federal and State agencies as nonnative recreational fisheries. To help resolve the conflicting management mandates of native fish recovery and the promotion of recreational fisheries, Clarkson *et al.* (2005, pp. 22–25) propose the designation of entire watersheds as having either native or nonnative fisheries and manage for these goals aggressively. While some discussion within Arizona has taken place to designate portions of watersheds as either native or nonnative fisheries, the geographic areas under consideration for native fishery development do not currently coincide with current populations of northern Mexican gartersnakes and no immediate benefit is provided to the subspecies from their implementation. Clarkson *et al.* (2005, p. 25) suggest that current management of fisheries within the southwestern United States as status quo will have serious adverse effects to native fish species and affect the long-term viability of the northern Mexican gartersnake and to its potential recovery.

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 may also provide long-term benefits (Krause and Burghardt 2001, p. 101). Krause and Burghardt (2001, p. 112) stated that varied predatory experience played an important role in the feeding abilities of gartersnakes through the first 8 months of age. These data suggest that a varied prey base might also be important for neonatal and juvenile northern Mexican gartersnakes (also a species with a varied diet) and that decreases in the diversity of the prey base during the young age classes might adversely affect the ability of individuals to capture prey throughout their lifespan, in addition to the more obvious effects of reduced prey availability.

The most conclusive evidence for the northern Mexican gartersnake's intolerance for nonnative fish invasions remains the fact that, in most incidences, nonnative fish species generally do not occur in the same locations as the northern Mexican gartersnake and its native prey species. Additional information on the decline of the northern Mexican gartersnake's native fish prey species can be found in Bonar *et al.* (2004, pp. 4, 79–87); DFT (2003, pp. 1–3, 5–6, 19; 2004, pp. 1–2, 4–5, 10, Table 1; 2006, pp. iii, 25); Richter *et al.* (1997, pp. 1081–1093); and Haney *et al.* (2008, pp. 54–61, 82, 93).

Bullfrog Diet and Distribution. Bullfrogs are widely considered one of the most serious threats to the northern Mexican gartersnake throughout its range (Conant 1974, pp. 471, 487–489; Rosen and Schwalbe 1988, pp. 28–30; Rosen *et al.* 2001, pp. 21–22). Bullfrogs adversely affect northern Mexican gartersnakes through direct predation of juveniles and sub-adults and from competition with native prey species. Bullfrogs first appeared in Arizona in 1926, as a result of a systematic introduction effort by the State Game Department (now, the Arizona Game and Fish Department) for the purposes of sport hunting and as a food source. (Tellman 2002, p. 43). Bullfrogs are extremely prolific, adept at colonizing new areas, and may disperse to distances of 6.8 miles (10.9 km) and likely further within drainages (Bautista 2002, p. 131; Rosen and Schwalbe 2002a, p. 7; Casper and Hendricks 2005, p. 582). In Arizona, using mark and recapture methods, bullfrogs have been documented to make overland movements of up to 7 miles (11 kilometers) across semi-desert grassland habitat on the Buenos Aires National Wildlife Refuge (BANWR) (Suhre 2008). Investigators on the BANWR also observed two bullfrogs at an overland distance of 10 miles (16 kilometers) from the nearest source population although the origin of the bullfrogs could not be confirmed. Batista (2002, p. 131) confirmed ''the strong colonizing skills of the bullfrog and that the introduction of this exotic species can disturb local anuran communities.''

Bullfrogs are voracious, opportunistic, even cannibalistic predators that readily attempt to consume any animal smaller than themselves, including other species within the same genus, which can comprise 80 percent of their diet (Casper and Hendricks 2005, p. 543). Bullfrogs have a varied diet, which has been documented to include vegetation, numerous invertebrate and vertebrate species which include 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, p. 544; Combs *et al.* 2005, p. 439; Wilcox 2005, p. 306; DaSilva *et al.* 2007, p. 443; Neils and Bugbee 2007, p. 443).

Bullfrogs have been documented throughout the State of Arizona. Holycross *et al.* (2006, pp. 13–14, 52–61) found bullfrogs at 55 percent of sample sites in the Agua Fria watershed, 62 percent of sites in the Verde River watershed, 25 percent of sites in the Salt River watershed, and 22 percent of sites in the Gila River watershed. 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 through their survey efforts throughout Arizona in specific regional areas, drainages, and disassociated wetlands within or adjacent to the historical distribution of the northern Mexican gartersnake, including the Kaibab National Forest (Sredl *et al.* 1995a, p. 7); the Coconino National Forest (Sredl *et al.* 1995c, p. 7); the White Mountain Apache Reservation (Hulse 1973, p. 278); Beaver Creek (tributary to the Verde River) (Drost and Nowak 1997, p. 11); the Watson Woods Riparian Preserve near Prescott (Nowak and Spille 2001, p. 11); the Tonto National Forest (Sredl *et al.* 1995b, p. 9); the Lower Colorado River (Vitt and Ohmart 1978, p. 44; Clarkson and DeVos 1986, pp. 42–49; Ohmart *et al.* 1988, p. 143); the Huachuca Mountains (Rosen and Schwalbe 1988, Appendix I; Holm and Lowe 1995, pp. 27–35; Sredl *et al.* 2000, p. 10; Rosen *et al.* 2001, Appendix I); the Pinaleno Mountains region (Nickerson and Mays 1970, p. 495); the San Bernardino National Wildlife Refuge (Rosen and Schwalbe 1988, Appendix I; 1995, p. 452; 1996, pp. 1–3; 1997, p. 1; 2002b, pp. 223–227; 2002c, pp. 31, 70; Rosen *et al.* 1995, p. 254; 1996b, pp. 8–9; 2001, Appendix I); the Buenos Aires National Wildlife Refuge (Rosen and Schwalbe 1988, Appendix I); the Arivaca Area (Rosen and Schwalbe 1988, Appendix I; Rosen *et al.* 2001, Appendix I); Cienega Creek drainage (Rosen *et al.* 2001, Appendix I); Babocamari River drainage (Rosen *et al.* 2001, Appendix I); Turkey Creek drainage (Rosen *et al.* 2001, Appendix I); O'Donnell Creek drainage (Rosen *et al.* 2001, Appendix I); Appleton-Whittell Research Ranch near Elgin (Rosen *et al.* 2001, Appendix I); Santa Cruz River drainage (Rosen and Schwalbe 1988, Appendix I; Rosen *et al.* 2001, Appendix I); San Rafael Valley (Rosen *et al.* 2001, Appendix I); San Pedro River drainage (Rosen and Schwalbe 1988, Appendix I; Rosen *et al.* 2001, Appendix I); Bingham Cienega (Rosen *et al.* 2001, Appendix I); Sulfur Springs Valley (Rosen *et al.* 1996a, pp. 16–17); Whetstone Mountains region (Turner *et al.* 1999, p. 11); Aqua Fria River drainage (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, pp. 13, 15–18, 52–53); Verde River drainage (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, pp. 13, 26–28, 55–56); greater metropolitan Phoenix area (Rosen and Schwalbe 1988, Appendix I); greater metropolitan Tucson area (Rosen and Schwalbe 1988, Appendix I); Sonoita Creek drainage (Rosen and Schwalbe 1988, Appendix I); Sonoita Grasslands (Rosen and Schwalbe 1988, Appendix I); Canelo Hills (Rosen and Schwalbe 1988,

Appendix I); Pajarito Mountains (pers. observation, J. Servoss, Fish and Wildlife Biologist, U.S. Fish and Wildlife Service); Picacho Reservoir (Rosen and Schwalbe 1988, Appendix I); Dry Creek drainage (Holycross *et al.* 2006, pp. 19, 53); Little Ash Creek drainage (Holycross *et al.* 2006, pp. 19, 54); Oak Creek drainage (Holycross *et al.* 2006, pp. 23, 54); Sycamore Creek drainages (Holycross *et al.* 2006, pp. 20, 25, 54–55); Rye Creek drainage (Holycross *et al.* 2006, pp. 37, 58); Spring Creek drainage (Holycross *et al.* 2006, pp. 25, 59); Tonto Creek drainage (Holycross *et al.* 2006, pp. 40–44, 59; Wallace *et al.* 2008, pp. 243–244); San Francisco River drainage (Holycross *et al.* 2006, pp. 49–50, 61); Sonoita Creek (Tuner 2006; p. 10); and the upper Gila River drainage (Holycross *et al.* 2006, pp. 45–50, 60–61).

Perhaps one of the most serious consequences of bullfrog introductions is their persistence in an area once they have become established, and the subsequent difficulty in eliminating bullfrog populations. Rosen and Schwalbe (1995, p. 452) experimented with bullfrog removal at various sites on the San Bernardino National Wildlife Refuge in addition to a control site with no bullfrog removal in similar habitat on the 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 sub-adult 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, bullfrogs in the young adult and subadult age classes also negatively impact northern Mexican gartersnakes and their prey species.

Bullfrog Effects on the Native Anuran Prey Base for the Northern Mexican Gartersnake. As documented above and in the following studies, bullfrogs significantly reduce native anuran prey availability for the northern Mexican gartersnake (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); Moyle (1973, pp. 18–22)). Different age classes of bullfrogs within a community 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.

Bullfrog Predation on Northern Mexican Gartersnakes. Sub-adult and adult bullfrogs not only compete with the northern Mexican gartersnake for prey items, but directly prey upon juvenile and occasionally sub-adult northern Mexican 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 Arizona Game and Fish Department in 1964, provides photographic documentation of bullfrog predation (Rosen and Schwalbe 1988, p. 29; 1995, p. 452). 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 due to bullfrogs preying on young small snakes, which ultimately leads to low reproductive rates and survival of young (Rosen and Schwalbe 1988, p. 18; Holm and Lowe 1995, p. 34). Potential recruitment problems for northern Mexican gartersnakes due to effects from nonnative species are also suspected at Tonto Creek (Wallace *et al.* 2008, pp. 243–244).

The tails of gartersnakes broken off through predation attempts may also lead to infection or compromise an individual's physical ability to escape future predation attempts or successfully forage. Tails of gartersnakes do not regenerate. The incidence of tail breaks in gartersnakes can often be used to assess predation pressures within gartersnake populations. Rosen and Schwalbe (1988, p. 22) found the incidence of tail breaks to be statistically higher in females than in males. Fitch (2003, p. 212) also found that tail breaks in the common gartersnake occurred more frequently in females than males and in adults more than in juveniles. Fitch (2003, p. 212) also 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. Furthermore, Mushinsky and Miller (1993, pp. 662–664) found that the incidence of tail injury in water snakes in the genera *Nerodia* and *Regina* (which have similar life histories to northern Mexican gartersnakes) was higher in females than in males and in adults more than juveniles. This can be explained by higher basking rates associated with pregnant females that increase their visibility to predators. Additionally, predation on juvenile snakes generally results in complete consumption of the animal, which would limit observations of tail injury in their age class. Rosen and Schwalbe (1988, p. 22) suggested that the indication that female northern Mexican gartersnakes bear more injuries is consistent with the inference that they employ a riskier foraging strategy. 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 mortality.

Ecologically significant observations on tail injuries were made by Rosen and Schwalbe (1988, pp. 28–31) on the formerly occurring population of northern Mexican gartersnakes on the San Bernardino National Wildlife Refuge. Seventy-eight percent of specimens 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. While a sub-adult or adult northern Mexican gartersnake may survive an individual predation attempt from a bullfrog while only incurring tail damage, secondary effects from infection of the wound can significantly contribute to mortality of individuals.

Research on the effects of attempted predation performed by Mushinsky and Miller (1993, pp. 661–664) and Willis *et al.* (1982, pp. 100–101) supports the observations made by Holm and Lowe (1995, p. 34) on the northern Mexican gartersnake population age class structure in Scotia Canyon in the Huachuca Mountains of southeastern Arizona in the early 1990s. Specifically, Holm and Lowe (1995, pp. 33–34) observed a conspicuously greater number of adult snakes in that population than sub-adult snakes, as well as a higher incidence of tail injury (89 percent) in all snakes captured. Bullfrogs have been identified as the primary cause for both the collapse of the native leopard frog (prey base for the northern Mexican gartersnake) and northern Mexican gartersnake populations on the San Bernardino National Wildlife Refuge (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). Rosen and Schwalbe (1988, p. 18) stated that the low survivorship of newborns, and possibly yearlings, due to bullfrog predation is an important proximate cause of population declines of this snake at the San Bernardino National Wildlife Refuge and throughout its distribution in Arizona.

Crayfish. Nonnative crayfish are a primary threat to many prey species of the northern Mexican gartersnake and may also prey upon juvenile gartersnakes (Fernandez and Rosen 1996, p. 25; Voeltz 2002, pp. 87–88; USFWS 2007, p. 22). 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*). 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 also prey on fish eggs and larvae (Inman *et al.* 1998, p. 17).

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) also found that crayfish frequently burrow into stream banks, which leads to increased bank erosion, stream turbidity, and siltation of substrates. Creed (1994, p. 2098) found that filamentous alga (*Cladophora glomerata*) was at least 10-fold greater in aquatic habitat absent crayfish. Filamentous alga is an important component of aquatic vegetation that provides cover for foraging gartersnakes as well as microhabitat for prey species.

Inman *et al.* (1998, p. 3) documented nonnative 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 overlapped the historical and current distribution of the northern Mexican gartersnake. 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 watershed; in 85 percent of the sites in the Verde River watershed; in 46 percent of the sites in the Salt River watershed; and in 67 percent of the sites in the Gila River watershed. 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 occupied by northern Mexican gartersnakes, or sites the investigators believed possessed suitable habitat and may be occupied based upon the known historical distribution of the subspecies.

Several other authors have specifically documented the presence of crayfish in many areas and drainages throughout Arizona, which is testament to their ubiquitous distribution in Arizona and their strong colonizing abilities. These areas all fall within the range of the northern Mexican gartersnake and include the Kaibab National Forest (Sredl *et al.* 1995a, p. 7); the Coconino National Forest (Sredl *et al.* 1995c, p. 7); the Watson Woods Riparian Preserve near Prescott (Nowak and Spille 2001, p. 33); the Tonto National Forest (Sredl *et al.* 1995b, p. 9); the Lower Colorado River (Ohmart *et al.* 1988, p. 150; Inman *et al.* 1998, Appendix B); the Huachuca Mountains (Sredl *et al.* 2000, p. 10); the Arivaca Area (Rosen *et al.* 2001, Appendix I); Babocamari River drainage (Rosen *et al.* 2001, Appendix I); O'Donnell Creek drainage (Rosen *et al.* 2001, Appendix I); Santa Cruz River drainage (Rosen and Schwalbe 1988, Appendix I; Rosen *et al.* 2001, Appendix I); San Pedro River drainage (Inman *et al.* 1998, Appendix B; Rosen *et al.* 2001, Appendix I); Aqua Fria River drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 14, 15–18, 52–54); Verde River drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 14, 20–28, 54–56); Salt River drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 15, 29–44, 56–60); Black River drainage (Inman *et al.* 1998, Appendix B); San Francisco River drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 14, 49–50, 61); Nutrioso Creek drainage (Inman *et al.* 1998, Appendix B); Little Colorado River drainage (Inman *et al.* 1998, Appendix B); Leonard Canyon Drainage (Inman *et al.* 1998, Appendix B); East Clear Creek drainage (Inman *et al.* 1998, Appendix B); Chevelon Creek drainage (Inman *et al.* 1998, Appendix B); Eagle Creek drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 47–48, 60); Bill Williams drainage (Inman *et al.* 1998, Appendix B); Sabino Canyon drainage (Inman *et al.* 1998, Appendix B); Dry Creek drainage (Holycross *et al.* 2006, pp. 19, 53); Little Ash Creek drainage (Holycross *et al.* 2006, pp. 19, 54); Sycamore Creek drainage (Holycross *et al.* 2006, pp. 25, 54–55); East Verde River drainage (Holycross *et al.* 2006, pp. 21–22, 54); Oak Creek drainage (Holycross *et al.* 2006, pp. 23, 54); Pine Creek drainage (Holycross *et al.* 2006, pp. 24, 55); Spring Creek drainage (Holycross *et al.* 2006, pp. 25, 55); Big Bonito Creek drainage (Holycross *et al.* 2006, pp. 29, 56); Cherry Creek drainage (Holycross *et al.* 2006, pp. 33, 57); East Fork Black River drainage (Holycross *et al.* 2006, pp. 34, 57); Haigler Creek drainage (Holycross *et al.* 2006, pp. 35, 58); Houston Creek drainage (Holycross *et al.* 2006, pp. 35–36, 58); Rye Creek drainage (Holycross *et al.* 2006, pp. 37, 58); Tonto Creek drainage (Holycross *et al.* 2006, pp. 40–44, 59; Wallace *et al.* 2008; pp. 243–244); Blue River drainage (Holycross *et al.* 2006, pp. 45, 60); Campbell Blue River drainage (Holycross *et al.* 2006, pp. 46, 60); and the Gila River drainage (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 45–50, 61). Like bullfrogs, crayfish can be very difficult, if not impossible, to eradicate once they have become established in an area (Rosen and Schwalbe 1996a, pp. 5–8; 2002a, p. 7; Hyatt undated, pp. 63–71).

Nonnative Fish Distribution and Community Interactions. As indicated earlier in this document, nonnative fish are a threat to northern Mexican gartersnakes and their native anuran and fish prey. Similar to bullfrogs, predatory nonnative fish species, such as largemouth bass, also prey upon juvenile northern Mexican gartersnakes. 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. Rosen *et al.* (2001, Appendix I) found nonnative fish in the following survey locations: The Arivaca Area; Babocamari River drainage; O'Donnell Creek drainage; Appleton-Whittell Research Ranch (Post Canyon) near Elgin; Santa Cruz River drainage; Agua Caliente Canyon; Santa Catalina Mountains; and the San Pedro River drainage. Holycross *et al.* (2006, pp. 14–15, 52–61) found nonnative fish in the Aqua Fria River drainage; the Verde River drainage; the Dry Creek drainage; the Little Ash Creek drainage; the Sycamore Creek drainage; the East Verde River drainage; the Oak Creek drainage; the Pine Creek drainage; the Big Bonito Creek drainage; the Black River drainage; the Canyon Creek drainage; the Cherry Creek drainage; the Christopher Creek drainage; the East Fork Black River drainage; the Haigler Creek drainage; the Houston Creek drainage; the Rye Creek drainage; the Salt River drainage; the Spring Creek drainage; the Tonto Creek drainage; the Blue River drainage; the Campbell Blue River drainage; the Eagle Creek drainage; and the San Francisco River drainage. Other authors have documented the presence of nonnative fish through their survey efforts in specific regions that include the Tonto National Forest (Sredl *et al.* 1995b, p. 8) and the Huachuca Mountains (Sredl *et al.* 2000, p. 10).

Holycross *et al.* (2006, pp. 14–15) found nonnative fish species in 64 percent of the sample sites in the Agua Fria watershed, 85 percent of the sample sites in the Verde River watershed, 75 percent of the sample sites in the Salt River watershed, and 56 percent of the sample sites in the Gila River watershed. 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 detected in only 8 of 57 sites surveyed (14 percent) (Holycross *et al.* 2006, p. 14). While the locations and drainages identified above that are known to support populations of nonnative fish do not provide a thorough representation of the status of nonnative fish distribution Statewide in Arizona, it is well documented that nonnative fish have infiltrated the majority of aquatic communities in Arizona.

Nonnative fish can also affect native amphibian populations. 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 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 prediction by Jennings *et al.* (1992, p. 503) that native amphibian declines will lead directly to gartersnake declines. Matthews *et al.* (2002, p. 20) noted that in addition to nonnative fish species adversely impacting amphibian populations that are part of the gartersnake's prey base, direct predation on gartersnakes by nonnative fish also occurs. Inversely, gartersnake predation on nonnative species, such as centrarchids, may physically harm the snake. Choking injuries to northern Mexican gartersnakes may occur from attempting to ingest nonnative spiny-rayed fish species (such as green sunfish and bass) because the spines located in the dorsal fins of these species can become lodged in, or cut into the gut tissue, of the snake, as observed in narrow-headed gartersnakes (Nowak and Santana-Bendix 2002, p. 25).

Nonnative fish invasions can indirectly affect the health, maintenance, and reproduction of the northern Mexican gartersnake by altering its foraging strategy and foraging success. The more energy expended in foraging, coupled by the reduced number of small to medium-sized prey fish available in lower densities, may lead to deficiencies in nutrition affecting growth and reproduction because energy is instead allocated to maintenance and the increased energy costs of intense foraging activity (Rosen *et al.* 2001, p. 19). In contrast, a northern Mexican gartersnake diet that includes both fish and amphibians such as leopard frogs provides larger prey items which reduce 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 in juvenile snakes that were deprived of regular feedings versus the control group that were fed regularly at natural frequencies. Reduced foraging success means that individuals will become vulnerable to effects from starvation, which may, therefore, increase mortality rates in the juvenile size class and consequently affect recruitment of northern Mexican gartersnakes where their prey base has been compromised by nonnative species.

Nonnative Species in Mexico. As in the United States, the native fish prey base for northern Mexican gartersnakes in Mexico has been dramatically affected by the introduction of nonnative species (Conant 1974, pp. 471, 487–489; Miller *et al.* 2005, pp. 60–61; Abarca 2006). In the lower elevations of Mexico where northern Mexican gartersnakes occurred historically or are still found, 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 become extinct due to human activities, which include the introduction of nonnative species (Contreras Balderas and Lozano 1994, pp. 383–384). In 1979, The American Fisheries Society listed 69 species of native fish in Mexico as threatened or in danger of becoming extinct. Ten years later that number rose to 123 species, an increase of 78 percent

(Contreras Balderas and Lozano 1994, pp. 383–384). Miller *et al.* (2005, p. 60) concludes that some 20 percent of Mexico's native fish are threatened or in danger of becoming extinct. Nonnative species are increasing everywhere throughout Mexico, and this trend will have adverse impacts on native fish, according to Miller *et al.* (2005, p. 61). A number of freshwater fish populations have been adversely affected by nonnative species in many locations, several of which were previously noted in the discussion under Factor A.

At the time of our 2006 12-month finding, we had less information on the status and distribution of bullfrogs within Mexico. However, since that time, 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 7 more States: Aguacalientes, Baja California Sur, Chihuahua, Distrito Federal, Puebla, San Luis Potosi, and Sonora (Luja and Rodríguez-Estrella 2008, p. 20). To date, 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.

Sponsored by the then Mexican Secretary of Aquaculture Support, bullfrogs have been commercially produced for food in Mexico in Yucatan, Nayarit, Morelos, Estado de Mexico, Michoacán, Guadalajara, San Luis Potosi, Tamaulipas, and Sonora (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, p. 20 and 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.'' To further compound these introductions, bullfrogs are available for purchase at Mexican pet stores (Luja and Rodríguez-Estrella 2008, p. 22).

Adverse effects such as predation upon, and competition with, northern Mexican gartersnakes and their prey base from bullfrog invasions in Mexico have been specifically documented with respect to Chiricahua leopard frogs, a primary prey item for northern Mexican gartersnakes (Luja and Rodríguez-Estrella 2008, p. 21). Luja and Rodríguez-Estrella (2008, p. 21) also stated that bullfrog eradication efforts in Mexico are often thwarted by their being favored by local communities. Currently, no regulation exists in Mexico to address the threat of bullfrog invasions (Luja and Rodríguez-Estrella 2008, p. 22).

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 (2008, p. 25) also considers the bullfrog to be a significant threat to the northern Mexican gartersnake and its prey base.

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 current populations of northern Mexican gartersnake, as did much of the Gila Basin before the introduction of nonnative species. Loss of native fishes will impact prey availability for the northern Mexican gartersnake and threaten its persistence in these areas.

Summary of Factor C. While disease is not currently considered a direct threat to northern Mexican gartersnakes, Bd does have a widespread effect on anuran prey availability for the species. In addition, stress placed on northern Mexican gartersnakes as a result of threats discussed under Factor A may affect the health condition of individuals within populations affected by these threats, which may increase the potential for disease within current populations in the future.

Direct predation by nonnative bullfrogs, crayfish, and fishes on northern Mexican garter snakes is a significant threat rangewide, as is predation on gartersnake prey species (competition) by these same groups of nonnative taxa. Nonnative fish, crayfish, and bullfrogs have reduced native populations of prey species throughout the range.

D. The Inadequacy of Existing Regulatory Mechanisms

Currently, the northern Mexican gartersnake is considered ''State Endangered'' in New Mexico. In the State of New Mexico, an ''Endangered Species'' is defined as ''any species of fish or wildlife whose prospects of survival or recruitment within the State are in jeopardy due to any of the following factors: (1) The present or threatened destruction, modification, or curtailment of its habitat; (2) overutilization for scientific, commercial or sporting purposes; (3) the effect of disease or predation; (4) other natural or man-made factors affecting its prospects of survival or recruitment within the state; or (5) any combination of the foregoing factors'' as per New Mexico Statutory Authority (NMSA) 17–2–38.D. ''Take,'' defined as ''means to harass, hunt, capture or kill any wildlife or attempt to do so'' by 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 northern Mexican gartersnakes, the same provisions are not in place for actions that result in loss or modification of habitat (NMSA 17–2–41.C and NMAC 19.33.6) (Painter 2005).

The northern Mexican gartersnake is considered a ''Candidate Species'' in the Arizona Game and Fish Department draft document, Wildlife of Special Concern (WSCA) (AGFD *In Prep.*, p. 12). A ''Candidate Species'' is one ''whose threats are known or suspected but for which substantial population declines from historical levels have not been documented (though they appear to have occurred)'' (AGFD *In Prep.*, p. 12). The purpose of the WSCA list is to provide guidance in habitat management implemented by land-management agencies. Additionally, the northern Mexican gartersnake is considered a ''Tier 1b Species of Greatest Conservation Need'' in the Arizona Game and Fish Department draft document, Arizona's Comprehensive Wildlife Conservation Strategy (CWCS) (AGFD 2006a, p. 32; 2006b). The purpose for the CWCS is to ''provide an essential foundation for the future of wildlife conservation and a stimulus to engage the States, federal agencies, and other conservation partners to strategically think about their individual and coordinated roles in prioritizing conservation efforts'' (AGFD 2006a, p. 2). A ''Tier 1b Species of Greatest Conservation Need'' is one that requires immediate conservation actions aimed at improving conditions through intervention at the population or habitat level (AGFD 2006a, p. 32).

Prior to 2005, the Arizona Game and Fish Department allowed for take of up to four northern Mexican gartersnakes per person per year as specified in Commission Order Number 43. The Arizona Game and Fish Department 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 Arizona Game and Fish Department subsequently amended Commission Order Number 43, effective January 2005. Take of northern Mexican gartersnakes is no longer permitted in Arizona without issuance of a scientific collecting permit (Ariz. Admin. Code R12–4–401 *et seq.*). While the Arizona Game and Fish Department can seek criminal or civil penalties for illegal take of northern Mexican gartersnakes, the same provisions are not in place for actions that result in destruction or modification of northern Mexican gartersnake habitat.

In addition to making the necessary regulatory changes to promote the conservation of the northern Mexican gartersnake, the Arizona Game and Fish Department continues as a strong partner in research and survey efforts that further our understanding of current populations within Arizona. They continue to assist with future conservation efforts and the establishment of long-term conservation partnerships.

Gartersnakes are active, diurnal (daytime) foragers and humans encounter gartersnake species in riparian areas used for recreational purposes or for other reasons. These encounters can result in the capture, injury, or death of the gartersnake due to the lay person's fear or dislike of 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). It is very difficult for the Arizona Game and Fish Department or the New Mexico Department of Fish and Game to monitor or even be aware of such forms of take. We believe that unregulated take occurs, particularly in areas frequently visited by the public with current populations of northern Mexican gartersnakes, such as at Page Springs and Bubbling Ponds hatcheries and along Tonto Creek near the town of Gisela. We are reasonably certain that the level of illegal field collecting by the hobbyist community is low because gartersnakes are relatively undesirable in amateur herpetological collections.

Neither the New Mexico Department of Game and Fish, nor the Arizona Game and Fish Department have specified or mandated recovery goals for the northern Mexican gartersnake, nor has either State developed a conservation agreement or plan for this species.

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 2001). 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'' (SEDESOL 2001 (NOM–059–ECOL–2001), p. 4). This designation prohibits taking of the species, unless specifically permitted, as well as prohibits any activity that intentionally destroys or adversely modifies its habitat (SEDESOL 2000 (LGVS) and 2001 (NOM–059–ECOL–2001)). Additionally, in 1988, the Mexican Government passed a regulation that is similar to the National Environmental Policy Act of the United States (42 U.S.C. 4321 *et seq.*). This Mexican regulation requires an environmental assessment of private or government actions that may affect wildlife or their habitat (SEDESOL 1988 (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 a threatened and endangered 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 considered a federally threatened species in Mexico, no recovery plan or other conservation planning occurs because of this status. Enforcement of the regulation protecting the gartersnake is sporadic, based on available resources and location. Based upon the information on the status of the species and the historic and continuing threats to its habitat in Mexico, our analysis concludes that protections afforded to the northern Mexican gartersnake may not be adequate to preclude the continued decline of this species throughout its range.

Ortega-Huerta and Kral (2007, p. 1) found that land legislation within Mexico has changed considerably over recent years to integrate free market policies into local agricultural production methods. This may result in the loss of land management practices that protect the natural environment. In 1992, the Mexican Government made a constitutional amendment ending the Ejido's special legal status and permitting the sale of collectively controlled lands (Ortega-Huerta and Kral 2007, p. 2). An Ejido is an amalgamation of various types of ownership of a particular piece of land, e.g., state, cooperative, communal, and private. Ejidos are generally managed in traditional means, which generally have less of an impact to the environment compared to more modern free market uses, resulting in higher levels of biodiversity (Ortega-Huerta and Kral 2007, p. 2; Randall 1996, pp. 218–220; Kiernan 2000, pp. 13–23). The loss of regulation that prevented the division and sale of collectively controlled lands in Mexico is likely to reduce the protection of intact northern Mexican gartersnake habitat.

Existing water laws in Arizona, New Mexico, and Mexico are inadequate to protect wildlife. The presence of water is a primary habitat constituent for the northern Mexican gartersnake. Gelt (2008, pp. 1–12) highlighted the fact that, because the existing water laws are so old, they reflect a legislative interpretation of the resource that is not consistent with what we know today; yet the laws have never been updated or amended to account for this discrepancy. For example, over 100 years ago when Arizona's water laws were written, the important connection between groundwater and surface water was not known (Gelt 2008, pp. 1–12). Gelt (2008, pp. 8–9) suggested that preserving stream flows and riparian areas may be better accomplished by curtailing surface water uses rather than ground water uses, and that the prior appropriation doctrine (appropriation of water rights based upon the water law concept of ''first in use, first in rights'') may be outdated and impractical for arid areas like Arizona.

The majority of current populations of northern Mexican gartersnake in the United States occur on lands managed by the U.S. Bureau of Land Management and U.S. Forest Service. Although both agencies have riparian protection goals, neither agency has specific management plans for the northern Mexican gartersnake. The U.S. Bureau of Land Management considers the northern Mexican gartersnake as a ''Special Status Species,'' and agency biologists actively attempt to identify gartersnakes observed incidentally during fieldwork for their records (Young 2005). Otherwise, no specific protection or land-management consideration is afforded to the species on Bureau of Land Management lands.

The U.S. Forest Service does not include northern Mexican gartersnake on their Management Indicator Species List, but it is included on the Regional Forester's Sensitive Species List. This means that northern Mexican gartersnakes are considered in land management decisions. Individual U.S. Forest Service biologists who work within the range of the northern Mexican gartersnake may opportunistically gather data for their records on gartersnakes observed incidentally in the field, although it is not required.

Activities that could adversely affect northern Mexican gartersnakes and their habitat continue to occur throughout their current distribution on National Forest lands. Clary and Webster (1989, p. 1) stated that ''* * * most riparian grazing results suggest that the specific grazing system used is not of dominant importance, but good management is—with control of use in the riparian area a key item.'' Due to ongoing constraints in funding, staff levels, and time and regulatory compliance pertaining to monitoring and reporting duties tied to land management, proactive measures continue to be limited. These factors affect a land manager's ability to employ adaptive management procedures when effects to sensitive species or their habitat could be occurring at levels greater than anticipated in regulatory compliance mechanisms, such as in section 7 consultation under the Act for listed species that may co-occur with the northern Mexican gartersnake in an area. In other words, and due to the existing regulatory framework, some land managers may not have the flexibility required to adopt adaptive management where necessary to adequately account for adverse effects of projects on public lands.

Riparian communities are complex and recognized as unique in the southwestern United States but are highly sensitive to many human-caused land uses, as evidenced by the comparatively high number of federally listed riparian or aquatic species. Four primary prey species for the northern Mexican gartersnake, the Chiricahua leopard frog, Gila topminnow, Gila chub, and roundtail chub, are federally listed or were petitioned for listing. Other listed or proposed riparian species or their proposed or designated critical habitat overlap the current or historical distribution of the northern Mexican gartersnake. Despite secondary protections that may be afforded to the northern Mexican gartersnake from federally listed species or their critical habitat, riparian and aquatic communities continue to be adversely impacted for reasons previously discussed, contributing to the declining status of the northern Mexican gartersnake throughout its range in the United States.

Summary of Factor D. Existing regulations within the range of the northern Mexican gartersnake address the direct take of individuals without a permit, and unpermitted take by recreationists or collectors is not thought to be at levels that impact the subspecies. Arizona and New Mexico statutes do not provide protection of habitat and ecosystems. Legislation in Mexico prohibits intentional destruction or modification of the snake's habitat, but neither that or prohibitions on take appear to be adequate to preclude the continued decline of the subspecies. Currently, there are no regulatory mechanisms in place that specifically target the conservation of northern Mexican gartersnake habitat. Legislation in Mexico has removed regulation of ejidos that promoted intact protection of important riparian and aquatic habitats. Regulations protecting the quantity and quality of water in riparian and aquatic communities are inadequate to protect water resources for the northern Mexican gartersnake, particularly in the face of the significant population growth expected within the historical range of the snake discussed under Factor A.

E. Other Natural or Manmade Factors Affecting Its Continued Existence

Competition With Other Species Within the Same Genus. Marcy's checkered gartersnake (*Thamnophis marcianus marcianus*) may impact the future conservation of the northern Mexican gartersnake in southern Arizona, although supporting data are limited. Marcy's checkered gartersnake is a semi-terrestrial species that is able to co-exist to some degree with riparian and aquatic nonnative predators. This is largely due to its ability to forage in more terrestrial habitats, specifically in the 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 bullfrogs, nonnative sportfish, and crayfish also occur, which increases not only the encounter rate between the species but also the juvenile mortality rate of the northern Mexican gartersnake. As northern Mexican gartersnake numbers decline within a population, space becomes available for occupation by checkered gartersnakes. Marcy's checkered gartersnake subsequently affects the maximum number of northern Mexican gartersnakes that an area can maintain based upon available resources and could potentially accelerate the decline of or preclude reoccupancy by the northern Mexican gartersnake (Rosen and Schwalbe 1988, p. 31).

Rosen *et al.* (2001, pp. 9–10) documented the occurrence of Marcy's checkered gartersnakes out-competing and replacing northern Mexican gartersnakes at the San Bernardino National Refuge and surrounding habitats of the Black Draw. They suspected that the drought from the late 1980s through the late 1990s played a role in the degree of competition for aquatic resources, provided an advantage to the more versatile Marcy's checkered gartersnake, and expedited the decline of the northern Mexican gartersnake. The competition between these two species, in combination with other factors described above that have adversely affected the northern Mexican gartersnake prey base and the suitability of occupied and formerly occupied habitat, may be contributing to the decline of this species.

Current and Future Effects from Changes in Climatic Patterns and Drought. Seagar *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). The northern Mexican gartersnake and its prey base depend on permanent or nearly permanent water for survival. A large percentage of habitat within the current distribution of the northern Mexican gartersnake is predicted to be at risk of becoming more arid (Seager *et al.* 2007, pp. 1183–1184), which has severe implications to the integrity of aquatic and riparian ecosystems and the water that supports them. Potential drought associated with changing climatic patterns may not only adversely affect habitat of the northern Mexican gartersnake, but also its prey. Amphibians may be among the first vertebrates to exhibit broad-scale changes in response to changes in global climatic patters 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 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).

Changes to climatic patterns are predicted to have implications for the effect of, and management for, nonnative species within the distribution of the northern Mexican gartersnake. Based upon climate change models, nonnative species biology, and ecological observations, Rahel *et al.* (2008, p. 551) conclude 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. Many of the nonnative species have similar, basic ecological requirements as our native species, such as the need for permanent or nearly permanent water. Therefore, it is likely that effects from changes to climatic patterns (such as a trend towards a more arid environment) that negatively affect nonnative species such as bullfrogs and nonnative fish may also negatively affect native prey species for the northern Mexican gartersnake.

Changes to climatic patterns may warm water temperatures, alter stream flow events, and may 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 aquatic nonnative species by providing 31 percent more suitable habitat for aquatic nonnative species, which are often tropical in origin and adaptable to warmer water temperatures. 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 in North America are expected to have reductions in their distribution from effects of climate change, several warmwater fish 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 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).

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 the northern Mexican gartersnake and its prey base. Warmwater nonnative species such as red shiner, common carp, mosquitofish, and largemouth bass are expected to benefit from prolonged periods of low flow (Rahel and Olden 2008, p. 527).

Data specific to changing climatic patterns in Mexico, other than the Seager *et al.* (2007) climate change modeling, are limited. However, because the predictive climate models include northern Mexico, we assume that the changes predicted for the southwestern United States will likely be similar.

The effects of the water withdrawals discussed above may be exacerbated by the current, long-term drought facing the arid southwestern United States. Philips and Thomas (2005, pp. 1–4) provided streamflow 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) (2008) assessed Arizona's drought status through June 2008 in watersheds where the northern Mexican gartersnake occurs or historically occurred. They found that the Verde, Agua Fria, San Pedro, Santa Cruz, and Whitewater Draw watersheds continue to experience moderate drought (ADPPMTC 2008). Whereas the Salt, Upper Gila, Lower Gila, and Lower Colorado watersheds were abnormally dry (ADPPMTC 2008). Ongoing drought conditions have depleted recharge of aquifers and decreased baseflows 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. Holycross *et al.* (2006, pp. 52–53) recently documented the effects of drought on northern Mexican gartersnake habitat in the vicinity of Arcosante along the Agua Fria River and at Big Bug Creek. The streams were completely dry and therefore unsuitable northern Mexican gartersnake habitats.

Summary of Factor E. It is unlikely that competition with other gartersnakes will be a significant cause of decline in northern Mexican gartersnake populations in comparison to other threats we have discussed. All but one model evaluating changing climatic patterns for the southwestern United States and northern Mexico predict a drying trend for the region (Seagar *et al.* 2007, pp. 1181–1184). We acknowledge that drought and the loss of surface water in riparian and aquatic communities are related to changing climatic conditions (Seagar *et al.* 2007, pp. 1181–1184). The extent to which changing climate patterns will affect the northern Mexican gartersnake is not known with certainty at this time. However, threats to the northern Mexican gartersnake indentified in Factors A and C will likely be exacerbated by changes to climatic patterns in the southwestern United States due to resulting increasing drought and reduction of surface waters if the predicted patterns are realized. Data specific to changes in climatic patterns in Mexico are limited, but because the models for the southwestern United States included northern Mexico, we believe that the effect from the changing climatic patterns will exacerbate threats due to Factors A and C in that country as well.

Foreseeable Future

When determining whether a species is in danger of extinction throughout all or a significant portion of its range, or is likely to become in danger of extinction in the foreseeable future, we must identify that foreseeable future for the species. The Act does not specifically define the term ‘‘foreseeable future.’’ In discussing the concept of foreseeable future for the northern Mexican gartersnake, we considered (1) the biological and demographic characteristics of the species (such as generation times, population genetics, trends in age-class distribution within current populations, etc.); (2) our ability to predict or extrapolate the effects of threats facing the species into the future; and (3) the relative permanency or irreversibility of these threats. Of the threats to the northern Mexican gartersnake and its prey base that have been discussed above in our analysis of the threats, we believe the threat of nonnative species presents the most widespread, imminent, and serious threat to the long-term sustainability of this subspecies. Therefore, we concentrate primarily upon this threat to the northern Mexican gartersnake in our analysis of the subspecies' viability into the foreseeable future. Because our knowledge of the threats to and status of the northern Mexican gartersnake in Mexico is not as robust as that for the United States, our analysis focuses on the United States and presumes (1) similar human-caused threats occur to the subspecies' habitat in areas in proximity to human population centers in Mexico, and (2) a time-lagged effect, with respect to nonnative species invasions, within more remote habitat in Mexico as postulated in Unmack and Fagan (2004, pp. 233–243).

Based on museum records found in Holycross *et al.* (2006, Appendix F), we expect the northern Mexican gartersnake retained its entire historic distribution within the United States through the 1920s and likely into the 1930s. Activities such as the construction of dams and water diversions that occurred throughout the early to mid-1900s for agriculture and regional economic development likely eliminated surface flow throughout stream reaches with occupied habitat, which led to subsequent and widespread extirpations of northern Mexican gartersnake populations in areas such as the lower Gila and Salt rivers in Arizona.

After the period of dam construction and the subsequent creation of reservoirs, widespread nonnative fish stocking efforts ensued throughout Arizona beginning during the mid 1900's. In the Verde River system alone, Rinne *et al.* (1998, p. 3) estimated that over 5,300 independent stocking actions occurred that involved 12 different species of nonnative fish species since the 1930s and 1940s. If we extrapolate that effort over the same timeframe for other historically occupied, larger-order systems known as recreational fisheries such as the Salt, upper Gila, Colorado, Santa Cruz, Agua Fria, and San Pedro rivers, Tonto and Oak creeks, and other tributaries with significant flow throughout central and southern Arizona, in addition to the other private stockings of stock tanks and other isolated habitat, the magnitude of the nonnative species invasion over this timeframe becomes clear. Subsequent to these efforts, but to a lesser extent, the spread of bullfrogs and crayfish, both purposefully and incidentally, commenced during the 1970s and 1980s (Tellman 2002, p. 43). We estimate that near 100 percent of the habitat that historically supported northern Mexican gartersnakes has been invaded over-time, either purposefully or indirectly through dispersal, by nonnative species whether they be nonnative fish, bullfrogs, or crayfish. The effects from this influx of nonnative species throughout the American Southwest resulted in significant declines in native fish and ranid frog distribution and abundance, and the subsequent listing of 19 of Arizona's 31 native fish species throughout the last 35 years (see discussion under ‘‘Declines in the Northern Mexican Gartersnake Native Fish Prey Base’’ within Listing Factor C). The decline of native fish species that depend on native riparian and aquatic systems provides evidence of overall impacts to the affected biotic communities. These effects were discussed in detail in Factor A and Factor C above.

In response to the impacts to the northern Mexican gartersnake and its native prey base discussed above and in our analysis of threats, the distribution of northern Mexican gartersnake has been reduced to approximately 10 percent of its historic range within the United States over the last 80 years. However, because of the sensitivity of the northern Mexican gartersnake to community-wide effects from nonnative species, we believe the most significant period of declines and subsequent extirpations of entire populations likely coincided with the proliferation of nonnative species beginning in the 1940s and 1950s, most notably with the widespread introduction and expansion of sportfish such as largemouth bass, green sunfish, and channel and flathead catfish. In addition, further declines and extirpations likely resulted from systematic bullfrog introductions, beginning in the 1970s and early 1980s, caused by the bullfrog's natural capacity to disperse and its predation behavior on the northern Mexican gartersnake and associated prey base. In several areas where northern Mexican gartersnakes remain in the United States, we have observed skewed age-class distributions within populations that favor large-bodied, older individuals with significantly less newborns and juveniles (Holm and Lowe 1995, pp. 33–34; Holycross *et al.* 2006, pp. 41–44; Wallace *et al.* 2008, pp. 243–244). These trends are particularly apparent in areas where habitat remains structurally intact, but where nonnative species maintain stable populations.

The observed effects of nonnative species on age-class distribution and recruitment are an important influence on the maintenance of current populations to be considered in our evaluation of the foreseeable future for this species. We were not able to locate any quantitative studies on longevity of the northern Mexican gartersnake in the wild, or on gartersnakes in general. However, Bowler (1975) recorded longevity of amphibians and reptiles in captivity that included several species within the genus *Thamnophis.* Lifespans of six different gartersnake species ranged from 2 to 10 years (Bowler 1975). These data are old, however, and innovations in the captive care of specimens in the subsequent three decades have improved our knowledge of captive husbandry for these species, allowing longer lifespans in captivity. Simply knowing that individuals of a certain species are capable of living a certain number of years under ideal captive conditions means that longevity in the wild might be longer than suspected, although usually shorter than in captivity. Ernst and Zug (1996, p. 39) provide one record on wild longevity in the common gartersnake (*Thamnophis sirtalis*) as nine years. It is reasonable to conclude that the northern Mexican gartersnake, a similarly sized snake of the same genus, may have similar longevity in the wild.

The average age of sexual maturity is 2.5 years for female northern Mexican gartersnakes, and 2 years for males. Females may only breed once every 2 years (Rosen and Schwalbe 1988, pp. 16–17). Considering these timeframes, a female northern Mexican gartersnake might reproduce up to three times during a maximum lifespan in the wild. We are aware of no studies on the survivorship of northern Mexican gartersnakes in the wild. However, Jayne and Bennett (1990, pp. 1209–1221) studied survivorship within a population of common gartersnakes, a similar species, and found that, in two groups of similarly aged snakes within that population, survivorship during the first year following birth was 29 percent and 43 percent in this 2-year study, although we are unaware of the presence, type, or extent of threats that may have influenced survivorship. Only 16 percent of one group survived into their second year, while 50 percent of the second group survived into their second year (Jayne and Bennett 1990, pp. 1209–1221). Jayne and Bennett (1990, pp. 1209–1221) calculated that 15 percent of individuals live to be older than 2 years. Adult survival rates in common gartersnakes appears to be quite variable, however. In Manitoba, adult year-to-year survivorship was calculated at 34 percent and at 67 percent in the Northwest Territories (Larsen and Gregory 1989, pp. 84–85; Larsen *et al.* 1993, pp. 338–342). Based on demographic studies on the common gartersnake and making a conservative estimate on survivorship and fecundity rates without consideration of the presence or degree of threats, it is reasonable to presume that, on average, two individual northern Mexican gartersnakes from each litter may reach reproductive age. Whether or not these individuals find a mate and successfully reproduce depends upon the population density and the degree of threats that may be acting on a given population.

In Table 4 of Holycross *et al.* (2006, p. 64), capture rates of northern Mexican gartersnakes during surveys in 2004 and 2005 along the Mogollon Rim of Arizona were compared to those from a previous study, Rosen and Schwalbe (1988, Appendix I). In total, capture rates in nine different stream reaches surveyed by both sets of investigators were compared. Rosen and Schwalbe (1988, Appendix I) spent 128 person-search hours to capture a total of 10 individuals at six of the nine (66 percent) stream reaches. Holycross *et al.* (2006, p. 64) spent 142 person-search hours [11 percent more than Rosen and Schwalbe (1988, Appendix I)] and found six total individuals in only two stream reaches of the nine (22 percent) that were comparably surveyed. These data indicate that Holycross *et al.* (2006, p. 64) found northern Mexican gartersnakes at 66 percent fewer locations than did Rosen and Schwalbe (1988, Appendix I) which indicate potential population extirpations in two-thirds of populations during that 17-year time period. The averaged number of person-search hours per capture was 12.8 hours in 1988 (Rosen and Schwalbe 1988, Appendix I), but approximately twice that (23.6 person-search hours) in 2004–2005 (Holycross *et al.* 2006, p. 64).

Today, there remain three areas in the United States where the northern Mexican gartersnake is most reliably found, the Upper Santa Cruz River in the San Rafael Valley of south-central Arizona, Tonto Creek from the vicinity of Gisela downstream to Roosevelt Lake, and the Page Springs/Bubbling Ponds hatchery complex along Oak Creek slightly upstream of its confluence with the Verde River. These populations are geographically disjunct, genetically isolated from one-another, and lack significant, nearby source populations to serve as a natural source of individuals for recolonization should any one of them become extirpated. Therefore, these populations remain highly vulnerable to the effects of the threats discussed in detail in Factors A–E above, and to stochastic events not previously anticipated. If we extrapolate the last 20 years of population trends documented in the previous paragraph, we anticipate that in approximately 15–20 years, these remaining, currently reliable populations may become extirpated should current trends persist into the future. This is not to say that the northern Mexican gartersnake, in its entirety, will be extirpated from the United States during this time frame because it would remain plausible that extremely low-density populations of a few individuals may persist in other areas past this time frame.

Considering the above discussion on (1) reproduction biology, observed trends in population demographics, and age-class survivorship; (2) the time periods that correlated to the onset of the most significant threats to the species and number of years it has taken for a 90 percent reduction of the distribution of the subspecies in the United States; (3) the relative isolation and disjunct nature of current populations and their inability to serve as a basis for genetic exchange; (4) comparative analysis between comprehensive survey results spread over 17 years over a significant portion of the subspecies' historical distribution in the United States and subsequent extrapolations for remaining populations; and (5) the future potential for threats most detrimental to the long-term viability of the subspecies in the United States (such as the continued proliferation of nonnative species), we anticipate that northern Mexican gartersnake may be predominantly extirpated from the U.S. within 25 years. We base this estimate largely upon our most current observations of population trends and their response to threats posed by nonnative species, as discussed above.

We do not expect that current policies on native fish restoration and recovery will change. These policies now focus activities on replacing fisheries which contain nonnative species with wholly native fisheries in stream types that are generally not suitable for northern Mexican gartersnakes, rather than mainstem rivers of lower gradient which provide preferred habitat for the northern Mexican gartersnake. We have also discussed in Factor C above the widespread influence of crayfish and bullfrogs on riparian and aquatic communities and the significant difficulty of removing them from areas once they have become established. As discussed in Factor E, climate change and subsequent drought will likely exacerbate the threats to the northern Mexican gartersnake related to habitat and prey base. Thus, the foreseeable future for the northern Mexican gartersnake in the U.S. is 25 years to 2033.

With respect to the species' foreseeable future throughout its distribution in Mexico, threats to the northern Mexican gartersnake from human-related activities are most likely in areas adjacent to human population centers, and these threats affect the subspecies to a similar degree as observed in the United States. We conclude that changes to climatic patterns will affect northern Mexican gartersnake habitat in similar ways in the more northern latitudes of Mexico as has been anticipated for the southwestern United States. Therefore, we estimate the foreseeable future in populated areas of Mexico within the range of the subspecies to be 25 years.

Unmack and Fagan (2004, p. 233) hypothesized that a time-lagged effect is occurring in portions of Mexico with respect to nonnative species invasions, due primarily to the remoteness of some areas. However, there is widespread consensus that it is inevitable that nonnative species will continue to invade new habitats throughout Mexico, leading to further declines and extirpations of the northern Mexican gartersnake and its prey species in Mexico (Conant 1974, pp. 471, 487–489; Contreras Balderas and Lozano 1994, pp. 383–384; Miller *et al.* 2005, pp. 60–61; Abarca 2006; Luja and Rodríguez-Estrella 2008, pp. 17–22). Consequently, for the more remote areas of Mexico, the foreseeable future may be beyond 2033, but we are not confident estimating how far beyond.

Significant Portion of the Range Analysis

As required by the Act, we considered the five potential threat factors to assess whether the northern Mexican gartersnake is threatened or endangered throughout all or a significant portion of its range. When considering the listing status of the species, the first step in the analysis is to determine whether the species is in danger of extinction throughout all of its range. If this is the case, then we list the species in its entirety. For instance, if the threats to a species are directly acting on only a portion of its range, but they are at such a large scale that they place the entire species in danger of extinction, we would list the entire species.

We next consider whether any significant portion of the northern Mexican gartersnake range meets the definition of endangered or is likely to become endangered in the foreseeable future (threatened). On March 16, 2007, a formal opinion was issued by the Solicitor of the Department of the Interior, ''The Meaning of 'In Danger of Extinction Throughout All or a Significant Portion of Its Range' '' (USDOI 2007, pp. 1–36). A portion of a species' range is significant if it is part of the current range of the species and is important to the conservation of the species because it contributes meaningfully to the representation, resiliency, or redundancy of the species. The contribution must be at a level such that its loss would result in a decrease in the ability of the species to persist.

The first step in determining whether a species is threatened or endangered in a significant portion of its range is to identify any portions of the range of the species that warrant further consideration. The range of a species can theoretically be divided into portions in an infinite number of ways. To identify portions that warrant further consideration, we determine whether there is substantial information indicating that (1) the portions may be significant, and (2) the species may be in danger of extinction there or likely to become so within the foreseeable future. In practice, a key part of this analysis is whether the threats are geographically concentrated in some way. If the threats to the species are essentially uniform throughout its range, no portion is likely to warrant further consideration. Moreover, if any concentration of threats applies only to portions of the range that are unimportant to the conservation of the species, such portions will not warrant further consideration.

If we identify any portions that warrant further consideration, we then determine whether the species is threatened or endangered in any significant portion. If we determine that a portion of the range is not significant, we do not determine whether the species is threatened or endangered there.

The terms ''resiliency,'' ''redundancy,'' and ''representation'' are intended to be indicators of the conservation value of portions of the range. Resiliency of a species allows it to recover from periodic disturbances. A species will likely be more resilient if large populations exist in high-quality habitat that is distributed throughout its range in a way that captures the environmental variability available. A portion of the range of a species may make a meaningful contribution to the resiliency of the species if the area is relatively large and contains particularly high-quality habitat, or if its location or characteristics make it less susceptible to certain threats than other portions of the range. When evaluating whether or how a portion of the range contributes to resiliency of the species, we evaluate the historical value of the portion and how frequently the portion is used by the species, if possible. The range portion may contribute to resiliency for other reasons; for instance, it may contain an important concentration of certain types of habitat that are necessary for the species to carry out its life-history functions, such as breeding, feeding, migration, dispersal, or wintering.

Redundancy of populations may be needed to provide a margin of safety for the species to withstand catastrophic events. This concept does not mean that any portion that provides redundancy is per se a significant portion of the range of a species. The idea is to conserve enough areas of the range so that random perturbations in the system only act on a few populations. Therefore, we examine each area based on whether that area provides an increment of redundancy that is important to the conservation of the species.

Adequate representation ensures that the species' adaptive capabilities are conserved. Specifically, we evaluate a range portion to see how it contributes to the genetic diversity of the species. The loss of genetically based diversity may substantially reduce the ability of the species to respond and adapt to future environmental changes. A peripheral population may contribute meaningfully to representation if there is evidence that it provides genetic diversity due to its location on the margin of the species' habitat requirements.

Based upon factors that contribute to our analysis of whether a species or subspecies is ''In Danger of Extinction Throughout All or a Significant Portion of Its Range,'' and in consideration of the status of and threats to the northern Mexican gartersnake discussed previously, we find that significant threats to the continued existence of the northern Mexican gartersnake occur throughout all of its range in the United States and Mexico. Therefore, it is not necessary to conduct further analysis with respect to the significance of any portion of its range at this time.

Finding

We have carefully examined the best scientific and commercial information available regarding the past, present, and future threats faced by the northern Mexican gartersnake. We reviewed the petition, information available in our files, other published and unpublished information submitted to us during the public comment periods following our 90-day and previous 12-month petition findings and consulted with recognized northern Mexican gartersnake experts and other Federal, State, Tribal, and Mexican resource agencies. On the basis of the best scientific and commercial information available, we find that listing of the northern Mexican gartersnake as threatened or endangered throughout its range in the United States and Mexico, based on its rangewide status, is warranted, due to the present or threatened destruction, modification or curtailment of its habitat; predation; and the inadequacy of existing regulatory mechanisms. However, as explained in more detail below, an immediate proposal of a regulation implementing this action is precluded by higher priority listing actions, and progress is being made to add or remove qualified species from the Lists of Endangered and Threatened Wildlife and Plants.

We recognize there have been remarkable declines in the distribution and abundance of the northern Mexican gartersnake within its distribution in the United States, which are primarily attributed to individual and community interactions with nonnative species that occur in every single locality where northern Mexican gartersnakes have been documented. We identified the ecological mechanisms for which nonnative interactions occur to include: (1) Direct predation on northern Mexican gartersnakes by nonnative species; and (2) the effects of a diminished prey base via nonnative species preying upon and competing with native prey species as documented in a large body of scientific research, which is cited and analyzed in our discussion of threats under each of the listing factors.

Throughout the range of the northern Mexican gartersnake, literature documents the cause and effect relationship of modification of the food chains within native riparian and aquatic communities. The substantial decline of primary native prey species, such as leopard frogs and native fish, has contributed significantly to the decline of a primary predator, the northern Mexican gartersnake. In this respect, the northern Mexican gartersnake is considered an indicator species, or a species that can be used to gauge the condition of a particular habitat, community, or ecosystem. The synergistic effect of nonnative species both reducing the prey base of, and directly preying upon, northern Mexican gartersnakes has placed significant pressure upon the viability and sustainability of current northern Mexican gartersnake populations and has led to significant fragmentation and risks to the continued viability of current populations. The evolutionary biology of the northern Mexican gartersnake, much like that of native fish and leopard frogs, has left the species without adaptation to and defenseless against the effect of nonnative species invasions.

The decline of the northern Mexican gartersnake has been exacerbated by historical and ongoing threats to its habitat in the United States. The threats identified and discussed above in detail under Factor A include: (1) The modification and loss of ecologically valuable riparian and aquatic communities; (2) urban and rural development; (3) road construction, use, and maintenance; (4) human population growth; (5) groundwater pumping, surface water diversions, and flood; (6) improper livestock grazing; (7) catastrophic wildfire and wildfire in non-fire adapted communities; and (8) undocumented immigration and international border enforcement and management. In addition, disease and parasitism, climate change, and drought may pose threats to the northern Mexican gartersnake and its prey base.

As a result of our assessment, we find that certain land use activities, such as road construction and use, improper livestock grazing, undocumented immigration and associated international border enforcement and management activities, and some types of development, pose a more significant risk to highly fragmented, low-density populations of northern Mexican gartersnakes, particularly in the presence of nonnative species. We know of no current population of northern Mexican gartersnakes in the United States that does not occur in the presence of nonnative species.

In this finding, we have emphasized the importance of the protection of the ecosystems upon which the northern Mexican gartersnake depends, and documented the status of riparian and aquatic communities in the southwestern United States and much of Mexico. Evidence of the current precarious status of native riparian and aquatic ecosystems in the southwestern United States is the proportion of riparian or aquatic obligate species that are either federally listed under the Act or candidates for listing. In Arizona, there is a total of 73 species that meet these criteria. Of these 73 species, 38 (52 percent) are riparian or aquatic. Of the 45 vertebrate species that are either federally listed or candidates for listing in Arizona, 30 (67 percent) have riparian or aquatic life histories, and 19 (42 percent) are potential northern Mexican gartersnake prey species in larval, juvenile, or adult forms, based on overlapping historical distributions. These data suggest that the riparian and aquatic ecosystems in Arizona, upon which the northern Mexican gartersnake depends, cannot currently support many of the species that rely upon them.

In making this finding, we acknowledge that the Mexican Government has found the Mexican gartersnake to be in danger of disappearance in the short-or medium-term future in their country from the destruction and modification of its habitat or from the effects of shrinking population sizes, or both, and has, therefore, listed the species as Threatened, under the listing authority of SEMARNAT (SEDESOL 2001). We have provided an assessment of the status of the northern Mexican gartersnake and its habitat in Mexico, but we also rely on the assessment of the species made by the Mexican Government in listing the entity as Threatened. The available literature supports the assessment of the species made by the Mexican Government, which indicates that nonnative species and habitat modification and loss are adversely affecting the status of northern Mexican gartersnakes in Mexico.

Additionally, land uses, such as urbanization and development, improper livestock grazing, water diversions and groundwater pumping, and impoundments, have resulted in losses of vegetative cover, deforestation, erosion, and pollution that have modified or destroyed historical northern Mexican gartersnake habitat in Mexico. Collectively, the impacts of traditional rural land management practices and growth of the economic sector, infrastructure, and population growth are expected to continue into the future.

We have reviewed the available information to determine if the existing and foreseeable threats pose an emergency. We have determined that an emergency listing is not warranted for this subspecies at this time because, within the current distribution of the subspecies in Mexico, there are at least some populations of the northern Mexican gartersnake that exist in relatively natural conditions that are unlikely to change in the short-term. However, if at any time we determine that emergency listing of the northern Mexican gartersnake is warranted, we will initiate an emergency listing.

The Service adopted guidelines on September 21, 1983 (48 FR 43098) to establish a rational system for allocating available appropriations to the highest priority species when adding species to the Lists of Endangered or Threatened Wildlife and Plants or reclassifying threatened species to endangered status. The system places greatest importance on the immediacy and magnitude of threats, but also factors in the level of taxonomic distinctiveness by assigning priority in descending order to monotypic genera, full species, and subspecies (or equivalently, distinct population segments of vertebrates). As a result of our analysis of the best available scientific and commercial information, we have assigned the northern Mexican gartersnake a Listing Priority Number of 3, based on high magnitude and immediacy of threats. One or more of the threats discussed above is occurring in each known population in the United States and throughout historically occupied habitats in Mexico. These threats are ongoing and, in some cases (e.g., nonnative species), considered irreversible. While we conclude that listing the northern Mexican gartersnake is warranted, an immediate proposal to list this species is precluded by other higher priority listing, which we address below.

Preclusion and Expeditious Progress

Preclusion is a function of the listing priority of a species in relation to the resources that are available and competing demands for those resources. Thus, in any given fiscal year (FY), multiple factors dictate whether it will be possible to undertake work on a proposed listing regulation or whether promulgation of such a proposal is warranted but precluded by higher-priority listing actions.

The resources available for listing actions are determined through the annual Congressional appropriations process. The appropriation for the Listing Program is available to support work involving the following listing actions: proposed and final listing rules; 90-day and 12-month findings on petitions to add species to the Lists of Endangered and Threatened Wildlife and Plants (Lists) or to change the status of a species from threatened to endangered; annual determinations on prior ''warranted but precluded'' petition findings as required under section 4(b)(3)(C)(i) of the Act; proposed and final rules designating critical habitat; and litigation-related, administrative, and program management functions (including preparing and allocating budgets, responding to Congressional and public inquiries, and conducting public outreach regarding listing and critical habitat). The work involved in preparing various listing documents can be extensive and may include, but is not limited to: Gathering and assessing the best scientific and commercial data available and conducting analyses used as the basis for our decisions; writing and publishing documents; and obtaining, reviewing, and evaluating public comments and peer review comments on proposed rules and incorporating relevant information into final rules. The number of listing actions that we can undertake in a given year also is influenced by the complexity of those listing actions; that is, more complex actions generally are more costly. For example, during the past several years, the cost (excluding publication costs) for preparing a 12-month finding, without a proposed rule, has ranged from approximately $11,000 for one species with a restricted range and involving a relatively uncomplicated analysis to $305,000 for another species that is wide-ranging and involving a complex analysis.

We cannot spend more than is appropriated for the Listing Program without violating the Anti-Deficiency Act (see 31 U.S.C. 1341(a)(1)(A)). In addition, in FY 1998 and for each fiscal year since then, Congress has placed a statutory cap on funds which may be expended for the Listing Program, equal to the amount expressly appropriated for that purpose in that fiscal year. This cap was designed to prevent funds appropriated for other functions under the Act (for example, recovery funds for removing species from the Lists), or for other Service programs, from being used for Listing Program actions (see House Report 105–163, 105th Congress, 1st Session, July 1, 1997).

Recognizing that designation of critical habitat for species already listed would consume most of the overall Listing Program appropriation, Congress also put a critical habitat subcap in place in FY 2002 and has retained it each subsequent year to ensure that some funds are available for other work in the Listing Program: ''The critical habitat designation subcap will ensure that some funding is available to address other listing activities'' (House Report No. 107–103, 107th Congress, 1st Session, June 19, 2001). In FY 2002 and each year until FY 2006, the Service has had to use virtually the entire critical habitat subcap to address court-mandated designations of critical habitat, and consequently none of the critical habitat subcap funds have been available for other listing activities. In FY 2007, we were able to use some of the critical habitat subcap funds to fund proposed listing determinations for high-priority candidate species; however, in FY 2008 we were unable to do this due to our workload for designating critical habitat.

Thus, through the listing cap, the critical habitat subcap, and the amount of funds needed to address court-mandated critical habitat designations, Congress and the courts have in effect determined the amount of money available for other listing activities. Therefore, the funds in the listing cap, other than those needed to address court-mandated critical habitat for already listed species, set the limits on our determinations of preclusion and expeditious progress.

Congress also recognized that the availability of resources was the key element in deciding whether, when making a 12-month petition finding, we would prepare and issue a listing proposal or instead make a ''warranted but precluded'' finding for a given species. The Conference Report accompanying Public Law 97–304, which established the current statutory deadlines and the warranted-but-precluded finding, states (in a discussion on 90-day petition findings that by its own terms also covers 12-month findings) that the deadlines were ''not intended to allow the Secretary to delay commencing the rulemaking process for any reason other than that the existence of pending or imminent proposals to list species subject to a greater degree of threat would make allocation of resources to such a petition [that is, for a lower-ranking species] unwise.''

In FY 2008, expeditious progress is that amount of work that could be achieved with $8,206,940, which is the amount of money that Congress appropriated for the Listing Program (that is, the portion of the Listing Program funding not related to critical habitat designations for species that are already listed). Our process is to make our determinations of preclusion on a nationwide basis to ensure that the species most in need of listing will be addressed first and also because we allocate our listing budget on a nationwide basis. The $8,206,940 was used to fund work in the following categories: Compliance with court orders and court-approved settlement agreements requiring that petition findings or listing determinations be completed by a specific date; section 4 (of the Act) listing actions with absolute statutory deadlines; essential litigation-related, administrative, and listing program management functions; and high-priority listing actions. The allocations for each specific listing action are identified in the Service's FY 2008 Allocation Table (part of our administrative record).

For FY 2009, on September 23, 2008 Congress passed a Continuing Resolution to operate the Federal government at the FY 2008 level of funding through March 6, 2009 (Pub. L.

110–329). Although we are currently developing the allocations for specific listing actions that we will fund during FY 2009, we anticipate funding work to comply with court orders and court-approved settlement agreements, work on statutorily required petition findings, final listing determinations for those species that were proposed for listing with funds from FY 2008, and continued work on proposed listing determinations for high-priority species.

In FY 2007, we had more than 120 species with an LPN of 2, based on our September 21, 1983, guidance for assigning an LPN for each candidate species (48 FR 43098). Using this guidance, we assign each candidate an LPN of 1 to 12, depending on the magnitude of threats, imminence of threats, and taxonomic status; the lower the LPN, the higher the listing priority (that is, a species with an LPN of 1 would have the highest listing priority). Because of the large number of high-priority species, we further ranked the candidate species with an LPN of 2 by using the following extinction-risk type criteria: International Union for the Conservation of Nature and Natural Resources (IUCN) Red list status/rank, Heritage rank (provided by NatureServe), Heritage threat rank (provided by NatureServe), and species currently with fewer than 50 individuals, or 4 or fewer populations. Those species with the highest IUCN rank (critically endangered), the highest Heritage rank (G1), the highest Heritage threat rank (substantial, imminent threats), and currently with fewer than 50 individuals, or fewer than 4 populations, comprised a list of approximately 40 candidate species (''Top 40''). These 40 candidate species have had the highest priority to receive funding to work on a proposed listing determination. As we work on proposed listing rules for these 40 candidates, we are applying the ranking criteria to the next group of candidates with LPN of 2 and 3 to determine the next set of highest priority candidate species.

To be more efficient in our listing process, as we work on proposed rules for these species in the next several years, we are preparing multi-species proposals when appropriate, and these may include species with lower priority if they overlap geographically or have the same threats as a species with an LPN of 2. In addition, available staff resources are also a factor in determining high-priority species provided with funding. Finally, proposed rules for reclassification of threatened species to endangered are lower priority, since as listed species, they are already afforded the protection of the Act and implementing regulations.

We assigned the northern Mexican gartersnake an LPN of 3, based on our finding that the subspecies faces immediate and high magnitude threats from the present or threatened destruction, modification or curtailment of its habitat; predation; and the inadequacy of existing regulatory mechanisms. One or more of the threats discussed above are occurring in each known population in the United States and throughout historically occupied habitats in Mexico. These threats are on-going and, in some cases (e.g., nonnative species), considered irreversible. Pursuant to the 1983 Guidelines, a ''species'' facing imminent high-magnitude threats is assigned an LPN of 1, 2, or 3 depending on its taxonomic status. Because the northern Mexican gartersnake is a subspecies, we assigned it an LPN of 3 (the highest category available for a subspecies). Therefore, work on a proposed listing determination for the northern Mexican gartersnake was, and will continue to be in the next year, precluded by work on higher priority candidate species (species with LPN of 2); listing actions with absolute statutory, court ordered, or court-approved deadlines; and final listing determinations for those species that were proposed for listing with funds from FY 2008. This work includes all the actions listed in the tables below under expeditious progress.

As explained above, a determination that listing is warranted but precluded must also demonstrate that expeditious progress is being made to add or remove qualified species to and from the Lists of Endangered and Threatened Wildlife and Plants. (We note that we do not discuss specific actions taken on progress towards removing species from the Lists because that work is conducted using appropriations for our Recovery program, a separately budgeted component of the Endangered Species Program. As explained above in our description of the statutory cap on Listing Program funds, the Recovery Program funds and actions supported by them cannot be considered in determining expeditious progress made in the Listing Program.) As with our ''precluded'' finding, expeditious progress in adding qualified species to the Lists is a function of the resources available and the competing demands for those funds. Our expeditious progress in FY 2008 in the Listing Program included preparing and publishing the following determinations:

FY 2008 COMPLETED LISTING ACTIONS

Publication date	Title	Actions	FR pages
10/09/2007	90-Day Finding on a Petition to List the Black-Footed Albatross (Phoebastria nigripes) as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	72 FR 57278–57283.
10/09/2007	90-Day Finding on a Petition To List the Giant Palouse Earthworm as Threatened or Endangered.	Notice of 90-day Petition Finding, Not substantial.	72 FR 57273–57276.
10/23/2007	90-Day Finding on a Petition To List the Mountain Whitefish (Prosopium williamsoni) in the Big Lost River, ID, as Threatened or Endangered.	Notice of 90-day Petition Finding, Not substantial.	72 FR 59983–59989.
10/23/2007	90-Day Finding on a Petition To List the Summer-Run Kokanee Population in Issaquah Creek, WA, as Threatened or Endangered.	Notice of 90-day Petition Finding, Not substantial.	72 FR 59979–59983.
11/08/2007	Response to Court on Significant Portion of the Range, and Evaluation of Distinct Population Segments, for the Queen Charlotte Goshawk.	Response to Court	72 FR 63123–63140.

FY 2008 COMPLETED LISTING ACTIONS—Continued

Publication date	Title	Actions	FR pages
12/13/2007	12-Month Finding on a Petition To List the Jollyville Plateau salamander (Eurycea tonkawae) as Endangered With Critical Habitat.	Notice of 12-month Petition Finding, Warranted but Precluded.	72 FR 71039–71054.
1/08/2008	90-Day Finding on a Petition To List the Pygmy Rabbit (Brachylagus idahoensis) as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 1312–1313.
1/10/2008	90-Day Finding on Petition To List the Amargosa River Population of the Mojave Fringe-Toed Lizard (Uma scoparia) as Threatened or Endangered With Critical Habitat.	Notice of 90-day Petition Finding, Substantial.	73 FR 1855–1861.
1/24/2008	12-Month Finding on a Petition To List the Siskiyou Mountains Salamander (Plethodon stormi) and Scott Bar Salamander (Plethodon asupak) as Threatened or Endangered.	Notice of 12-month Petition Finding, Not Warranted.	73 FR 4379–4418.
2/05/2008	12-Month Finding on a Petition To List the Gunnison's Prairie Dog as Threatened or Endangered.	Notice of 12-month Petition Finding, Warranted.	73 FR 6660 6684.
02/07/2008	12-Month Finding on a Petition To List the Bonneville Cutthroat Trout (Oncorhynchus clarki utah) as Threatened or Endangered.	Notice of Review	73 FR 7236 7237.
02/19/2008	Listing Phyllostegia hispida (No Common Name) as Endangered Throughout Its Range.	Proposed Listing, Endangered	73 FR 9078 9085.
02/26/2008	Initiation of Status Review for the Greater Sage-Grouse (Centrocercus urophasianus) as Threatened or Endangered.	Notice of Status Review	73 FR 10218 10219.
03/11/2008	12-Month Finding on a Petition To List the North American Wolverine as Endangered or Threatened.	Notice 12 month petition finding, Not warranted.	73 FR 12929 12941.
03/20/2008	90-Day Finding on a Petition To List the U.S. Population of Coaster Brook Trout (Salvelinus fontinalis) as Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 14950 14955.
04/29/2008	90-Day Finding on a Petition to List the Western Sage-Grouse (Centrocercus urophasianus phaios) as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 23170 23172.
04/29/2008	90-Day Finding on Petitions To List the Mono Basin Area Population of the Greater Sage-Grouse (Centrocercus urophasianus) as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 23173 23175.
05/06/2008	Petition To List the San Francisco Bay-Delta Population of the Longfin Smelt (Spirinchus thaleichthys) as Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 24611 24915.
05/06/2008	90-Day Finding on a Petition to List Kokanee (Oncorhynchus nerka) in Lake Sammamish, Washington, as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 24915 24922.
05/06/2008	12-Month Finding on a Petition to List the White-tailed Prairie Dog (Cynomys leucurus) as Threatened or Endangered.	Notice of Status Review	73 FR 24910 24911.
05/15/2008	90-Day Finding on a Petition To List the Ashy Storm-Petrel (Oceanodroma homochroa) as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 28080 28084.
05/15/2008	Determination of Threatened Status for the Polar Bear (Ursus maritimus) Throughout Its Range; Final Rule.	Final Listing, Threatened	73 FR 28211 28303.
05/15/2008	Special Rule for the Polar Bear; Interim Final Rule.	Interim Final Special Rule	73 FR 28305 28318.
05/28/2008	Initiation of Status Review for the Northern Mexican Gartersnake (Thamnophis eques megalops).	Notice of Status Review	73 FR 30596 30598.
06/18/2008	90-Day Finding on a Petition To List the Long-Tailed Duck (Clangula hyemalis) as Endangered.	Notice of 90-day Petition Finding, Not substantial.	73 FR 34686 34692.

FY 2008 COMPLETED LISTING ACTIONS—Continued

Publication date	Title	Actions	FR pages
07/10/2008	90-Day Finding on a Petition To Reclassify the Delta Smelt (Hypomesus transpacificus) From Threatened to Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 39639 39643.
07/29/2008	90-Day Finding on a Petition To List the Tucson Shovel-Nosed Snake (Chionactis occipitalis klauberi) as Threatened or Endangered with Critical Habitat.	Notice of 90-day Petition Finding, Substantial.	73 FR 43905 43910.
8/13/2008	Proposed Endangered Status for Reticulated Flatwoods Salamander; Proposed Designation of Critical Habitat for Frosted Flatwoods Salamander and Reticulated Flatwoods Salamander.	Proposed Critical Habitat, Proposed Listing, Endangered.	73 FR 47257 47324.
9/9/2008	12-month Finding on a Petition to List the Bonneville Cutthroat Trout as Threatened or Endangered.	Notice 12 month petition finding, Not warranted.	73 FR 52235 52256.
10/15/2008	90-Day Finding on a Petition To List the Least Chub.	Notice of 90-day Petition Finding, Substantial.	73 FR 61007 61015.
10/21/2008	Listing 48 Species on Kauai as Endangered and Designating Critical Habitat.	Proposed Listing, Endangered; Proposed Critical Habitat.	73 FR 62591 62742.
10/24/2008	90-Day Finding on a Petition to List the Sacramento Valley Tiger Beetle as Endangered.	Notice of 90-day Petition Finding, Not substantial.	73 FR 63421 63424.
10/28/2008	90-Day Finding on a Petition To List the Dusky Tree Vole (Arborimus longicaudus silvicola) as Threatened or Endangered.	Notice of 90-day Petition Finding, Substantial.	73 FR 63919 63926.

Our expeditious progress also included work on listing actions, which were funded in FY 2008, but have not yet been completed. These actions are listed below. We have completed all work funded in FY 2008 on all actions under a deadline set by a court. Actions in the middle section of the table are being conducted to meet statutory timelines, that is, timelines required under the Act. Actions in the bottom section of the table are high priority listing actions. These actions include work primarily on species with an LPN of 2, and selection of these species is partially based on available staff resources, and when appropriate, include species with a lower priority if they overlap geographically or have the same threats as the species with the high priority. Including these species together in the same proposed rule results in considerable savings in time and funding as compared to preparing separate proposed rules for each of them in the future.

ACTIONS FUNDED IN FY 2008 BUT NOT COMPLETED

Species	Action
Actions Subject to Court Order/Settlement Agreement	
NONE	NONE.
Actions with Statutory Deadlines	
Phyllostegia hispida	Final listing.
Yellow-billed loon	12-month petition finding.
Black-footed albatross	12-month petition finding.
Mount Charleston blue butterfly	12-month petition finding.
Goose Creek milk-vetch	12-month petition finding.
Mojave fringe-toed lizard	12-month petition finding.
White-tailed prairie dog	12-month petition finding.
Pygmy rabbit (rangewide)	12-month petition finding.
Black-tailed prairie dog	90-day petition finding.
Lynx (include New Mexico in listing)	90-day petition finding.
Wyoming pocket gopher	90-day petition finding.
Llanero coqui	90-day petition finding.
American pika	90-day petition finding.
Sacramento Mts. checkerspot butterfly	90-day petition finding.
206 species	90-day petition finding.
475 Southwestern species	90-day petition finding.
High Priority Listing Actions	
21 Oahu candidate species (16 plants, 5 damselflies) (18 with LPN =2, 3 with LPN = 3, 1 with LPN =9).	Proposed listing.

ACTIONS FUNDED IN FY 2008 BUT NOT COMPLETED—Continued

Species	Action
3 southeast aquatic species (Georgia pigtoe, interrupted rocksnail, rough hornsnail)[1] (all with LPN = 2).	Proposed listing.
Casey's june beetle (LPN = 2)	Proposed listing.
Sand dune lizard (LPN = 2)	Proposed listing.
2 southwest springsnails (*Pyrgulopsis bernadina* (LPN = 2), *Pyrgulopsis trivialis* (LPN = 2)).	Proposed listing.
3 southwest springsnails (*Pyrgulopsis chupaderae* (LPN = 2), *Pyrgulopsis gilae (LPN = 11), Pyrgulopsis thermalis* (LPN 11)).	Proposed listing.
2 mussels (rayed bean (LPN = 2), snuffbox No LPN)	Proposed listing.
2 mussels (sheepnose (LPN = 2), spectaclecase (LPN = 4),)	Proposed listing.
Ozark hellbender[2] (LPN = 3)	Proposed listing.
Altamaha spinymussel (LPN = 2)	Proposed listing.
4 southeast fish (rush darter (LPN = 2), chucky madtom (LPN = 2), Cumberland darter (LPN = 5), laurel dace (LPN = 5)).	Proposed listing.
2 Colorado plants (Parchute beardtongue (*Penstemon debilis*) (LPN = 2), Debeque phacelia (*Phacelia submutica*) (LPN = 8)).	Proposed listing.
Pagosa skyrocket (*Ipomopsis polyantha*) (LPN = 2)	Proposed listing.

[1] Funds for listing actions for 3 of these species were also provided in FY 2007.
[2] We funded a proposed rule for this subspecies with an LPN of 3 ahead of other species with LPN of 2, because the threats to the species were so imminent and of a high magnitude that we considered emergency listing if we were unable to fund work on a proposed listing rule in FY 2008.

We have endeavored to make our listing actions as efficient and timely as possible, given the requirements of the relevant law and regulations, and constraints relating to workload and personnel. We are continually considering ways to streamline processes or achieve economies of scale, such as by batching related actions together. Given our limited budget for implementing section 4 of the Act, these actions described above collectively constitute expeditious progress.

The northern Mexican gartersnake will be added to the list of candidate species upon publication of this 12-month finding. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures.

We intend that any proposed listing action for the northern Mexican gartersnake will be as accurate as possible. Therefore, we will continue to accept additional information and comments from all concerned governmental agencies, the scientific community, industry, or any other interested party concerning this finding.

References Cited

A complete list of all references cited in this document is available upon request from the Field Supervisor at the Arizona Ecological Services Office (see **ADDRESSES** section).

Author

The primary author of this notice is the Arizona Ecological Services Office (see **FOR FURTHER INFORMATION CONTACT** section).

Authority

The authority for this action is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*).

Dated: November 12, 2008.

Kenneth Stansell,

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

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