DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

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 scenarios for consideration by the Service: (1) Listing the United States 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. After thorough analysis and review of all available scientific and commercial information, we find that listing of the subspecies, under any of the three scenarios, is not warranted. Of the three listing scenarios specified above, we found scenario two provided the most rigorous evaluation of the status of the northern Mexican gartersnake and herein provide detailed discussion of our conclusions in that context. We also provide additional discussion of our evaluation of scenarios (1) listing the United States population as a DPS and (3) listing *Thamnophis eques megalops* throughout its range in the United States and Mexico based on its status in the United States.

DATES: The finding announced in this document was made on September 26, 2006.

ADDRESSES: The complete supporting file for this finding is available for inspection, by appointment, during normal business hours at the 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 species or this finding to the above address.

FOR FURTHER INFORMATION CONTACT: Steve Spangle, Field Supervisor, Arizona Ecological Services Office (see **ADDRESSES**) 602–242–0210.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Act (16 U.S.C. 1531 *et seq.*), requires that, for any petition to revise the Lists of Threatened and Endangered Wildlife and Plants that contains substantial scientific and commercial information 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 that the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether any species is 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 a petition for which the requested action is found to be warranted but precluded be treated as though resubmitted on the date of such finding, i.e., requiring a subsequent finding to be made within 12 months. Each subsequent 12-month finding will be published 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.

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 positive, 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). We are required, under the court-approved stipulated settlement agreement, to submit to the **Federal Register** our 12-month finding pursuant to the Act [16 U.S.C. 1533(b)(3)(B)] on or before September 15, 2006. This notice constitutes our 12-month finding for the petition to list the northern Mexican gartersnake as threatened or endangered.

Previous Federal Actions

The Mexican gartersnake (*Thamnophis eques*) (which included the subspecies) 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. In addition, on January 4, 2006, we published a 90-day finding on a petition to list the northern Mexican gartersnake (71 FR 315), as discussed above.

Biology

Species Description. The northern Mexican gartersnake may occur with other native gartersnake species and can be difficult for people without herpetological expertise to identify. With a maximum known length of 44 inches (in) (112 centimeters (cm)), it ranges in background color from olive to olive-brown to olive-gray with three stripes that run the length of the body. The middle dorsal stripe is yellow and darkens toward the tail. The pale yellow to light-tan lateral stripes distinguish the 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 and the olive-gray ventrolateral fields. A conspicuous, light-colored crescent extends behind the corners of the mouth. The two dark brown to black blotches that occur behind the head of several gartersnake species may be diffuse or absent in the Mexican gartersnake. The coloration of the venter is bluish-gray or greenish-grey. The dorsolateral scalation is keeled, the anal plate is single, and there are eight or nine upper labial scales (Rosen and Schwalbe 1988, p. 4; Rossman et al. 1996, pp. 171–172).

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). There are approximately 30 species that have been described in the gartersnake genus *Thamnophis* (Rossman et al. 1996, p. xvii–xviii). De Queiroz et al. (2002, p. 323) identified two large overlapping clades (related taxonomic groups) of gartersnakes that they called the ''Mexican'' and ''widespread'' clades which were supported by allozyme and mitochondrial DNA genetic analyses. *Thamnophis eques* is a member of the ''widespread'' clade and is most closely related taxonomically to, although genetically and phenotypically distinct from, the checkered gartersnake (*Thamnophis marcianus*) (De Queiroz and Lawson 1994, p. 217).

Rossman et al. (1996, p. 175) noted that the current specific name *eques* was not applied at the time of the original description of the holotype because the specimen was mistakenly identified as a black-necked gartersnake (*Thamnophis cyrtopsis*). 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). *T. eques* displays considerable phenotypic variability (variation in its physical appearance) across its distribution, and all subspecific descriptions under *T. eques* have been based on morphometrics or morphological characters. The subspecies *T. e. eques* and *T. e. megalops* are distinguished by average differences in sub-caudal scale counts, while *T. e. virgatenuis* is distinguished from *T. e. megalops* based on having a darker background color and a narrower vertebral stripe (Rossman et al. 1996, p. 175). Rossman et al. (1996, p. 175) also noted that the discontinuous distributions of high-elevation and low-elevation *T. e. virgatenuis* and *T. e. megalops*, respectively, are ''zoogeographically peculiar and unique among gartersnakes.''

Rossman et al. (1996, p. 172) describe the distribution of *T. e. eques* as occurring from southern Nayarit eastward along the Transverse Volcanic Axis to west-central Veracruz, and identified an additional disjunct population in central Oaxaca. *T. e. virgatenuis* is distributed in three isolated, high-elevation populations in southwestern Durango and in west-central and northwestern Chihuahua (Rossman et al. 1996, p. 172).

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). These seven new subspecies were described based on morphological differences in coloration and pattern; have high endemism (degree of restriction to a particular area) with 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). We are not aware of any challenges within the scientific literature of the validity of current taxonomy of any of the 10 subspecies of *T. eques*.

The most widely distributed of the 10 subspecies under *Thamnophis eques* is the northern Mexican gartersnake (*Thamnophis eques megalops*), which is the only subspecies that occurs in the United States and the entity we address in this finding. In Mexico, *T. e. megalops* historically occurred throughout the Sierra Madre Occidental south to Guanajuato, and east across the Mexican Plateau to Hidalgo, which comprised approximately 85 percent of the total rangewide distribution of the species (Rossman et al. 1996, p. 173). Robert Kennicott first described the northern Mexican gartersnake in 1860, as *Eutenia megalops* from the type locality of Tucson, Arizona (Rosen and Schwalbe 1988, p. 2). In 1951, Dr. Hobart Smith renamed the subspecies with its current scientific name (Rosen and Schwalbe 1988, p. 3). A summary of this species' lengthy taxonomic history can be found in Rosen and Schwalbe (1988, pp. 2–3). Several common names have been applied to the northern Mexican gartersnake in the United States over the years, such as the Arizona ribbon snake, the Emory's gartersnake, and the Arizona gartersnake (Rosen and Schwalbe 1988, p. 2).

In summary, while the taxonomic history of *Thamnophis eques* is robust, we found no indication in the significant body of taxonomic literature we reviewed that its current taxonomy is in doubt or in any way invalid (Rosen and Schwalbe 1988, pp. 2–3; De Queiroz and Lawson 1994, pp. 215–217; Liner 1994, p. 107; Rossman et al. 1996, pp. 171, 175; Conant 2003, p. 6; Crother et al. 2000, p. 72; 2003, p. 202; De Queiroz et al. 2002, p. 327).

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 considered 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). Vegetation characteristics vary based on the type of habitat. For example, in source-area wetlands, dense vegetation consists of knot grass (*Paspalum distichum*), spikerush (*Eleocharis*), bulrush (*Scirpus*), cattail (*Typha*), deergrass (*Muhlenbergia*), sacaton (*Sporobolus*), Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), and velvet mesquite (*Prosopis velutina*) (Rosen and Schwalbe 1988, pp. 14–16).

In riparian woodlands consisting of cottonwood and willow or gallery forests of broadleaf and deciduous species along larger rivers, the northern Mexican gartersnake may be observed in mixed grasses along the bank or in the shallows (Rossman et al. 1996, p. 176; Rosen and Schwalbe 1988, p. 16). Within and adjacent to the Sierra Madre Occidental in Mexico, it occurs in montane woodland, Chihuahuan desertscrub, mesquite-grassland, and Cordillera Volcánica montane woodland (McCranie and Wilson 1987, pp. 14–17).

In small streamside riparian habitat, this snake is often associated with Arizona sycamore (*Platanus wrightii*), sugar leaf maple (*Acer grandidentatum*), velvet ash (*Fraxinus velutina*), Arizona cypress (*Cupressus arizonica*), Arizona walnut (*Juglans major*), Arizona alder (*Alnus oblongifolia*), alligator juniper (*Juniperus deppeana*), Rocky Mountain juniper (*J. scopulorum*), and a number of oak species (*Quercus* spp.) (McCranie and Wilson 1987, pp. 11–12; 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. 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). 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 maniculatus*), lizards of the genera *Aspidoscelis* and *Sceloporus*, larval tiger salamanders (*Ambystoma tigrinum*), and leeches (Rosen and Schwalbe 1988, p. 20; Holm and Lowe 1995, pp. 30–31; Degenhardt et al. 1996, p. 318; Rossman et al. 1996, p. 176; Manjarrez 1998). To a much lesser extent, this snake's diet may include nonnative species, including juvenile fish, larval and juvenile bullfrogs, and mosquitofish (*Gambusia affinis*) (Holycross et al. 2006, p. 23).

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 in their northern distribution followed by the live birth of between 7 and 26 neonates (newly born individuals) (average is 13.6) in July and August (Rosen and Schwalbe 1988, p. 16). Approximately half of the sexually mature females within a population reproduce in any one season (Rosen and Schwalbe 1988, p. 17).

Distribution

Historical Distribution. The United States comprises the northern portion of the northern Mexican gartersnake's distribution. Within the United States, the northern Mexican gartersnake historically occurred predominantly in Arizona with a limited distribution in New Mexico that consisted of scattered locations throughout the Gila and San Francisco headwater drainages in western Hidalgo and Grant counties (Price 1980, p. 39; Fitzgerald 1986, Table 2; Degenhardt et al. 1996, p. 317; Holycross et al. 2006, pp. 1–2). Fitzgerald (1986, Table 2) provided museum records for the following historical localities for northern Mexican gartersnakes in New Mexico: (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.

Within Arizona, the historical distribution of the northern Mexican gartersnake ranged from 130 to 6,150 ft (40 to 1,875 m) in elevation and spread variably based on the relative permanency of water and the presence of suitable habitat. In Arizona, the northern Mexican gartersnake historically occurred within several perennial or intermittent drainages and disassociated wetlands that included: (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; (5) the Santa Cruz River headwaters/San Rafael Valley and adjacent montane canyons; (6) the Salt River; (7) the Rio San Bernardino from International Border to headwaters at Astin Spring (San Bernardino National Wildlife Refuge); (8) Agua Fria River; (9) the Verde River; (10) Tanque Verde Creek in Tucson; (11) Rillito Creek in Tucson; (12) Agua Caliente Spring in Tucson; (13) the downstream portion of the Black River from the Paddy Creek confluence; (14) the downstream portion of the White River from the confluence of the East and North forks; (15) Tonto Creek from the mouth of Houston Creek downstream to Roosevelt Lake; (16) Cienega Creek from the headwaters to the ''Narrows'' just downstream of Apache Canyon; (17) Pantano Wash (Cienega Creek) from Pantano downstream to Vail; (18) Potrero Canyon/Springs; (19) Audubon Research Ranch and vicinity near Elgin; (20) Upper Scotia Canyon in the Huachuca Mountains; (21) Arivaca Creek; (22) Arivaca Cienega; (23) Sonoita Creek; (24) Babocomari River; (25) Babocamari Cienega; (26) Barchas Ranch, Huachuca Mountain bajada; (27) Parker Canyon Lake and tributaries in the Canelo Hills; (28) Big Bonito Creek; (29) Lake O'Woods, Lakeside area; (30) Oak Creek from Midgley Bridge downstream to the confluence with the Verde River; and (31) Spring Creek above the confluence with Oak Creek (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).

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); however, any populations of northern Mexican gartersnakes that may have historically occurred in Nevada pertained directly to the Colorado River and are likely 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, which comprises approximately 70 to 80 percent of its historical rangewide distribution (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. Holycross et al. (2006, p. 12) included the northern Mexican gartersnake as a target species at 33 sites surveyed within drainages along the Mogollon Rim. A total of 874 person-search hours and 63,495 trap-hours were devoted to that effort, which resulted in the capture of 23 snakes total in 3 (9 percent) of the sites visited. This equates to approximately 0.03 snakes observed per person-search hour and 0.0004 snakes captured per trap-hour over the entire effort. For comparison, a population of northern Mexican gartersnakes at Page Springs, Arizona, that we consider stable yielded 0.22 snakes observed per person-search hour and 0.004 snakes captured per trap-hour (an order of magnitude higher) (Holycross et al. 2006, p. 23). Survey sites were selected based on the existence of historical records for the species or sites where the species may occur based on habitat suitability within the historical distribution of the species. Holycross et al. (2006, p. 12) calculated the capture rates for the northern Mexican gartersnake as 12,761 trap-hours per snake and 49 person-search hours per snake. Northern Mexican gartersnakes were found at 2 of 11 (18 percent) historical sites and 1 of 22 (4 percent) sites where the species was previously unrecorded (Holycross et al. 2006, p. 12). When compared with extensive survey data in Rosen and Schwalbe (1988, Appendix I), these data demonstrate dramatic declines in both capture rates and the total number of populations of the species in areas where multiple surveys have been completed over time. However, these data may be affected by differences in survey efforts and drought.

In 2000, Rosen et al. (2001, Appendix I) resurveyed many sites in southeastern Arizona that were historically known to support northern Mexican gartersnake populations during the early to mid-1980s, and also provided additional survey data collected from 1993–2001. Rosen et al. (2001, pp. 21–22) reported their results in terms of increasing, stabilized, or decreasing populations of northern Mexican gartersnakes.

Three sites (San Bernardino National Wildlife Refuge, Finley Tank at the Audubon Research Ranch near Elgin, and Scotia Canyon in the Huachuca Mountains) were intensively surveyed and yielded mixed results. The northern Mexican gartersnake population on the San Bernardino National Wildlife Refuge experienced ''major, demonstrable declines'' to near or at extirpation over the span of a decade. That population is now considered extirpated (Radke 2006). The status of the population at Finley Tank is uncertain. Scotia Canyon was the last area intensively resurveyed by Rosen et al. (2001, pp. 15–16). In comparing this information with survey data from Holm and Lowe (1995, pp. 27–35), northern Mexican gartersnake populations in this area suggest a possible decline from the early 1980s, as evidenced by low capture rates in 1993 and even lower capture rates in 2000.

The remaining 13 sites in southeastern Arizona resurveyed by Rosen et al. (2001, pp. 21–22) also yielded mixed results. Population trend information is difficult to ascertain given the variability of survey sample design and effort used by Rosen et al. (2001). However, the survey results suggested population increases at one site (lower Cienega Creek), possible stability at two sites (lower San Rafael Valley, Arivaca), and negative trends at many other sites [Empire-Cienega Creek, Babocomari, Bog Hole, O'Donnell Creek, Turkey Creek (Canelo), Post Canyon, Lewis Springs (San Pedro River), San Pedro River near Highway 90, Barchas Ranch Pond (Huachuca Mountain bajada), Heron Spring, Sharp Spring, and Elgin-Sonoita windmill well site (San Rafael Valley)] (Rosen et al. 2001, pp. 21–22). While this survey effort could not confirm any specific extirpations of northern Mexican gartersnake populations on a local scale in southeastern Arizona, most sites yielded no snakes during resurvey (Rosen et al. 2001, Appendix I).

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 in the United States, and it is now considered extirpated from New Mexico (Nickerson and Mays 1970, p. 503; Rosen and Schwalbe 1988, pp. 25–26, Appendix I; Holm and Lowe 1995, pp. 27–35; Sredl *et al.* 1995b, pp. 2, 9–10; 2000, p. 9; Rosen *et al.* 2001, Appendix I; Painter 2005, 2006; Holycross *et al.* 2006, p. 66; Brennan and Holycross 2006, p. 123; Radke 2006; Rosen 2006; Holycross 2006). Fitzgerald (1986, pp. 9–10) visited 33 localities of potential habitat for northern Mexican gartersnakes in New Mexico in the Gila River drainage and was unable to confirm its existence at any of these sites. The New Mexico Department of Game and Fish State Herpetologist, Charles Painter, provided several causes that have synergistically contributed to the decline of northern Mexican gartersnakes in New Mexico, including bullfrog and nonnative fish introductions, modification and destruction of habitat, commercial exploitation, direct human-inflicted harm, and fragmentation of populations. The last known observation of the northern Mexican gartersnake in New Mexico occurred in 1994 on private land (Painter 2000, p. 36; Painter 2005).

Our analysis of the best available information indicates that the northern Mexican gartersnake has likely been extirpated from a large portion of its historical distribution in 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 at least minimal survey efforts, and natural recovery at the site is not expected due to the presence of known threats. The perennial or intermittent stream reaches and disassociated wetlands where the northern Mexican gartersnake has likely been extirpated 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). Information pertaining to the cause or causes of extirpation of these sites is summarized in Table 1 below.

Conversely, our review of the best available information indicates the northern Mexican gartersnake is likely extant in a fraction of its historical range in Arizona. We define populations as ''likely extant'' 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 extant 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) Upper Scotia Canyon in the Huachuca Mountains; and (8) the Audubon Research Ranch and vicinity near Elgin

(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).

The current status of the northern Mexican gartersnake is unknown in several areas in Arizona where the species is known to have historically occurred. We base this determination on mostly 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; and (9) Arivaca Cienega (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, after consultation with species' experts and land managers, and based upon our analysis of the best available scientific and commercial data, we conclude that the northern Mexican gartersnake has been extirpated from 85 to 90 percent of its historical distribution in the United States.

Status in Mexico. Throughout this finding, and due to the significantly limited amount of available literature that addresses the status of and threats to extant populations of the northern Mexican gartersnake in Mexico, we rely in part on (1) information that addresses the status of and threats to both riparian and aquatic biological communities within the historical distribution of the northern Mexican gartersnake in Mexico; and (2) information that addresses the status of and threats to native freshwater fish within the historical distribution of the northern Mexican gartersnake in Mexico, which we use as ecological surrogates due to their similar habitat requirements and their role as important prey species utilized by the northern Mexican gartersnake. Observations on the status of riparian and aquatic communities in Mexico are available but limited in comparison to our knowledge of these communities in the United States. The current distribution of the northern Mexican gartersnake in Mexico is also not well understood, although its status is believed to be in decline in many areas due to historical and continuing threats to its habitat and prey base, as discussed below. A large number of springs have dried up in several Mexican states within the distribution of the northern Mexican gartersnake, namely, Chihuahua, Durango, Coahila, and San Luis Potosí (Contreras Balderas and Lozano 1994, p. 381). Contreras Balderas and Lozano (1994, p. 381) also stated that several streams and rivers throughout Mexico and within the distribution of the northern Mexican gartersnake have dried up or become intermittent due to overuse of surface and groundwater supplies. We further acknowledge that northern Mexican gartersnakes were historically distributed in several regions within Mexico that have remained roadless and isolated and, according to the information we were able to obtain regarding the status of the northern Mexican gartersnake in Mexico, few ecological investigations have occurred in these areas due to their remote nature and the logistical difficulties that face research in such areas. However, Mexican biologists Ramirez Bautista and Arizmendi (2004, p. 3) were able to provide general information on the principal threats to northern Mexican gartersnake habitat in Mexico which included the dessication 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). Given the lack of specific data on the status of the northern Mexican gartersnake in Mexico, we cannot conclude with any degree of certainty its overall status in Mexico.

Northern Mexican Gartersnake Distinct Population Segment

In the petition to list the northern Mexican gartersnake, the petitioners specified several listing options for our consideration, including listing northern Mexican gartersnake in the United States as a DPS. Under the Act, we must consider for listing any species, subspecies, or DPSs of vertebrate species/subspecies, if information is sufficient to indicate that such action may be warranted. To implement the measures prescribed by the Act and its Congressional guidance, we developed a joint policy with the National Oceanic and Atmospheric Administration (NOAA) Fisheries entitled Policy Regarding the Recognition of Distinct Vertebrate Population (DPS Policy) to clarify our interpretation of the phrase ''distinct population segment of any species of vertebrate fish or wildlife'' for the purposes of listing, delisting, and reclassifying species under the Act (61 FR 4721; February 7, 1996). Under our DPS policy, we consider three elements in a decision regarding the status of a possible DPS as endangered or threatened under the Act. The elements are: (1) The population segment's discreteness from the remainder of the taxon to which it belongs; (2) the population segment's significance to the taxon to which it belongs; and (3) the population segment's conservation status in relation to the Act's standards for listing (*i.e.*, when treated as if it were a species, is the population segment endangered or threatened?). Our policy further recognizes it may be appropriate to assign different classifications (*i.e.*, threatened or endangered) to different DPSs of the same vertebrate taxon (61 FR 4721; February 7, 1996).

Discreteness

The DPS policy's standard for discreteness requires an entity given DPS status under the Act to be adequately defined and described in some way that distinguishes it from other populations of the species. A population segment may be considered discrete if it satisfies either one of the following conditions: (1) Marked separation from other populations of the same taxon resulting from physical, physiological, ecological, or behavioral factors, including genetic discontinuity; or (2) populations delimited by international boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of 4(a)(1)(D) of the Act.

Marked Separation from Other Populations of the Same Taxon as a Consequence of Physical, Physiological, Ecological or Behavioral Factors. We do not have any information to indicate that a marked separation exists between the United States and Mexico that would distinguish populations of northern Mexican gartersnake in the United States from those in Mexico. There is no information to indicate that a marked separation exists as a result of physical, physiological, ecological, or behavioral factors.

There has been no genetic analysis completed for the northern Mexican gartersnake. Thus, we have no information to indicate that genetic differences exist.

Populations Delimited by International Boundaries Within Which Differences in Control of Exploitation, Management of Habitat, Conservation Status, or Regulatory Mechanisms Exist that are Significant. In terms of the conservation status of the northern Mexican gartersnake, despite the significantly limited amount of monitoring and/or survey data for the northern Mexican gartersnake in Mexico, we believe there is a higher probability that the subspecies is fairing better overall in Mexico in terms of having more total populations, because a larger percentage of the overall range of the subspecies (approximately 70 to 80 percent of it historical distribution) occurs in Mexico. However, we have no information to indicate that the populations on either side of the United States-Mexico border have a more stable or better conservation status.

We recognize that differences in management regulatory protection of northern Mexican gartersnake populations may exist between populations within Mexico and those within the United States. These differences primarily pertain to protections afforded to occupied habitat. In Mexico, any activity that intentionally destroys or adversely modifies occupied northern Mexican gartersnake habitat is prohibited [SEDESOL 2000 (LGVS) and 2001 (NOM–059–ECOL–2001)]. Neither the Arizona Game and Fish Department or the New Mexico Department of Game and Fish can offer protections to occupied habitat. Instead, these agencies regulate take in the form of lethal or live collection of individuals which is prohibited in both states. However, any conclusions that may be drawn with reference to differences in management across the United States-Mexico border are largely speculative due to the lack of information available as to the efficacy and protections of these regulations in practice. Because we determine in the following section that populations of the northern Mexican gartersnake in the United States are not significant to the subspecies as a whole, we need not address further the ''discreteness'' test of the DPS policy. For further information on regulatory considerations, please see our discussion under Factor D below.

Significance

Under our DPS policy, a population segment must be significant to the taxon to which it belongs. The evaluation of ''significance'' may address, but is not limited to, (1) evidence of the persistence of the discrete population segment in an ecological setting that is unique for the taxon; (2) evidence that loss of the population segment would result in a significant gap in the range of the taxon; (3) evidence that the population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; and (4) evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

Ecological Setting. Throughout its rangewide distribution, the northern Mexican gartersnake occurs at elevations from 130 to 8,497 ft (40 to 2,590 m) (Rossman *et al.* 1996, p. 172). The northern Mexican gartersnake is considered a riparian obligate (restricted to riparian areas when not engaged in dispersal behavior) and occurs chiefly in the following general habitat types in both the United States and Mexico: (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). Based on this information, we determine that populations of the northern Mexican gartersnake in Arizona do not occupy an ecological setting differing enough from populations that occur in Mexico to be considered unique for the subspecies.

Gap in the Range. The Service can determine that a gap in a taxon's range caused by the potential loss of a population would be significant based on any relevant considerations. One factor which may support such a determination is whether the loss of a geographic area amounts to a substantial reduction of a taxon's range and this reduction is biologically important. The United States comprised the most northern portion of the northern Mexican gartersnake's range and constituted approximately 20–30 percent of its rangewide historical distribution. Because we do not currently know exactly what the status of the northern Mexican gartersnake is in Mexico at this time, we are unable to ascertain what percentage of extant populations occur in the United States as compared to Mexico. However, this is not sufficient evidence to support a determination that loss of the northern Mexican gartersnake in the United States represents a substantial reduction in the subspecies' range based on the geographic area which would be lost. Furthermore, no area that is uniquely biologically significant to the northern Mexican gartersnake is located within the United States as compared to Mexico.

Another factor relevant to determining whether a gap is significant is the biological significance of the number of total individuals of the taxon in the population that may be lost. Although we have no data on the absolute numbers of northern Mexican gartersnakes in the United States or Mexico, the best available science suggests that there are far more individuals in Mexico than in the United States, based on the more extensive range in Mexico and the current low density and number of extant populations in the United States. Therefore, we have no information to indicate that the loss of between 8 and 17 populations of northern Mexican gartersnakes known in the United States is biologically significant to the taxon as a whole.

In conclusion, we have determined that the gap in the range of the northern gartersnake that would be caused by the loss of the United States population would not be significant because: (1) Loss of the United States population would not constitute a substantial and biologically important reduction of the range of the subspecies; (2) the loss of the individuals in the United States would not be biologically significant to the subspecies; and (3) we have not identified any other reason why loss of the United States population would result in a significant gap in the range of the subspecies.

Marked Differences in Genetic Characteristics. Within the distribution of every species there exists a peripheral population, an isolate or subpopulation of a species at the edge of the taxon's range. Long-term geographic isolation and loss of gene flow between populations is the foundation of genetic changes in populations resulting from natural selection or change. Evidence of changes in these populations may include genetic, behavioral, and/or morphological differences from populations in the rest of the species' range. We have no information to indicate that genetic differences exist between populations of the northern Mexican gartersnake at the northern portion of its range in the United States from those in Mexico. Therefore, based on the genetic information currently available, the northern Mexican gartersnake in the United States should not be considered biologically or ecologically significant based simply on genetic characteristics. Biological and ecological significance under the DPS policy is always considered in light of Congressional guidance (see Senate Report 151, 96th Congress, 1st Session) that the authority to list DPS's be used ''sparingly'' while encouraging the conservation of genetic diversity.

Whether the Population Represents the Only Surviving Natural Occurrence of the Taxon. As part of a determination of significance, our DPS policy suggests that we consider whether there is evidence that the population represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range. The northern Mexican gartersnake in the United States is not the only surviving natural occurrence of the subspecies. Consequently, this factor is not applicable to our determination regarding significance.

Conclusion

Following a review of the available information, we conclude that the northern Mexican gartersnake in the United States is not significant to the remainder of the subspecies. We made this determination based on the best available information, which does not demonstrate that (1) these populations persist in an ecological setting that is unique for the subspecies; (2) the loss of these populations would result in a significant gap in the range of the subspecies; and (3) these populations differ markedly from populations of northern Mexican gartersnake in Mexico in their genetic characteristics, or in other considerations that might demonstrate significance. Further, available information does not demonstrate that the life history and behavioral characteristics of the northern Mexican gartersnake in the United States is unique to the subspecies. Therefore, on the basis of the best scientific and commercial information available, we find that proposing to list a DPS for the northern Mexican gartersnake in the United States is not warranted; these populations do not meet the definition of a distinct population segment. We are not addressing the third prong of the DPS policy (*i.e.* the population segment's conservation status in relation to the Act's standards for listing) since we find that the United States portion of the range of the northern Mexican gartersnake does not qualify as a listable entity pursuant to our DPS policy, as discussed above.

Significant Portion of the Range

In the petition to list the northern Mexican gartersnake, the petitioners also requested that we consider listing the species throughout its range based on its status in the United States. As required by the Act, we have considered in this finding whether the northern Mexican gartersnake is in danger of extinction ''in all or a significant portion of its range'' as defined in the terms ''threatened species'' and ''endangered species'' pursuant to section 3 of the Act. In order to determine if Arizona constitutes a significant portion of the range of the subspecies, we evaluate whether threats in this geographic area imperil the viability of the subspecies as a whole due to any biological importance of this portion of the subspecies range. Based upon the best scientific information available, we find that the extant populations in the United States are not considered a stronghold for the subspecies, they do not represent core or important breeding habitat, we are not aware of any unique genetic or behavioral characteristics, and we are not aware that threats in this portion of its range threaten the whole subspecies with extinction. Therefore, we determine that the extant populations of the northern Mexican gartersnake in Arizona do not constitute a significant portion of the range of the subspecies because there is no particular characteristic to any segment within this portion of its range that would render it biologically more significant to the taxon as a whole than other portions of its current range.

We note that the court in Defenders of Wildlife v. Norton, 258 F.3d 1136 (9th Cir. 2001), appeared to suggest that a species could be in danger of extinction in a significant portion of its range if there is a ''major geographical area'' in which the species is no longer viable but once was. Although we do not necessarily agree with the court's suggestion, we have determined that the historical range of the subspecies within the United States does not constitute a ''major geographical area'' in this context. The portion of the northern Mexican gartersnake's historical range in United States (20 to 30 percent) constitutes a small percentage of the total range of the subspecies.

The petitioners also requested that we consider listing the species throughout its range based on its rangewide status. Below we respond to the petitioners request through our analysis of the five listing factors for the United States and Mexico.

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) 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 UNITED STATES

[All locations in Arizona unless otherwise specified.]

Population locality	Current status	Regional historical/current threats
Gila River	Extirpated	Considered extirpated by nonnatives, improper grazing, recreation, development, groundwater pumping, diversions, channelization, dewatering, road construction/use, wildfire, intentional harm, dams, prey base reductions.
Gila and San Francisco Headwaters in New Mexico.	Extirpated	Considered extirpated by nonnatives, improper grazing, recreation, prey base reductions.
Lower Colorado River from Davis Dam to International Border.	Extirpated	Considered extirpated by nonnatives, prey base reductions, recreation, development, road construction/use, borderland security/undocumented immigration, intentional harm, dams.

TABLE 1.—SUMMARY OF NORTHERN MEXICAN GARTERSNAKE STATUS AND THREATS BY POPULATION IN UNITED STATES—Continued

[All locations in Arizona unless otherwise specified.]

Population locality	Current status	Regional historical/current threats
San Pedro River in United States	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, groundwater pumping, road construction/use, borderland security/undocumented immigrants, intentional harm.
Santa Cruz River downstream of the Nogales area of the International Border.	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, development, groundwater pumping, diversions, channelization, road construction/use, borderland security/undocumented immigrants, intentional harm, contaminants.
Salt River	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, development, diversions, wildfire, channelization, road construction/use, intentional harm, dams.
Rio San Bernardino from International Border to headwaters at Astin Spring (San Bernardino National Wildlife Refuge).	Extirpated	Considered extirpated by nonnatives, prey base reductions, borderland security/undocumented immigration, intentional harm, competition with Marcy's checkered gartersnake.
Agua Fria River	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, development, recreation, dams, road construction/use, wildfire, intentional harm.
Verde River upstream of Clarkdale	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, development, groundwater pumping, diversions, channelization, road construction/use, intentional harm.
Verde River from the confluence with the Salt upstream to Fossil Creek.	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, groundwater pumping, diversions, channelization, road construction/use, wildfire, development,intentional harm, dams.
Potrero Canyon/Springs	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing.
Tanque Verde Creek in Tucson	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, development, groundwater pumping, road construction/use, intentional harm.
Rillito Creek in Tucson	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, development, groundwater pumping, road construction/use, intentional harm.
Agua Caliente Spring in Tucson	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, development, groundwater pumping, road construction/use, intentional harm.
Babocamari Cienega	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing.
Barchas Ranch, Huachuca Mountain bajada.	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, borderland security/undocumented immigration, intentional harm.
Parker Canyon Lake and tributaries in the Canelo Hills.	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, road construction/use, borderland security/undocumented immigration, intentional harm, dams.
Oak Creek at Midgley Bridge	Extirpated	Considered extirpated by nonnatives, prey base reductions, improper grazing, recreation, development, intentional harm.
Santa Cruz River/Lower San Rafael Valley (headwaters downstream to International Border).	Extant	Nonnatives, prey base reductions, improper grazing, borderland security/undocumented immigration, intentional harm.
Verde River from the confluence with Fossil Creek upstream to Clarkdale.	Extant	Nonnatives, prey base reductions, improper grazing, recreation, development, groundwater pumping, diversions, channelization, road construction/use, intentional harm, dams.
Oak Creek at Page Springs	Extant	Nonnatives, prey base reductions.
Tonto Creek from mouth of Houston Creek downstream to Roosevelt Lake.	Extant	Nonnatives, prey base reductions, improper grazing, recreation, development, diversions, channelization, road construction/use, wildfire, intentional harm, dams.
Cienega Creek from headwaters downstream to the "Narrows" just downstream of Apache Canyon.	Extant	Nonnatives, prey base reductions, improper grazing.
Pantano Wash (Cienega Creek) from Pantano downstream to Vail.	Extant	Nonnatives, prey base reductions, improper grazing, wildfire.
Upper Scotia Canyon in the Huachuca Mountains.	Extant	Nonnatives, prey base reductions, wildfire.
Audubon Research Ranch and vicinity near Elgin.	Extant	Nonnatives, prey base reductions, improper grazing.
Downstream portion of the Black River drainage from the Paddy Creek confluence.	Unknown	Nonnatives, prey base reductions, improper grazing, recreation, intentional harm.

TABLE 1.—SUMMARY OF NORTHERN MEXICAN GARTERSNAKE STATUS AND THREATS BY POPULATION IN UNITED STATES—Continued

[All locations in Arizona unless otherwise specified.]

Population locality	Current status	Regional historical/current threats
Downstream portion of the White River drainage from the confluence of the East/North.	Unknown	Nonnatives, prey base reductions, improper grazing, recreation, road construction/use, intentional harm.
Big Bonito Creek	Unknown	Nonnatives, prey base reductions, improper grazing.
Lake O' Woods (Lakeside)	Unknown	Nonnatives, prey base reductions, recreation, development, road construction/use, intentional harm.
Spring Creek above confluence with Oak Creek.	Unknown	Nonnatives, prey base reductions, development.
Bog Hole Wildlife Area	Unknown	Nonnatives, prey base reductions.
Upper 13 Tank, Patagonia Mountains bajada.	Unknown	Nonnatives, prey base reductions, improper grazing.
Babocamari River	Unknown	Nonnatives, prey base reductions, improper grazing.
Arivaca Cienega	Unknown	Nonnatives, prey base reductions, improper grazing, borderland security/undocumented immigration, intentional harm.

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 and/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, and/or survey data is unavailable or insufficient, or where threats could preclude occupancy. The information used to develop this table can be found in the sources listed below.

Sources: Hyatt undated, p. 71; Nickerson and Mays 1970, pp. 495, 503; Hulse 1973, p. 278; Vitt and Ohmart 1978, p. 44; Hendrickson and Minckley 1984, p. 131, 138–162; Meffe 1985, pp. 179–185; Rosen 1987, p. 5; Ohmart et al. 1988, pp. 143–147, 150; Rosen and Schwalbe 1988, Appendix I; 1995, p. 452; 1996, pp. 1–3; 1997, p. 1; 2002b, pp. 223–227; 2002c, pp. 31, 70; Bestgen and Propst 1989, pp. 409–410; Clarkson and Rorabaugh 1989, pp. 531–538; Marsh and Minckley 1990, p. 265; Medina 1990, pp. 351, 358–359; Sublette et al. 1990, pp. 112, 243, 246, 304, 313, 318; Abarca and Weedman 1993, pp. 2, 6–12; Girmendonk and Young 1993, pp. 45–52; Sullivan and Richardson 1993, pp. 35–42; Stefferud and Stefferud 1994, p. 364; Bahre 1995, pp. 240–252; Hale et al. 1995, pp. 138–140; Holm and Lowe 1995, pp. 5, 27–35, 37–38, 45–46; Rosen et al. 1995, p. 254; 1996b, pp. 8–9; 2001, Appendix I; Sredl et al. 1995a, p. 7; 1995b, p. 9; 1995c, p. 7; 2000, p. 10; Degenhardt et al. 1996, p. 319; Fernandez and Rosen 1996, pp. 6–19, 52–56; Stromberg et al. 1996, pp. 113–114, 123–128; Yuhas 1996; Drost and Nowak 1997, p. 11; Weedman and Young 1997, pp. 1, Appendices B, C; Inman et al. 1998, Appendix B; Rinne et al. 1998, pp. 75–80; Nowak and Spille 2001, pp. 11, 32–33; Esque and Schwalbe 2002, pp. 161–193; Nowak and Santana-Bendix 2002, p. 39; Stromberg and Chew 2002, pp. 198, 210–213; Tellman 2002, p. 43; USFWS 2002a, pp. 40802–40804; 2002b, Appendix H; 2006, pp. 91–105; Voeltz 2002, pp. 40, 45–81; Krueper et al. 2003, pp. 607, 613–614; Bonar et al. 2004, pp. 1–108; Forest Guardians 2004, p. 1; Unmack and Fagan 2004, p. 233; Fagan et al. 2005, pp. 34–41; Olden and Poff 2005, pp. 75, 82–87; Painter 2005; Philips and Thomas 2005; Webb and Leake 2005, pp. 302, 305–310, 318–320; ADWR 2006; American Rivers 2006; Brennan and Holycross 2006, p. 123; Holycross et al. 2006, pp. 15–61; McKinnon 2006a, 2006b, 2006c, 2006d, 2006e; Paradzick et al. 2006, pp. 88–93, 104–110; Segee and Neeley 2006, Executive Summary, pp. 5–7; 10–12, 15–16, 21–23.

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. The majority of this assessment is specific to those factors that have contributed to its status in the United States. The following 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 we were unable to find specific information documenting that populations of the northern Mexican gartersnake in Mexico are directly affected by these threats. In some instances, we do include discussion on more refined geographic areas of Mexico when supported by the literature. However, many of the threats that affect the northern Mexican gartersnake in the United States are also present in Mexico. Thus, the relationship between the threats to the habitat and species in Mexico may be similar to what we have documented in the United States.

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

In the following discussion, we elaborate on the physical threats to northern Mexican gartersnake habitats (i.e., riparian and aquatic communities) that have occurred and continue to occur within the distribution of the species in the United States and Mexico. Various threats that have affected and continue to affect riparian and aquatic communities include dams, diversions, groundwater pumping, introduction of nonnative species (vertebrates, plants, and crayfish), woodcutting, mining, contaminants, urban and agricultural development, road construction, 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). These activities 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 synergistically 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.

Threats to Riparian and Aquatic Biological Communities in the United States. The modification and destruction of aquatic and riparian communities in the post-settlement arid southwestern United States is well documented and apparent in the field (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). 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) 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 at length 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 in the United States. 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 soils.'' Many of these unique communities of the southwestern United States, and Arizona in particular, have been lost in the past century to streambed modification, improper livestock grazing, cultural impacts, stream flow stabilization by upstream dams, channelization, and stream flow reduction from groundwater pumping and 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 along many southwestern streams, including the San Pedro River. Conservation of the remaining natural cienegas in Arizona will be contingent on their protection from severe flooding and from lowering of groundwater levels (Hendrickson and Minckley 1984, p. 169).

Many sub-basins where cienegas have been severely modified or lost entirely overlap, wholly or partially, 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 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 in the United States. 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). 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 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. Medina (1990, pp. 358–359) concluded that perennial streams had greater tree densities in all diameter size classes of Arizona alder and box elder (*Acer negundo*) 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 thermoregulation. Regional development and subsequent land use changes, spurred by increasing populations, along lower Tonto Creek and within the Verde Valley where northern Mexican gartersnakes are extant 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 adverse effects to northern Mexican gartersnake habitat in the vicinity of Rock Springs along the Agua Fria River and also throughout the Verde Valley along the Verde River.

The effects of urban and rural development are expected to increase as 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. 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 (SSDAR 2000). Over the same time period, population growth rates in Arizona counties where the northern Mexican gartersnake historically occurred or may still be extant have varied by county but are no less remarkable: 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, and 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).

Development growth predictions have also 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 area (*http://www.census.gov*). All of these communities are near or within the vicinity of historical or extant northern Mexican gartersnake populations.

Road Construction, Use, and Maintenance in the United States. Roads cover approximately one 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 (reptiles and amphibians) 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) an 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 and/or inhibition of reproduction; (7) contributions of pollutants to riparian and aquatic communities; and (8) population sinks 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 visually-based hunting behaviors; and (3) filling in interstitial spaces of the substrate which reduces reproduction and foraging success of fish interfering with respiration, and restricting reproduction and foraging of fish. 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. Sediment can lead to several effects in resident fish species used by northern Mexican gartersnakes as prey species, which can ultimately cause the northern Mexican gartersnake's increased direct mortality, reduced reproductive success, lower overall abundance, lower species diversity, and reductions in food base as documented by Wheeler et al. (2005, p. 145). The underwater foraging ability of northern Mexican gartersnakes can also be directly compromised by excessive turbidity caused by sedimentation of water bodies. Metal contaminants, including iron, zinc, lead, cadmium, nickel, copper, and chromium, are bioaccumulative) and 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). 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 and lead to adverse health affects.

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 have similar effects. 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 effects 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. There are several reasons for this phenomenon. First, all snakes are thigmotherms (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). Additionally, many species of snakes are active when traffic densities are greatest, as is the case with gartersnakes, which are generally diurnal (active during daylight hours) (Rosen and Lowe 1994, p. 147). 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, which highlights the seasonal variability in surface activity of this snake, and many other species of reptiles. 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 in general in modern-day society (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, such as the North American pit vipers in the genera *Agkistrodon, Sistrurus,* and *Crotalus,* 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.

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

While snakes of all species may suffer direct mortality from 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). 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 that roads may affect a snake's movement behavior by a variety of means and that generalizing these resultant behaviors does not adequately address this variability.

In addition to altering the movement patterns of some snakes, roads can 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 trail females may exacerbate the effects of low population density and fragmentation that affect several species of snakes, including the northern Mexican gartersnake. Furthermore, roads can facilitate an increase in the distance traveled by male snakes seeking receptive females, which 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 tend to adversely affect aquatic breeding anuran (frog and/or toad) populations more so than other species due to their activity patterns, population structures, and preferred habitats (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 affected more significantly 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 in the United States. As discussed above, population growth trends are expected to continue into the future. Expanding population growth leads to higher recreational use of riparian areas. 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 neonates. Increased human visitation of occupied habitat also increases the potential for human-gartersnake interactions, which frequently does not bode well for snakes, as it often leads to their capture, injury, or death of the snake due to the lay person's fear 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).

Groundwater Pumping, Surface Water Diversions, and Drought in the United States. 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 desiccation of riparian and wetland vegetative communities can follow. Continued groundwater pumping at such levels draws down the aquifer sufficiently to create a water-level gradient away from the stream and floodplain (Webb and Leake 2005, p. 309). 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 occurs by producing 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). Changes to the duration and timing of upwelling can potentially lead to localized extinctions in biota (Boulton and Hancock 2006, p. 139).

To varying degrees, 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 being currently dominated by woody species more tolerant of declining water tables due to their associated deeper rooting depths.

The full effects of largescale 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 ''Ten Most Endangered Rivers List (of 2006)'' (American Rivers 2006). This potential reduction or loss of baseflow in the Verde River could seasonally dry up large reaches and/or adversely affect the riparian community and the suitability of the habitat for extant 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 remains extant, 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 Tonto Creek regularly eliminates surface flows during parts of the year (Abarca and Weedman 1993, p. 2). The upper Gila River is also threatened by 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).

Further evidence of the threat of groundwater depletion can be found in the management activities of the Arizona Department of Water Resources (ADWR). 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. Geographically, all five AMAs overlap the historical distribution of the northern Mexican gartersnake in Arizona and provide further evidence of the role groundwater pumping has had and continues to have on historical and occupied northern Mexican gartersnake habitat. Such overdrafts are capable of adversely impacting surface water flow of streams that are hydrologically connected to the aquifer under stress and are often exacerbated by the ever-growing number of surface water diversions for various purposes.

In order to accommodate the needs of rapidly growing rural and urban populations, surface water is commonly diverted to serve many industrial and municipal uses. These 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 diversions for agriculture (Paradzick et al. 2006, pp. 104–110).

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) 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. 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 according to recorded history from the mid-1800s to the present, the effects of anthropogenic threats 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 where the streams were completely dry and therefore unsuitable northern Mexican gartersnake habitats.

Improper Livestock Grazing in the United States. 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). Livestock grazing, as a resource use on public and private lands, has more than doubled quantitatively in 50 years; the number of cattle being grazed in the western United States increased from 25.5 million head in 1940, to 54.4 million head in 1990 (Belsky et al. 1999, p. 3).

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 elucidate 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 causes for subsequent fragmentation of populations and widespread extirpations.

In the recent past, riparian and aquatic communities have been negatively impacted by poor livestock management (e.g., overgrazing, uncontrolled access to riparian areas, improper pasture rotation, no monitoring of use, etc.) within several watersheds that the northern Mexican gartersnake historically occupied, and in some cases, poor livestock management may constitute the greatest impact to riparian vegetation. The specific ways in which improper livestock grazing can adversely affect northern Mexican gartersnakes and contribute to their decline is discussed below. 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). 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 extant 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).

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 itself from: (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). Stock tanks 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). Specific attributes of ecosystems, such as composition, function, and structure, have been documented as being altered by improper livestock management through a variety of means including: (1) Decreasing the density and biomass of individual species, reducing species richness, and changing biological community organization; (2) interfering with nutrient cycling and ecological succession; and (3) changing vegetation stratification, contributing to soil erosion, and decreasing availability of water to biotic communities (Fleischner 1994, p. 631).

The management of stock tanks is an important consideration for northern Mexican gartersnakes. Stock tanks can be intermediary ‘‘stepping stones’’ in the dispersal of nonnative species from larger source populations to new areas (Rosen et al. 2001, p. 24). Additionally, 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. Poor management may also favor nonnative predators of the northern Mexican gartersnake (Rosen and Schwalbe 1988, pp. 47, 32). 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.

A key to proper livestock management appears to be increasing the distribution of cattle across the entire grazing space. 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 removed by cattle was from a riparian area which amounted to only two 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).

The northern Mexican gartersnake uses riparian herbaceous vegetation for cover, thermoregulation, and foraging. Clary and Webster (1989, p. 1) noted that excessive grazing and trampling from poor livestock management can affect riparian and stream communities by reducing or eliminating this vegetation, causing channel aggradation or degradation, causing widening or incisement of stream channels, and changing streambank morphology, with the cumulative result of lowering corresponding water tables. In support of findings made by Fleischner (1994, pp. 631–632), these effects can largely be attributed to the tendency of livestock in the arid Southwest to spend a disproportionately longer time in riparian areas than in upland range pasture (5–30 times longer, comparatively), which leads to overgrazing of the riparian vegetation (Clary and Medin 1990, p. 1). However, even when livestock's access to riparian areas is restricted, poor livestock management in the uplands leads to soil compaction and decreased filtering capacity of vegetation. These effects increase the speed and amount of runoff from the uplands, which contributes heightened, unnatural amounts of sediment in aquatic habitat. This damages the suitability of that habitat and fills in pools, which affects their permanency and suitability for many prey species of the northern Mexican gartersnake (Sartz and Tolsted 1974, p. 354; Weltz and Wood 1986, pp. 367–368; Orodho et al. 1990, p. 9; Trimble and Mendel 1995, pp. 235–236; Pearce et al. 1998, p. 302). The response of riparian herbaceous vegetation after the removal of cattle was documented as dramatic, with a four to six fold increase in density, as observed in the upper San Pedro River (Krueper et al. 2003, pp. 607, 613–614). Schulz and Leininger (1990, p. 295) also remarked that riparian ecosystems can improve quickly when livestock are removed.

As stated previously, dense vegetative cover is an essential component to habitat suitable for the northern Mexican gartersnake for several reasons (Szaro et al. 1985, p. 364; Rosen and Schwalbe 1988, p. 47). The removal or severe alteration of this habitat component significantly affects the foraging success and heightens the predation risk of the northern Mexican gartersnake. Small, isolated populations of northern Mexican gartersnakes that use stock tanks as refugia may be extirpated within 1 year of vegetation removal (Rosen and Schwalbe 1988, p. 33). Northern Mexican gartersnake populations that occur in isolated wetlands or stock tanks are not likely to recolonize naturally (i.e. without reestablishment efforts) once extirpated due to the species' tendency to avoid long overland movements (Rosen and Schwalbe 1988. p. 33).

Szaro et al. (1985, p. 360) assessed the effects of improper livestock management on the same stream 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 accumulates as the debris moves downstream during flood events. Specifically, results indicated that snake abundance and biomass were significantly higher in ungrazed habitat, with a five-fold difference in number of snakes captured, despite the difficulty of making observations in areas of increased habitat complexity (Szaro et al. 1985, p. 360). Szaro et al. (1985, p. 362) also noted the importance of riparian vegetation for the maintenance of an adequate prey base and as cover in thermoregulation and predation avoidance behaviors, as well as for foraging success.

Direct 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 hoof action of 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 photo 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 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.

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. However, we recognize that well-managed grazing can occur with limited effects to this species when management emphasis is directed to moderated access restrictions for occupied habitat combined with the use of remote drinkers (containerized water sources supplied by water pumped from a nearby source) as well as other livestock management protocols that lessen the effect of vegetation disturbance and removal adjacent to occupied habitat by increasing the distribution of cattle across an allotment. Lastly, as previously stated, we also recognize the value of well-managed stock tanks in the conservation of northern Mexican gartersnakes.

Catastrophic Wildfires in the United States. 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-type ecosystems 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 hydrographs, and increased sedimentation of streams. These effects can harm fish communities, as observed in the 1990 Dude Fire, in which corresponding ash flows decimated some fish populations in Dude Creek and the East Verde River (Voeltz 2002, p. 77). These effects can significantly lessen the prey base for northern Mexican gartersnakes and could lead to direct mortality in the case of fires that are within occupied habitat.

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). 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, brome 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 has significant effects on lower-elevation species, as observed in 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 in the United States. Undocumented immigrants attempt to cross the International border from Mexico into the United States in areas historically or currently occupied by the northern Mexican gartersnake. This method of immigration 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 concentrated levels of attempted undocumented immigrant 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).

Use of new roads and trails from immigration 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. These activities also serve as a source of additional sediment to streams that affect their suitability as habitat for prey species of the northern Mexican gartersnake and affect the suitability and availability of pool habitats by filling them in with sediment. Riparian areas along the upper San Pedro River have been impacted by out of control fires that undocumented immigrants likely started to keep warm and/or prepare food (Segee and Neeley 2006, p. 23). There also remains the threat of pursuit, capture, and death of northern Mexican gartersnakes when they are encountered by undocumented immigrants 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 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. These activities 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).

There remains the possibility that adverse effects to riparian communities may increase in the future as land access and infrastructure restrictions in sensitive wildlife areas may be relaxed according to proposed policy changes that aim to boost border enforcement activities in these currently roadless areas and as concentrated enforcement efforts in urban locations funnel more undocumented immigrant traffic to remote wilderness areas (Segee and Neeley 2006, pp. 15–16).

Habitat Threats in Mexico. 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; Contreras Balderas and Lozano 1994, p. 384; va Landa et al. 1997, p. 316; Miller et al. 2005, pp. 60–61; Abarca 2006). We experienced difficulty finding specific information documenting that populations of northern Mexican gartersnakes in Mexico are directly affected by these threats which is problematic in a rangewide analysis given that approximately 70 to 80 percent of the historic distribution of the northern Mexican gartersnake occurs in Mexico. We did, however, find enough information to provide some refined discussion of smaller geographic areas within Mexico, and acknowledge that many of the threats that affect the northern Mexican gartersnake in the United States also occur in Mexico and could affect the northern Mexican gartersnake in similar ways but at potentially varying intensities.

Conant (2003, p. 4) noted anthropogenic threats to seven fragmented, endemic subspecies of Mexican gartersnake in the Transvolcanic Belt Region of southern Mexico, which extends from southern Jalisco eastward through the state of México to central Veracruz which comprises a small proportion of the subspecies' range. Although Conant (2003) addresses threats to a small percentage of the historic distribution, many of these rural land uses are regionally ubiquitous and therefore these threats can be extrapolated to the surrounding vicinity of the distribution of these seven recently described subspecies of the Mexican gartersnake in Mexico. Some of these threats included water diversions, pollution (e.g., discharge of raw sewage), sedimentation of aquatic habitats, and eutrophication (increase of dissolved nutrients and decrease of dissolved oxygen) of lentic (still water) habitats. Conant (2003, p. 4) expressed great concern that while many of these threats were evident during his field work in the 1960s, 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. 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 downstream of Hoover (Boulder) Dam, have simply been destroyed by pollution and river alteration.'' Near Torreón, Coahuila, where the northern Mexican gartersnake was historically distributed, groundwater pumping has resulted in flow reversal, which has driedup many local springs, drawn arsenicladen water, further contaminated the area, and resulted in adverse human health effects in that area. Severe water pollution from untreated domestic waste is evident downstream of large Mexican cities, and inorganic pollution from nearby industrialized areas and agricultural irrigation return flow has dramatically affected aquatic communities (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) where the northern Mexican gartersnake was historically distributed: ''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 historic distribution 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 Río Colorado, where the northern Mexican gartersnake was distributed, 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 endemic, prey species of the northern Mexican gartersnake in several regions of Mexico, as discussed further in Factor C below (Miller et al. 2005, p. 60).

Miller et al. (2005) does provide some locality specific information on the status and threats of freshwater fishes and riparian and aquatic communities in specific waterbodies throughout Mexico that historically overlapped, or are adjacent to, the historic distribution of the northern Mexican gartersnake: the Río Grande (dam construction, p. 78); the Río Bravo (extirpations, pp. 82, 112); headwaters of the Río Lerma (extinction/rediscovery, nonnatives, pollution, dewatering, pp. 60, 105, 197); Lago de Chapala and its outlet to the Río Grande de Santiago (major declines, p. 106); medium-sized streams throughout the Sierra Madre Occidental (localized extirpations, logging, dewatering, pp. 109, 177, 247); the Río Conchos (extirpations, p. 112); the ríos Casas Grandes, Santa María, del Carmen, and Laguna Bustillos (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 (nonnatives, pp. 148, Plate 61); the Río Colorado (nonnatives, p. 153); the ríos Fuerte and Culiacán (logging, p. 177); canals, ponds, lakes in the endorheic (closed) Valle de México (nonnatives, extirpations, pollution, pp. 197, 281); the Río Verde Basin (dewatering, nonnatives, extirpations, Plate 88); the Río Mayo (dewatering, nonnatives, p. 247); the Río Papaloapan (pollution, p. 252); lagos de Zacapu and Yuriria (habitat destruction, p. 282); and the Río Pánuco Basin (nonnatives, p. 295).

Conant (1974, pp. 486–489) described significant threats to northern Mexican gartersnake habitat within its historical distribution in various locations in western Chihuahua, Mexico, and within the Rio Concho system where it is known to occur. These threats specifically included impoundments, 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. McCranie and Wilson (1987, p. 2) discuss threats to the pine-oak communities of higher elevation habitats in the Sierra Madre Occidental, 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, especially if the road is paved as has been the case with (Mexican) Highway 40 through southern Durango. We feel fortunate to have worked in an area of this country of rapid population growth that is all too fast disappearing.'' In Mexico, as compared to the United States, there is believed to be a delay in the magnitude and significance of adverse effects to riparian communities, but it is believed that threats to riparian and aquatic communities that have been observed in Arizona as described below are currently occurring with increasing significance in several regions across Mexico within the historic distribution of the northern Mexican gartersnake (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).

Collectively, the impacts described above 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. Mexico's human population grew 700 percent from 1910 to 2000 (Miller et al. 2005, p. 60). More recently, 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 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). To increase forage and stocking rates for livestock production in the arid lowlands of northern Mexico, African buffelgrass (*Pennisetum ciliare*) was widely introduced in Mexico and has spread on its own (Búrquez-Montijo et al. 2002, p. 131). Buffelgrass invasions pose a serious threat to native arid ecosystems because buffelgrass prevents germination of native 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 (Búrquez-Montijo et al. 2002, pp. 135, 138). Erosion affects the suitability of habitat for northern Mexican gartersnakes and their prey species. Recent estimates indicate that 80 percent of Mexico is affected by soil erosion with the most serious erosion 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 historically occurred.

The threats to riparian and aquatic communities in Mexico (such as 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, pollution, impoundments, and dams) vary in their significance both geographically and ecologically, based on geographical distribution of land management activities and urban centers, but are expected to continue into the future. Threats that affect the amount of water within an occupied area directly affect its suitability to northern Mexican gartersnakes. Threats that alter the vegetation of occupied habitat reduce the habitat's suitability as cover for protection from predators, as a foraging area, and as an effective thermoregulatory site. Nonnative species, explained further in our Factor C discussion, compete with the northern Mexican gartersnake for prey as well as prey on juvenile and sub-adult northern Mexican gartersnakes, which hampers the recruitment of young snakes into the population and lessens the viability of that population over time. However, because specific and direct survey information is significantly limited concerning the presence and potential effect of these threats to the subspecies in Mexico, this discussion is based on extrapolation of how we understand these threats to affect the subspecies in the United States. Furthermore, the subspecies was historically distributed in several regions within Mexico that have remained roadless and isolated, thus suggesting that the severity of threats may be less than that found within the range in United States where lands have greater past and current economic pressures such as grazing and development. As such we can not conclude that the subspecies is likely to become endangered throughout its range in Mexico. Although we acknowledge that these threats are affecting the subpecies in the United States, we have determined that the portion of the subspecies' range in the United States does not constitute a significant portion of the range of the subspecies or a DPS. Therefore, on the basis of the best available information, we determine that it is not likely that the northern Mexican gartersnake will become an endangered species within the foreseeable future based on threats under this factor.

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 field 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 photo vouchers for university museum collections. Additionally, universities such as Arizona State University and the University of Arizona recently began to accept photo voucher record, versus physical specimens, in their respective museum collections. We believe these measures further 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 from formal biological field investigations and field specimen collections. We were unable to obtain any 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. The outbreak of chytrid fungus (of the genus *Batrachochytrium*) 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). The chytrid fungus 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 the chytrid fungus a serious threat to amphibian diversity. In Arizona, chytrid infections have been reported in several northern Mexican gartersnake native prey species (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). Declines of native prey species of the northern Mexican gartersnake from chytrid infections have contributed to the decline of this species in the United States. However, we do not have specific information regarding potential impacts of chytrid infections on northern Mexican gartersnake native prey species in Mexico.

We also note that in a pure culture (uncontaminated growth medium), the fungus *Batrachochytrium* can grow on boiled snakeskin (keratin), which indicates the potential for the fungus to live saprobically (obtaining nutrients from non-living organic matter, commonly dead and decaying plant or animal matter, by absorbing soluble organic compounds) on gartersnake skin in the wild if other components of the ecosystem limit the growth of competing bacteria and oomycetes (a taxonomic group of fungi that produce oospores such as the genera *Pythium, Phytophthora*, and *Aphanomyces*) (Longcore et al. 1999, p. 227). While the genus *Batrachochytrium* has been grown on snakeskin in the laboratory, no reports of the organism on reptilian hosts in the wild have been documented. We anticipate diligence in monitoring the status of incidence of this disease in this species in the wild for early detection purposes should this potential threat come to fruition in wild populations of northern Mexican gartersnakes.

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). However, nonnative species, such as the bullfrog, the northern (virile) (*Orconectes virilis*) and red swamp (*Procambarus clarki*) crayfish, and numerous species of exotic sport and bait fish species continue to be the most prominent threat to the northern Mexican gartersnake and to its prey base from direct predation, competition, and modification of habitat in the United States and potentially in Mexico (Conant 1974, pp. 471, 487–489; 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; 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; Weedman and Young 1997, pp. 1, Appendices B, C; Inman et al. 1998, p. 17; Rinne et al. 1998, pp. 4–6; Fagan et al. 2005, pp. 34, 34–41; Olden and Poff 2005, pp. 82–87; Unmack and Fagan 2004, p. 233; Miller et al. 2005, pp. 60–61; Abarca 2006; Brennan and Holycross 2006, p. 123; Holycross et al. 2006, pp. 13–15; Rosen and Melendez 2006, p. 54).

Nonnative Species Interactions in the United States. Nonnative species represent serious threats to the northern Mexican gartersnake through competition for prey, direct predation, and alteration of habitat. Riparian and aquatic communities have been dramatically impacted by a shift in species' composition. Specifically, riparian and wetland communities have experienced a shift from being historically dominated by native fauna to being increasingly occupied by an expanding assemblage of nonnative plant and animal species that have been intentionally or accidentally introduced, or have colonized new areas from neighboring occupied localities. For example, nonnative shrub species in the genus *Tamarix* 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 demise 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).

Declines in the Northern Mexican Gartersnake Anuran Prey Base in the United States. The decline of the northern Mexican gartersnake within its historical and extant distribution was subsequent to the declines in its prey base (native amphibian and fish populations) from 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, pp. 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). The northern Mexican gartersnake is 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 a hypothesis involving two reasons for the decline in northern Mexican gartersnakes following the loss or decline in the native prey base: (1) The northern Mexican gartersnake 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 will result (Rosen et al. 2001, pp. 10, 13).

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.

Declines in the native leopard frog populations in Arizona have significantly contributed to declines in the northern Mexican gartersnake, as a primary native predator. Scotia Canyon in the Huachuca Mountains of southeastern Arizona is a location where corresponding declines between leopard frog and northern Mexican gartersnake populations has 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 in low numbers 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 stronghold for the northern Mexican gartersnake, the San Bernardino National Wildlife Refuge has also been affected by correlative declines between leopard frog and northern Mexican gartersnake populations (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). Declines of leopard frog populations, often correlated with nonnative species introductions (but also with the spread of chytridiomycosis, symptomatic disease caused by the chytrid fungus, and habitat modification and destruction), has not just occurred throughout southeastern Arizona, but throughout much of the U.S. distribution of the northern Mexican gartersnake based on survey data (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.''

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 in southeastern Arizona. Specifically, the authors identified the expansion of bullfrogs into the Sonoita grasslands (the threshold to the Canelo Hills) and the introduction of crayfish into Lewis Springs as being of particular concern in terms of future recovery efforts for the northern Mexican gartersnake. It should also be noted that Rosen et al. (2001, Appendix I) documented the decline of several native fish species in several locations visited, further affecting the prey base of northern Mexican gartersnakes. 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 ectothermic aquatic and semi-aquatic vertebrate species detected were nonnative. The most commonly encountered nonnative species was the bullfrog (Rosen et al. 1995, p. 254).

Declines in the Northern Mexican Gartersnake Native Fish Prey Base in the United States. Native fish species such as the federally endangered Gila chub, petitioned roundtail chub, and federally endangered Gila topminnow are among the primary prey species for the northern Mexican gartersnake (Rosen and Schwalbe 1988, p. 18). Similar to bullfrogs, predatory nonnative fish species such as largemouth bass also prey upon juvenile northern Mexican gartersnakes. Additionally both nonnative sport and bait 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.

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. These native fish species 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 at risk (85.7 percent, Stein 2002, p. 21).

Fragmentation of extant listed native fish populations is exacerbating the decline of these species and may preclude their recovery as well as continue to affect their role in the prey base of northern Mexican gartersnakes. Fagan et al. (2005, pp. 34–41) examined the correlation between fragmentation of extant distributions and the relative risk of extinction of any given species. They found the strongest correlation to risk of extinction due to fragmentation of fish populations occurred at the intermediate to large spatial scales, which geographically correspond to tributaries and river basins (Fagan et al. 2005, p. 38). At this range in spatial scale, the effects of dam building, water diversions, and introduced nonnatives appear to be significant factors exacerbating the fragmentation by acting as barriers to the exchange of genetic material among listed fish populations (Fagan et al. 2005, pp. 38–39).

Olden and Poff (2005, p. 75) stated that environmental degradation and the proliferation of nonnative fish species threaten the endemic 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 (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; Voeltz 2002, p. 88; Bonar et al. 2004, pp. 1–108).

Several authors have identified both the presence of nonnative fish species 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 influence in the lower reaches where the northern Mexican gartersnake is considered extant. At the Gisela sampling point, four of six sampling attempts resulted in no fish captured; of the 41 fish captured in the remaining two attempts, 90 percent were nonnative, including 28 fathead minnows, 5 green sunfish, 3 red shiner, and 1 yellow bullhead. 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).

A report provided by Bonar et al. (2004, pp. 1–108) is the most current and perhaps one of the most complete assessments of native and nonnative fish species interactions in the Verde River mainstem. Overall, Bonar et al. (2004, p. 57) found that nonnative fishes were approximately 2.6 times more dense per unit volume of river than native fishes, and their standing crop was approximately 2.8 times that of native fishes per unit volume of river. Bonar et al. (2004, p. 79) verified the findings of Voeltz (2002, pp. 71, 88), in stating that red shiner were the most commonly encountered nonnative fish species in the Verde River by almost four-fold; they found the species to be present throughout the Verde River year-around, but noted the highest numbers in the reach between Beasley Flat to Sheep Bridge above Horseshoe Reservoir in riffle habitats. River reaches above Horseshoe Reservoir have resident self-sustaining populations of bass, green sunfish, catfish, and carp, with a low, unstable native fish community, which results in fewer native fish predation observations in sampling results for this reach (Bonar et al. 2004, pp. 80, 87). Reaches below Bartlett Reservoir had both high native and nonnative fish abundance, which resulted in more frequent observations of nonnative predation on native fish according to Bonar et al. (2004, p. 87). Lastly, Bonar et al. (2004, p. 6) found that channel and flathead catfish, green sunfish, largemouth and smallmouth bass, and yellow bullhead had the highest rates of piscivory (fish predation) on native and nonnative fish species in all river reaches; of these species, largemouth bass were documented as the most significant predator on native fish.

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, are predatory on juvenile gartersnakes, and reduce the abundance of or completely eliminate native fish populations. This is particularly important in the wake of a stochastic event such as flooding, extreme water temperatures, or excessive turbidity. Native fish are adapted to the dramatic fluctuations in water conditions and flow regimes and persist in the wake of stochastic events as 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 extant populations. If an area is solely comprised of nonnative fish, the northern Mexican gartersnake may be faced with nutritional stress or starvation. The most conclusive evidence for the northern Mexican gartersnake's intolerance for nonnative fish remains in 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.

Bullfrog Diet and Distribution in the United States. 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 juvenile 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). By 1982, the Arizona Game and Fish Department had systematically introduced some 682,000 bullfrog tadpoles into streams throughout the State (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). 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 conspecifics (other species within the same genus) which can encompass 80 percent of their diet (Casper and Hendricks 2005, p. 543). Bullfrogs have demonstrated astonishing variability in their diet, which has been documented to include vegetation, earthworms, leeches, insects, centipedes, millipedes, spiders, scorpions, crayfish, snails, numerous species of larval and metamorphosed amphibians, fish, small alligators, turtles, lizards, numerous species of snakes [seven genera; including six different species of gartersnakes, two species of rattlesnakes, and Sonoran gophersnakes (*Pituophis catenifer affinis*)], small mammals (e.g., chipmunks, cotton rats, shrews, mice, and voles), numerous species of birds, bats, muskrats, and even juvenile mink (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).

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 documented the presence of bullfrogs through their survey efforts Statewide in specific regional areas, drainages, and disassociated wetlands that include 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); Audubon 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); San Francisco River drainage (Holycross et al. 2006, pp. 49–50, 61); 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 Buenos Aires National Wildlife Refuge. Removal of adult bullfrogs resulted in a substantial increase in younger age-class bullfrogs where removal efforts were the most intensive (Rosen and Schwalbe 1997, p. 6). 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 (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). Consequently, this strategy was viewed as being potentially ''self-defeating'' and ''counter-productive'' but required further investigation (Rosen and Schwalbe 1997, p. 6).

Bullfrog Effects on the Native Anuran Prey Base for the Northern Mexican Gartersnake in the United States. Bullfrog introductions in the United States and Mexico have adversely affected the native leopard frog prey base for northern Mexican gartersnakes (Conant 1974, pp. 471, 487–489; Hayes and Jennings 1986, pp. 491–492; Rosen and Schwalbe 1988, p. 28–30; 2002b, pp. 232–238; Rosen et al. 1995, pp. 257–258; 2001, pp. 2, Appendix I). Different age classes of bullfrogs within a community can affect native ranid populations via different mechanisms. Juvenile bullfrogs may affect native ranids by competition, male bullfrogs may affect native ranids by predation, and female bullfrogs may affect native ranids by 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 microhabitat use, but also suggested that an individual ranid frog species' physical ability to escape influences the effect of bullfrogs on each native ranid community.

Kupferberg (1994, p. 95) found that where bullfrogs were present in California, native anurans were rare or absent. Effects of larval bullfrogs on native ranid frogs have also been described in the literature. Survivorship of larval threatened California red-legged frogs (*Rana aurora*) was 700 percent greater in the absence of bullfrog larvae (Lawler et al. 1999). Bury and Whelan (1986, pp. 9–10) implicated bullfrog introductions in the decline of several native ranid frogs in several States within the western United States including Nevada, California, Montana, Colorado, Oregon, and Washington. Hayes and Jennings (1986, pp. 500–501) conclude that while bullfrog introductions have affected the status of native ranid frogs throughout the western United States, the synergistic effect of other factors, such as habitat alteration and destruction, introduced nonnative fishes, commercial exploitation, toxicants, pathogens and parasites, and acid rain, likely also played significant roles.

Bullfrog Predation on Northern Mexican Gartersnakes in the United States. 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 neonate (newborn) and juvenile age size classes due to bullfrogs preying on young small snakes, which ultimately leads to low recruitment levels (reproduction and survival of young) (Rosen and Schwalbe 1988, p. 18; Holm and Lowe 1995, p. 34).

The tails of gartersnakes are easily broken-off through predation attempts (tails of gartersnakes do not regenerate), which may assist in escaping an individual predation attempt but may also lead to infection or compromise an individual's physical ability to escape future predation attempts or successfully forage. 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. We believe this could be explained by higher basking rates associated with gravid (pregnant) females that increased their visibility to predators and that predation on juvenile snakes generally results in complete consumption of the animal, which would limit observations of tail injury in the juvenile 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) from the once-extant population of northern Mexican gartersnakes on the San Bernardino National Wildlife Refuge where 78 percent of specimens had broken tails with a ''soft and club-like'' terminus, which suggests repeated injury from multiple predation attempts. While palpating (medically examining by touch) gravid female northern Mexican gartersnakes, Rosen and Schwalbe (1988, p. 28) noted bleeding from this region which suggested 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 neonates, 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.

Effects of Crayfish on Northern Mexican Gartersnakes in the United States. Crayfish represent another category of nonnative species threat as they 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). 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 trophic structures (food chains) in riparian and aquatic ecosystems through their effect on vegetative structure, stream substrate 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 herpetofauna including narrow-headed gartersnakes (*Thamnophis rufipunctatus rufipunctatus*), 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 for 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 lotic (free-flowing) and lentic (still water) habitats throughout Arizona, many of which overlapped the historical and extant 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. 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 recently observed at 35 (61 percent) of the 57 sites surveyed across the Mogollon Rim (Holycross et al. 2006, p. 14).

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 included 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); 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).

Bullfrog and Crayfish Eradication in the United States. As previously noted, nonnative species such as bullfrogs and crayfish have proven difficult, if not impossible, to eradicate once established in certain environments. Bullfrogs, for example, are particularly damaging to, and persistent in, riparian communities. A population of adult bullfrogs can sustain itself even when the native vertebrate prey base has been severely reduced or extirpated because adult bullfrogs are cannibalistic and larval bullfrogs can be sustained by grazing on aquatic vegetation (Rosen and Schwalbe 1995, p. 452). Effective removal of semi-aquatic nonnative species is possible in simple, geographically isolated systems that can be manipulated (e.g., stock tanks); however, it can be expensive, and specially designed fencing is likely needed to prevent reinvasion until entire landscapes (e.g., an entire valley) have been cleared of nonnative species (Rosen and Schwalbe 2002a, p. 7; Hyatt undated). No single method is available to effectively remove bullfrogs or crayfish from lotic, or complex inter-connected systems (Rosen and Schwalbe 1996a, pp. 5–8; 2002a, p. 7; Hyatt Undated, pp. 63–71). The inability of land managers to effectively address the invasion of nonnative species in such communities highlights the serious nature of nonnative species invasions. Hyatt (undated, p. 71) concluded that successful eradication of crayfish in Arizona is highly unlikely. While potential threats to physical habitat from human land use activities can usually be lessened or removed completely with adjustments to land management practices, the concern for the apparent irreversibility of nonnative species invasions becomes paramount which leaves us to conclude that nonnative species are the greatest threat to the northern Mexican gartersnake due to the long-term implications.

Nonnative Fish distribution and Community Interactions in the United States. 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; Audubon 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 while surveying for narrow-headed and Mexican gartersnakes 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.

Rinne et al. (1998, p. 3) documented over a dozen species of nonnative fish that have been stocked within the historical distribution of the northern Mexican gartersnake in the Verde Basin with over 850 stocking events occurring in Horseshoe and/or Bartlett reservoirs and almost 4,500 in streams (mostly tributaries to the Verde) over the past 60 years. Rinne et al. (1998, pp. 4–6) found that in all but the uppermost reach, nonnatives predominated the sampling results in the Verde River. Voeltz (2002, p. 88) documented an ''alarming trend'' in the Verde River with the reduction of native fish abundance corresponding with an explosion in red shiner populations.

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, 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. Observations made by Dr. Phil Rosen at Finley Tank on the Audubon Research Ranch near Elgin, Arizona, of northern Mexican gartersnake populations and individual growth trends prior to the arrival of the nonnative bullfrog, provides information on the effects of nonnative fish invasions and the likely nutritional ramifications of a fish-only diet in a species that normally has a varied diet largely supported by amphibian prey items (Rosen et al. 2001, p. 19). The more energy expended in foraging, coupled by the reduced number of small to medium-sized 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 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 fish species also facilitate the invasion of other aquatic nonnative species such as bullfrogs. Adams et al. (2003, pp. 343, 349) found that the invasion of nonnative fish species indirectly facilitates the invasion of bullfrogs. Survivorship of tadpoles is increased when nonnative fish prey upon predatory macroinvertebrates, which reduces the densities of predatory macroinvertebrates and relaxes their predation rate on bullfrog tadpoles. These findings support the ''invasional meltdown'' hypothesis, which suggests that when positive interactions among nonnatives are prevalent, that community of nonnative species can increase the probability of further invasions (Simberloff and Von Holle 1999, p. 21; Adams et al. 2003, pp. 343, 348–350). While mutually facilitative interactions among introduced species have not been thoroughly examined, it has been concluded that nonnatives can and do facilitate the expansion of other nonnative species (Simberloff and Van Holle 1999, p. 21).

Nonnative Species in Mexico. The native fish prey base for northern Mexican gartersnakes has been dramatically affected by the introduction of nonnative species in several regions of Mexico (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 and may still be extant, 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 (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 the outlook for this trend looks ''bleak'' for 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 documented localities, several of which were previously noted in the discussion under Factor A.

Bullfrogs were purposefully introduced nationwide in a concerted effort to establish the species in all lakes and canal systems throughout Mexico as a potential food source for humans although frog legs ultimately never gained popularity in Mexican culinary culture (Conant 1974, pp. 487–489). Rosen and Melendez (2006, p. 54) report bullfrog invasions to be prevalent in northwestern Chihuahua and northeastern Sonora where the northern Mexican gartersnake is thought to occur. In many areas, native leopard frogs were completely displaced (extirpated) where bullfrogs were observed. Rosen and Melendez (2006, p. 54) also demonstrated the relationship between fish and amphibian communities in Sonora and western Chihuahua in that 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 addition to bullfrog invasions, the first record in Mexico for the nonnative Rio Grande leopard frog was recently documented in northwestern Sonora, Mexico where the northern Mexican gartersnake is considered likely extirpated (Rorabaugh and Servoss 2006, p. 102).

Unmack and Fagan (2004, p. 233) compared historical museum collections of nonnative fish species from the Gila River basin in Arizona and the geographically small 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 distribution, diversity, and abundance 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 and/or range reductions of native fish species are expected to occur in the Yaqui Basin of Sonora, Mexico which may have extant populations of northern Mexican gartersnake, as did much of the Gila Basin before the introduction of nonnative species. The implications of these declines in native fish to northern Mexican gartersnakes indicate a potentially serious threat to the gartersnake's persistence in these areas.

However, because specific and direct survey information is significantly limited concerning the presence and potential effect of nonnative species on the northern Mexican gartersnake in Mexico, this discussion is based on extrapolation of how we understand these threats to affect the subspecies in the United States. Furthermore, based on the information available concerning the threats in Mexico we can not conclude that the subspecies is likely to become endangered throughout its range in Mexico. Although we acknowledge that these threats are affecting the subpecies in the United States, we have determined that the portion of the subspecies' range in the United States does not constitute a significant portion of the range of the subspecies or a DPS. Therefore, on the basis of the best available information, we determine that it is not likely that the northern Mexican gartersnake will become an endangered species within the foreseeable future based on threats under this factor.

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, only recommendations are afforded with respect to actions that result in destruction or modification of habitat (NMSA 17–2–41.C and NMAC 19.33.6) (Painter 2005).

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 has subsequently amended Commission Order Number 43, which closed the season on northern Mexican gartersnakes, effective January 2005. Take of northern Mexican gartersnakes is no longer permitted in Arizona without issuance of a scientific collecting permit as per Arizona Administrative 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, only recommendations are afforded with respect to actions that result in destruction or modification of northern Mexican gartersnake habitat.

As previously mentioned, humans encounter gartersnake species somewhat regularly in riparian areas used for recreational purposes or for other reasons. This is partially due to gartersnakes having an active foraging strategy as well as diurnal behavior. Many such encounters 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 would be very difficult for the Arizona Game and Fish Department or the New Mexico Department of Fish and Game to cite lay people (who are not reptile hobbyists or amateur herpetologists in specific pursuit of herpetofauna) for such forms of take. Consequently, while the pursuit and intentional collection of reptiles, including the northern Mexican gartersnake, is regulated by these agencies, unregulated capture, collection, or killing likely occurs regularly.

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. However, there remains the possibility that small, isolated, and/or low-density populations could be negatively affected by the collection of reproductive females (Painter 2000, p. 39; Painter 2005; Holycross 2006).

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.

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.

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 presence of water is a primary habitat constituent for the northern Mexican gartersnake. Public concern over the inadequacy of Arizona surface water laws to ensure that flow is maintained perennial streams was discussed by Arizona Republic columnist Shaun McKinnon (2006b). McKinnon (2006b) 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 (McKinnon 2006b). Furthermore, meaningful changes to these regulations that account for the relative scarcity of surface water are unlikely to come about because Arizona is so ''entrenched in tradition and in property ownership'' and because the threat of litigation over proposed changes precludes such efforts (McKinnon 2006b). McKinnon (2006b) specifically, mentions the Gila, Salt, Verde, Santa Cruz, and San Pedro rivers as having habitat attributes that have directly suffered from inadequate surface water regulations.

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 may opportunistically gather data on the gartersnakes observed incidentally in the field for their records, although it is not required.

Activities that could adversely affect northern Mexican gartersnakes and their habitat continue to occur throughout their extant distribution on U.S. Forest Service 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 accounted for in regulatory compliance mechanisms, such as in section 7 consultation under the Act for other listed species that may co-occur with the northern Mexican gartersnake in an area.

The majority of extant 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.

Riparian communities are complex and recognized as unique in the southwestern United States but are highly sensitive to many anthropogenic 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 and/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.

Throughout Mexico, the Mexican gartersnake is federally 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 time frame, if the factors that impact negatively their viability, cause the deterioration or modification of their habitat or directly diminish directly 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 and/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, 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 recently developed the Method of Evaluation of the Risk of Extinction of the Wild Species in Mexico (MER) which unifies the criteria of decision 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 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, the Mexican gartersnake was placed on the NOM–059 [SEDESOL 1994 (NOM–059–ECOL–1994), p. 46] as a threatened species as determined by a panel of scientific experts. However, we are uncertain of the specific information that was used as the basis for the listing in Mexico and were unable to obtain any information that was used to validate the Federal listing of the Mexican gartersnake in Mexico.

Our review of the existing governmental regulatory mechanisms that pertain to the management of the northern Mexican gartersnake or its habitat in the United States leads us to conclude that the protections afforded by existing regulations may be insufficient to adequately address the declining status of the subspecies in the United States. However, the Mexican gartersnake (inclusive of the northern Mexican gartersnake) is considered a Federally-threatened species in Mexico. Although we do not have sufficient information to analyze the efficacy of existing regulatory mechanisms in Mexico, the best available data does not support the conclusion that the species is likely to become in danger of extinction within the foreseeable future due to the threats posed by the other factors. Therefore, uncertainty with respect to the efficacy of existing regulatory mechanisms is not dispositive as to the listing status of the subspecies, and it is not a threatened species on the basis of the lack of existing regulatory mechanisms.

E. Other Natural or Manmade Factors Affecting Its Continued Existence in the United States

Marcy's checkered gartersnake (*Thamnophis marcianus marcianus*) may have ecological implications in the decline and future conservation of the northern Mexican gartersnake in southern Arizona. 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. Marcy's checkered gartersnake is a potential benefactor of this scenario. As northern Mexican gartersnake numbers decline within a population, space becomes available for occupation by checkered gartersnakes. Marcy's checkered gartersnake subsequently maintains pressure on the carrying capacity (the maximum number of a given species that an area can maintain based upon available resources) for an area and could potentially accelerate the decline of 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 ecological relationship 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.

We were unable to obtain any information on other natural or manmade factors affecting the continued existence of the northern Mexican gartersnake in Mexico.

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 period following our 90-day petition finding and consulted with recognized northern Mexican gartersnake experts and other Federal, State, and Mexican resource agencies. Because specific and direct survey information is significantly limited concerning the presence and potential effect of the threats discussed in this finding to the subspecies in Mexico, much of our discussion is based on extrapolation of how we understand these threats to affect the subspecies in the United States. Furthermore, based on the information available concerning the threats in Mexico we can not conclude that the subspecies is likely to become endangered throughout its range in Mexico. Although we acknowledge that several threats are affecting the subpecies in the United States, we have determined that the portion of the subspecies' range in the United States does not constitute a significant portion of the range of the subspecies or a DPS. On the basis of the best scientific and commercial information available, we determine that it is not likely that the northern Mexican gartersnake is likely to become an endangered species within the foreseeable future and that listing of the northern Mexican gartersnake throughout its range in the United States and Mexico based on its rangewide status is not warranted.

In making this finding, we respectfully acknowledge that the Mexican government has found *Thamnophis eques* to be in danger of disappearance in the short-or medium-term future in their country from the destruction and modification of its habitat and/or from the effects of shrinking population sizes and has therefore listed the species as Threatened, under the listing authority of SEMARNAT (SEDESOL 2001). However, as discussed at length in Factor D above, we also note that the level of information required to list a species in Mexico may not be as rigorous as that required to list a species in the United States under the Endangered Species Act. Our conclusion that listing is not warranted under the Act is based on: (1) The apparent differences in listing protocols; (2) the significantly limited amount of information available on the status of and threats to the northern Mexican gartersnake in Mexico in comparison to our knowledge of the same in the United States; and most importantly (3) the relatively large percentage (70 to 80 percent) of the subspecies' historic distribution in Mexico for which we have little to no information about with respect to status and threats.

In making this Finding, we also recognize there have been 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 locality where northern Mexican gartersnakes have been documented in the United States. As discussed in Factor C above, the documented mechanisms for which nonnative interactions occur 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 (Meffe 1985, pp. 179–185; Rosen and Schwalbe 1988, pp. 28–31; 1995, p. 452; 2002b, pp. 223–227; 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; Rosen et al. 1995, pp. 257–258; 1996, pp. 2, 11–12; 2001, pp. 2, 21–22; Degenhardt et al. 1996, p. 319; Fernandez and Rosen 1996, pp. 21–33; Weedman and Young 1997, pp. 1, Appendices B, C; Inman et al. 1998, p. 17; Rinne et al. 1998, pp. 4–6; Fagan et al. 2005, pp. 38–39; Olden and Poff 2005, pp. 82–87; Holycross et al.2006, pp. 12–15; Brennan and Holycross 2006, p. 123). However, we again note that the portion of the historic distribution of the northern Mexican gartersnake in the United States represents approximately 20 to 30 percent of its rangewide distribution. Furthermore, we were unable to obtain substantial information regarding the status of the northern Mexican gartersnake in Mexico (representing approximately 70 to 80 percent of its rangewide distribution).

Throughout the range of the northern Mexican gartersnake, but most accurately within its distribution in the United States, literature documents the cause and effect relationship of disturbances to the trophic structure (food chain) of 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 extant northern Mexican gartersnake populations and has led to significant fragmentation and risks to the continued viability of extant 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.

We further recognize that in addition to the deleterious effects 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 in Factor A, ''The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range,'' effectively summarize our knowledge of the current and future status of its riparian and aquatic habitat in the United States. Chiefly, these threats include: (1) The modification and loss of ecologically valuable cienegas (Hendrickson and Minckley 1984, p. 161; Stromberg et al. 1996, p. 113); (2) urban and rural development (Medina 1990, p. 351; Girmendock and Young 1997, pp. 45–47; Voeltz 2002, p. 88; Wheeler et al. 2005, pp. 153–154); (3) road construction, use, and maintenance (Rosen and Lowe 1994, pp. 143, 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, p. 19; Shine et al. 2004, pp. 9, 17–19; Andrews and Gibbons 2005, p. 772; Wheeler et al. 2005, pp. 145, 148–149; Roe et al. 2006, pp. 163–166); (4) human population growth (Girmendock and Young 1993, p. 47; American Rivers 2006; Arizona Republic, March 16, 2006); (5) groundwater pumping, surface water diversions, and drought (Abarca and Weedman 1993, p. 2; Girmendock and Young 1993, pp. 45–52; Sullivan and Richardson 1993, pp. 35–42; Stromberg et al. 1996, pp. 124–127; Boulton et al. 1998, pp. 60–62; Rinne et al. 1998, pp. 7–11; Voeltz 2002, p. 88; Philips and Thomas 2005; Webb and Leake 2005, pp. 307–308; American Rivers 2006; Boulton and Hancock 2006, p. 139); (6) improper livestock grazing (Sartz and Tolsted 1974, p. 354; Kauffman and Krueger 1984, pp. 433–434; Szaro et al. 1985, pp. 361–363; Weltz and Wood 1986, p. 367–368; Clary and Webster 1989, pp. 1–3; Clary and Medin 1990, pp. 1–6; Orodho et al. 1990, p. 9; Fleischner 1994; pp. 631–632; Trimble and Mendel 1995, p. 233; Waters 1995, pp. 22–24; Girmendock and Young 1997, p. 47; Pearce et al. 1998, p. 302; Belsky et al. 1999, p. 1; Voeltz 2002, p. 88; Krueper et al. 2003, pp. 607, 613–614); (7) catastrophic wildfire and wildfire in non-fire adapted communities (Rinne and Neary 1996, p. 135; Esque and Schwalbe 2002, pp. 165, 190); and (8) undocumented immigration and international border enforcement and management activities (Segee and Neeley 2006, pp. 5–7; USFWS 2006, pp. 91–105).

In our discussion under Factors A through E above, we have provided a comprehensive, in-depth analysis of all known threats that have or continue to affect the status of the northern Mexican gartersnake in the United States, including those which have not yet been documented but where potential effects exist. As a result of our assessment, we note that certain land use activities such as road construction and use, direct mortality from livestock grazing, undocumented immigration and 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. As noted on several occasions above, in these types of situations where the viability of a known northern Mexican gartersnake population is clearly at risk, the loss of a single reproductive female due to these threats is of concern. However, these types of threats are less significant to the northern Mexican gartersnake when the status of these at-risk populations improves through the implementation of conservation activities. We also remain optimistic that our local, State, and Federal partners in wildlife conservation will be proactive in monitoring populations and implementing conservation measures to ensure that apparent declines of the northern Mexican gartersnake in the United States are reversed and that this species remains a member of our native riparian and aquatic communities. But we do not rely upon any future conservation actions in making this finding.

Notwithstanding our extensive discussion of the past and ongoing threats affecting this species, and the evidence of range contraction within the United States, neither the existence of the threats nor past range contraction means that a species meets the definition of a threatened or endangered species under the Act. Based on our evaluation of the best available data, we conclude that the northern Mexican gartersnake is not likely to become an endangered species in all or a significant portion of its range in the foreseeable future.

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 document is the Arizona Ecological Services Office (see **ADDRESSES** section).

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

Dated: September 14, 2006.

H. Dale Hall,

Director, Fish and Wildlife Service.

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