Lower Colorado River Multi-Species Conservation Program
Steering Committee Members

Federal Participant Group

Bureau of Reclamation
U.S. Fish and Wildlife Service
National Park Service
Bureau of Land Management
Bureau of Indian Affairs
Western Area Power Administration

California Participant Group

California Department of Fish and Wildlife
City of Needles
Coachella Valley Water District
Colorado River Board of California
Bard Water District
Imperial Irrigation District
Los Angeles Department of Water and Power
Palo Verde Irrigation District
San Diego County Water Authority
Southern California Edison Company
Southern California Public Power Authority
The Metropolitan Water District of Southern California

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Arizona Game and Fish Department
Arizona Power Authority
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City of Lake Havasu City
City of Mesa
City of Somerton
City of Yuma
Electrical District No. 3, Pinal County, Arizona
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Mohave Water Conservation District
North Gila Valley Irrigation and Drainage District
Town of Fredonia
Town of Thatcher
Town of Wickenburg
Salt River Project Agricultural Improvement and Power District
Unit “B” Irrigation and Drainage District
Wellton-Mohawk Irrigation and Drainage District
Yuma County Water Users’ Association
Yuma Irrigation District
Yuma Mesa Irrigation and Drainage District

Nevada Participant Group

Colorado River Commission of Nevada
Nevada Department of Wildlife
Southern Nevada Water Authority
Colorado River Commission Power Users
Basic Water Company

Native American Participant Group

Hualapai Tribe
Colorado River Indian Tribes
Chemehuevi Indian Tribe

Conservation Participant Group

Ducks Unlimited
Lower Colorado River RC&D Area, Inc.
The Nature Conservancy

Other Interested Parties Participant Group

QuadState Local Governments Authority
Desert Wildlife Unlimited
Lower Colorado River
Multi-Species Conservation Program

Northern Mexican Gartersnake
(Thamnophis eques megalops)
Species Profile

Prepared by:
Laura (Beth) Sabin, Wildlife Group
**ACRONYMS AND ABBREVIATIONS**

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INTRODUCTION

The northern Mexican gartersnake (*Thamnophis eques megalops*) is a subspecies of the Mexican gartersnake (*Thamnophis eques*). The northern Mexican gartersnake is the only subspecies that occurs in the United States and is listed as a threatened species under the Endangered Species Act of 1973 as amended. In this profile, when information is specific to the subspecies, the name northern Mexican gartersnake will be used. When the information pertains to the whole species, the name Mexican gartersnake will be used.

LEGAL STATUS

In July 2014, the northern Mexican gartersnake was listed as a threatened species under the ESA by the U.S. Fish and Wildlife Service (USFWS) (USFWS 2014). The USFWS also proposed designation of critical habitat for this species in July 2013 (USFWS 2013).

The northern Mexican gartersnake is designated as wildlife of special concern in Arizona, a State endangered species in New Mexico, and a threatened species in Mexico (Arizona Game and Fish Department [AGFD] 2012; New Mexico Department of Game and Fish [NMDGF] 2013). The northern Mexican gartersnake was identified as a species of greatest conservation need in the Comprehensive Wildlife Conservation Strategy for New Mexico (NMDGF 2013).

DISTRIBUTION

Historical Range

The Mexican gartersnake historically occurred from central and southeastern Arizona and southwestern New Mexico south through the highlands of western and southern Mexico to Oaxaca and Veracruz and southward down the Sierra Madre Occidental and the western edge of the Chihuahuan Desert through the southern mountains of the Mexican Plateau around Mexico City (Conant 1963, 2003; Rosen and Schwalbe 1988; Rossman et al. 1996; Smith et al.1950; Stebbins 2003). Isolated populations occurred in central Oaxaca, Sierra Madre del Sur, and Central Nuevo Leon, Mexico (Rosen and Schwalbe 1988; Rossman et al. 1996). The Mexican gartersnake occurred at elevations of 50–2600 meters (175–8500 feet) throughout its range (Rosen and Schwalbe 1988; Stebbins 2003). There are 10 subspecies of the Mexican gartersnake, but only the northern Mexican gartersnake occurs in the United States (Conant 2003).
Northern Mexican Gartersnake (*Thamnophis eques megalops*)
Species Profile

**Subspecies**

*Thamnophis eques megalops*

The northern Mexican gartersnake historically occurred in the United States and Mexico along the Sierra Madre Occidental, in the Chihuahuan Desert, and north of the Mexico Plateau in the States of Arizona, New Mexico, Sonora, Chihuahua, Durango, Guanajuato, Hidalgo, and San Luis Potosí (Conant 1963; Rosen and Schwalbe 1988; Rossman et al. 1996; Smith et al. 1950; Van Devender and Lowe 1977). Its range was from central Arizona and the Gila River in New Mexico southward to the Sierra Madre Occidental to Guanajuato and eastward across the Mexican Plateau to Hidalgo, with an apparently isolated population in central Nuevo Leon (Rossman et al. 1996).

In central Arizona, the northern Mexican gartersnake inhabited the watersheds of Tonto Creek (Gila County), the Verde and Agua Fria Rivers, and Big Bonito Creek (Bradley 1986; Brennan and Holycross 2006; Holycross et al. 2006). In southern Arizona, the northern Mexican gartersnake inhabited the San Bernardino National Wildlife Refuge, the Tucson and Phoenix areas, Cienaga Creek, the Huachuca Mountains, Sonoita Creek Basin and Grasslands, and the watersheds of the San Pedro, lower Colorado, Little Colorado, Bill Williams, Salt, Gila, Rio San Bernardino, Babocomari, and Santa Cruz Rivers (Brennan and Holycross 2006; Cotten et al. 2013; Holm and Lowe 1995; Holycross et al. 2006; Kauffeld 1943; Rosen and Schwalbe 1988; Rosen et al. 2001).

In New Mexico, the northern Mexican gartersnake inhabited the southwestern part of the State, occupying the upper reaches of the Gila River and San Francisco headwater streams (Degenhardt et al. 1996; Holycross et al. 2006; Price 1980, Rosen and Schwalbe 1988). The northern Mexican gartersnake has been documented in Mule, Duck Creek, and the Mimbres River Valley in Grant County and near Virden in Hidalgo County (Degenhardt et al. 1996; Fitzgerald 1986; Holycross et al. 2006; Kauffeld 1943; Rosen and Schwalbe 1988; Rosen et al. 2001).

There was one historical record of northern Mexican gartersnakes in the early 1900s in Nevada along the lower Colorado River (LCR) (De Queiroz and Smith 1996). There are no historical records for California, but they could have occurred on the California side of the LCR (USFWS 2014).

The only place in the United States where the northern Mexican gartersnake was known to be abundant was in Tucson, Arizona, and the surrounding area (Rosen and Schwalbe 1988). Campbell (1934) found them to be one of the most abundant snakes in Santa Cruz County, Arizona. Ortenburger and Ortenburger (1926) found that they were very generally distributed through the Tucson, Arizona, area (Pima County) in the canyons, rocks, and mesquite habitat.
Northern Mexican Gartersnake (*Thamnophis eques megalops*)

Species Profile

**Thamnophis eques eques**
This subspecies historically occurred from southern Nayarit eastward along the Transverse Volcanic Axis to west-central Veracruz, with an apparently isolated population in central Oaxaca in the States of Durango, Zacatecas, Guerrero, Nayarit, Jalisco, Michoacán, Mexico, Distrito Federal, Puebla, Veracruz, and Oaxaca (Conant 2003; Rosen and Schwalbe 1988; Rossman et al. 1996; Smith et al. 1950).

**Thamnophis eques virgatenuis**
This subspecies historically occurred disjunctly above 2200 meters in the Sierra Madre Occidental from southwestern Durango to northwestern Chihuahua and adjacent Sonora in wooded highlands (Conant 1963, 2003; Rosen and Schwalbe 1988; Tanner 1985).

**Thamnophis eques cuitzeoensis**
The holotype for this subspecies was collected east of the southern end of the south-north causeway across the Lago de Cuitzeo, Michoacán, Mexico (Conant 2003).

**Thamnophis eques patzcuaroensis**
The holotype for this subspecies was collected north of the town of Patzcuaro, Michoacán, Mexico (Conant 2003).

**Thamnophis eques insperatus**
The holotype for this subspecies was collected southeast of Zacapu, Michoacán, Mexico (Conant 2003).

**Thamnophis eques obscurus**
The holotype for this subspecies was collected from the town of Chapala, Jalisco, Mexico (Conant 2003).

**Thamnophis eques diluvialis**
The holotype for this subspecies was collected near Villa Corona at the north end of the Laguna de Atotonilco, Jalisco, Mexico (Conant 2003).

**Thamnophis eques scotti**
The holotype for this subspecies was collected near Lago de Magdalena, Jalisco, Mexico (Conant 2003).
Thamnophis eque carmensis
The holotype for this subspecies was collected near El Carmen, Tlaxcala, Mexico (Conant 2003).

Current Range
United States (Northern Mexican Gartersnake)
The only areas within the United States where there are currently viable populations of the northern Mexican gartersnake are: (1) the Page Springs and Bubbling Ponds Fish Hatcheries along Oak Creek, (2) the lower Tonto Creek, (3) the upper Santa Cruz River in the San Rafael Valley, (4) the Bill Williams River, and (5) the upper and middle Verde River (USFWS 2014). Throughout the rest of its historical range, the northern Mexican gartersnake is either extirpated or exists in low numbers that do not comprise viable populations (USFWS 2014).

Rosen and Schwalbe (1988) conducted surveys at 79 locations in Arizona. From 1980 to 1986, the northern Mexican gartersnake was detected at 5 locations in the Agua Fria River, 8 locations in the Verde River, 1 location in Big Bonito Creek, 1 location in the San Bernardino National Wildlife Refuge, 2 locations in the San Pedro River, 1 location in Cienaga Creek, 11 locations in the Sonoita Creek Basin and Grasslands, and 2 locations in the Huachuca Mountains (Rosen and Schwalbe 1988). The northern Mexican gartersnake occurred in the highest densities in the Sonoita Grasslands, Cienaga Creek, at the source of the Santa Cruz River, and it occurred in moderate densities in the Verde River (Rosen and Schwalbe 1988). Between 1995 and 2000, surveys were conducted again at 19 of the locations that were surveyed in the 1980s; major declines were detected at 2 locations, and downward trends were noticed at 14 locations (Rosen et al. 2001).

Holycross et al. (2006) surveyed 33 locations in the Agua Fria, Verde, Salt, and the Upper Gila Rivers. Within the Verde River, the northern Mexican gartersnake was detected in the “North Pond” in the Page Springs Fish Hatchery, in the center pond at Bubbling Ponds Fish Hatchery, and in Dead Horse Ranch State Park (Holycross et al. 2006). Within the Salt River, the northern Mexican gartersnake was detected in Tonto Creek from Gisela to the start of the 2-mile red quartzite box canyon (Holycross et al. 2006). It appears that populations have declined compared to the historical distribution and the distribution in the 1980s (Holycross et al. 2006; Rosen and Schwalbe 1988).

Nowak et al. (2015) detected the northern Mexican gartersnake in Tonto Creek between the present edges of Roosevelt Lake upstream to Bar-X Crossing Road. Emmons and Nowak (2013) detected the northern Mexican gartersnake in the Verde River at Deadhorse Ranch State Park, Oak Creek at Page Springs Cellars, Tavaski Marsh, the Verde River Greenway, and the Salt River Project Verde River property.
Rosen and Schwalbe (1988) estimated that probably no more than 10,000 northern Mexican gartersnakes existed in Arizona at that time. Currently within the United States, the northern Mexican gartersnake occupies only 10% of its historical distribution (USFWS 2014). The northern Mexican gartersnake is likely extirpated from the lower Salt River (Arizona), the lower Santa Cruz River downstream from Nogales (Arizona), Spring Canyon (New Mexico), the Mimbres River (New Mexico), Sycamore Creek (Arizona), and the Tucson and Phoenix areas (Arizona) (Holycross et al. 2006; Lowe 1985; USFWS 2014). In many other areas of its historic range, the northern Mexican gartersnake exists in small, fragmented, non-viable populations (USFWS 2014).

Since the 1990s, the population of the northern Mexican gartersnake had declined to the point of possible extirpation in New Mexico; three individuals were detected along the Gila River in Grant County on June 2013 by personnel from Albuquerque Bio Park (City of Albuquerque 2013; Holycross et al. 2006). This was the first observation of the northern Mexican gartersnake in New Mexico in 30 years; since juveniles were present, it was confirmed as a breeding population (City of Albuquerque 2013; NMDGF 2013). However, not enough information about this population is known to call it viable (NMDGF 2013; USFWS 2014).

Mexico (Mexican Gartersnake)
The current distribution of the Mexican gartersnake in Mexico is poorly documented (as summarized from multiple sources in USFWS 2014). Available information suggests local reductions in distribution and range, but the reductions have not been as severe as the reductions of this species in the United States (as summarized from multiple sources in USFWS 2014). Lemos-Espinal (2013, personal communication) thought that the number and magnitude of threats are not equal across the species’ range in Mexico (as quoted in USFWS 2014). Lemos-Espinal (2013, personal communication) observed that the Mexican gartersnake was quite common in the States of Sonora and Chihuahua (as quoted in USFWS 2014).

Populations Within the Lower Colorado Multi-Species Conservation Program Planning Area
On April 29, 2015, staff of the Lower Colorado River Multi-Species Conservation Program (LCR MSCP) were notified by the Great Basin Bird Observatory that they may have sighted a northern Mexican gartersnake at Beal Lake Conservation Area in the Havasu National Wildlife Refuge in Arizona (NAD 83 UTM 725850 E and 3851100 N) during riparian bird monitoring (Fletcher 2015, personal communication). The AGFD, USFWS, and U.S. Geological Survey were notified, and five photographs were provided for identification. A gartersnake was observed on May 4, 2015, in the same area (NAD 83 UTM 0725829 E, 3851076 N), and two additional photographs
Northern Mexican Gartersnake (*Thamnophis eques megalops*)
Species Profile

were taken for identification (Fletcher 2015, personal communication). Lesley Fitzpatrick notified staff of the LCR MSCP on June 1, 2015, that the snake species was confirmed as a northern Mexican gartersnake by Taylor Cotten and Tom Jones of the AGFD and Jeff Servoss of the USFWS (Fitzpatrick 2015, personal communication). The individual observed on both dates was missing part of its tail, which could mean that the same individual was observed on both dates (Fletcher 2015, personal communication).

The USFWS previously considered the northern Mexican gartersnake to be extirpated from the LCR (USFWS 2014). This was based on current fisheries management policies, the abundance of non-native predatory species, and the lack of recent records or reliable observations of the species (USFWS 2014). Due to the observations in the Havasu National Wildlife Refuge, the species is now considered an extant species on the LCR.

There are four other records (museum specimens) of the northern Mexican gartersnake within the LCR MSCP program area; two in Yuma County, Arizona, in 1890 and 1889; one in Clark County, Nevada, at “Lake Opposite Ft. Mohave, Arizona” in 1911; and one in Mohave County, Arizona, in 1904 (De Queiroz and Smith 1996; Holycross et al. 2006; Rosen and Schwalbe 1988).

Surveys for toads, frogs, lizards, and snakes were conducted at 147 localities within the LCR MSCP planning area during the spring and fall of 1973 from north of Davis Dam south to the International Boundary (Vitt and Ohmart 1978). Surveys of the herptofauna adjacent to Lake Mead and Needles, California, were conducted in 1931 and 1932 (Klauber 1932). No northern Mexican gartersnakes were detected on either of these surveys. In the late 1900s and earlier 20th century, various naturalists were in the vicinity of the LCR MSCP planning area describing the flora and fauna, and no northern Mexican gartersnakes were ever described except for the records and observations already mentioned (Cooper 1869; Cowles and Bogert 1936; Gloyd 1937; Van Denburgh 1912; Van Denburgh and Slevin 1913).

Ohmart et al. (1988) mentioned historical records of the northern Mexican gartersnake from Blythe, California, to Yuma, Arizona, and one near Fort Mohave, Arizona. Rosen and Schwalbe (1988) suspected this species was historically abundant along the LCR. However, there have only been four documented historic localities and one recent locality within the LCR MSCP planning area as mentioned above. The historical and current abundance of the northern Mexican gartersnake along the LCR is unknown. The LCR MSCP planning area is on the western edge of the northern Mexican gartersnake’s historical range (Holycross et al. 2006; Rosen and Schwalbe 1988).
The last large-scale surveys of reptiles and amphibians occurred along the LCR in 1973 (Vitt and Ohmart 1978). There have been no known targeted surveys conducted for the northern Mexican gartersnake within the LCR MSCP planning area or along the Bill Williams River.

The AGFD conducted surveys for the Colorado River toad (Incilius alvarius) and the lowland leopard frog (Lithobates yavapaiensis) within the LCR MSCP planning area from south of Davis Dam to the International Boundary and the Bill Williams River from east of Planet Ranch west to the confluence with Lake Havasu from 2011–13 (Cotten 2011; Cotten and Grandmaison 2013; Cotten and Leavitt 2015). Lentic and lotic backwaters and desert washes that appeared to provide suitable habitat for the toad and frog were surveyed using funnel traps arrays, visual surveys, nocturnal audio surveys, and eDNA (Cotten 2011; Cotten and Grandmaison 2013; Cotten and Leavitt 2015). Ten northern Mexican gartersnakes were captured in funnel traps along the Bill Williams River on Bureau of Land Management land upstream of Planet Ranch in 2012 (Cotten 2011; Cotten and Grandmaison 2013; Cotten and Leavitt 2015). Breeding populations of the lowland leopard frog and Colorado River toad were detected along the Bill Williams River upstream of and within Planet Ranch in 2011 and 2012 (Cotten 2011; Cotten and Grandmaison 2013; Cotten and Leavitt 2015). Two lowland leopard frogs were detected downstream from Planet Ranch in the Bill Williams River National Wildlife Refuge in 2013(Cotten and Leavitt 2015).

There is a probability that the northern Mexican gartersnake could be farther west at the Bill Williams River National Wildlife Refuge (Cotten 2013, personal communication). The northern Mexican gartersnake has been observed on Planet Ranch property (Cotten 2013, personal communication). The northern Mexican gartersnake can be secretive and difficult to detect, especially if present in low densities (Cotten 2013, personal communication; Emmons and Nowak 2013). The surveys from 2011–13 were targeted for the Colorado River toad and lowland leopard frog, not the northern Mexican gartersnake as methods, trap placement, location, and timing would be different depending upon the targeted species (Cotten 2013, personal communication).

Habitat for the northern Mexican gartersnake, native frog, and toad species along the main stem of the LCR is poor, containing aquatic areas that are often overrun with non-native plant species and containing an abundance of American bullfrogs (Lithobates catesbeiana), northern crayfish (Orconectes virilis), and non-native predatory fish species (Clarkson and Devos 1986; Cotten 2011; Cotten and Grandmaison 2013).

Potential prey along the main stem of the LCR are the Woodhouse’s toad (Anaxyrus woodhousii), Rio Grande leopard frogs (Lithobates berlandieri), Great Plains toad (Anaxyrus cognatus), Pacific tree frog (Hylla regilla), invertebrates, lizards, and small mammals (Cotten 2011; Cotten and Grandmaison 2013; Rorabaugh et al. 2004). Rorabaugh et al. (2004) detected Pacific tree frogs from
Northern Mexican Gartersnake (*Thamnophis eques megalops*)

Species Profile

Davis Dam to upper Lake Havasu. Potential prey along the Bill Williams River is the Arizona toad (*Anaxyrus microschaphus*), red-spotted toad (*Anaxyrus punctatus*), Colorado River toad, lowland leopard frog, roundtail chub (*Gila intermedia*), longfin dace (*Agosia chrysogaster*), invertebrates, lizards, and small mammals (Cotten 2011; Cotten and Grandmaison 2013).

**Critical Habitat**

The USFWS has proposed 14 units of critical habitat for the northern Mexican gartersnake within Arizona and New Mexico in the following areas: (1) upper Gila River (21,135 acres), (2) Mule Creek (2,579 acres), (3) Bill Williams River (5,412 acres), (4) Agua Fria River subbasin (7,946 acres), (5) upper Salt River subbasin (22,218 acres), (6) Tonto Creek (8,936 acres), (7) Verde River subbasin (29,191 acres), (8) upper Santa Cruz River subbasin (113,895 acres), (9) Redrock Canyon (1,972 acres), (10) Buenos Aires National Wildlife Refuge (117,313 acres), (11) Cienega Creek subbasin (50,393 acres), (12) San Pedro River subbasin (23,690 acres), (13) Babocomari River subbasin (14,334 acres), and (14) the San Bernardino National Wildlife Refuge (2,387 acres) (USFWS 2013).

The proposed critical habitat unit along the Bill Williams River encompasses 36 stream miles and includes the area from the Bill Williams River and the Lake Havasu Confluence upstream to Alamo Lake Dam (USFWS 2013). This critical habitat unit has records of the northern Mexican gartersnake from after 1980, is within the current range of the species, has populations of leopard frogs, contains adequate aquatic and terrestrial habitat, and is devoid of the American bullfrog (USFWS 2013).

**LIFE HISTORY**

**General Description**

The Mexican gartersnake is a member of the family Colubridae and subfamily Natricinae (Lawson et al. 2005; Pyron et al. 2013). The Mexican gartersnake averages between 45 centimeters (18 inches) to 101 centimeters (40 inches) in total length and can reach lengths up to 112 centimeters (44 inches) (Brennan and Holycross 2006; Degenhardt et al. 1996; Rosen and Schwalbe 1988; Stebbins 2003). The coloration of the Mexican gartersnake is rust or olive-brown with a creamy yellow mid-dorsal stripe (Brennan and Holycross 2006; Degenhardt et al. 1996; Rosen and Schwalbe 1988; Stebbins 2003). Margins of the mid-dorsal stripe are often delineated by thin black lines (Brennan and Holycross 2006). The two yellow to light tan lateral stripes are on the third and fourth scale rows on the anterior part of the body, and the second and third rows are on the posterior part of the body (Brennan and Holycross 2006; Degenhardt et al 1996; Rosen and
Schwalbe 1988; Wallace 2002). Black blotches appear between the stripes formed by small black dash marks (Brennan and Holycross 2006; Rosen and Schwalbe 1988; Stebbins 2003). Neck blotches are sometimes present but diffuse (Brennan and Holycross 2006). There may be a white or green crescent behind each corner of the mouth (Degenhardt et al. 1996; Rosen and Schwalbe 1988; Stebbins 2003). The venter is grey, often with a bluish/greenish tinge and two blackish stripes formed by the black spots on each scale (Brennan and Holycross 2006; Rosen and Schwalbe 1988). There are eight to nine barred upper labials with interlabial sutures marked with black, the dorsal scales are light in coloration and keeled in 19 or 21 rows at mid-body, and the anal plate is single (Conant 1963; Degenhardt et al. 1996; Rosen and Schwalbe 1988; Stebbins 2003). Females are larger than males (Degenhardt et al. 1996; Manjarrez 1998; Tanner 1985).

The Mexican gartersnake is often confused with the black-necked (*Thamnophis cyrtopsis*) and the checkered gartersnake (*Thamnophis marcianus*) and can be distinguished by the scale rows and lateral stripes that fall across on the anterior part of the body and occur on the fourth scale row (Brennan and Holycross 2006; Degenhardt et al. 1996; Rosen and Schwalbe 1988; Stebbins 2003; Wallace 2002). In the Mexican gartersnake there is a considerable amount of variation in the amount of dark pigment that invades the mid-dorsal stripe and the width of the stripe (Conant 1963). To distinguish between subspecies, one should be aware of the presence or absence of a pale longitudinal mid-dorsal strip; its width; and its edges, whether strong or weak; whether it has black edging; and whether the ventral crosslines are conspicuous (Conant 2003).

Ten subspecies of the Mexican gartersnake are recognized (Conant 2003; Kennicott 1860). Seven of the subspecies were described by Conant (2003) in the 1960s based on morphological differences in coloration and pattern; highly restricted home ranges; and their occurrence in the isolated wetland habitats in the mountainous Transvolcanic Belt region of southern Mexico (Conant 2003). However, significant lineages for the seven subspecies described by Conant (2003) have not been validated by genetic variation (NatureServe 2013).

**Subspecies**

*Thamnophis eques megalops*

This subspecies (northern Mexican gartersnake) was described by Robert Kennicott in 1860 and is distinguished from *Thamnophis eques eques* solely on the basis of averaging differences in subcaudal numbers (Conant 2003; Rossman et al. 1996).
Northern Mexican Gartersnake (*Thamnophis eques megalops*)
Species Profile

**Thamnophis eques eques**
Albert Reuss (1834) described the subspecies as Coluber eques (as quoted in Conant 2003). Early misapplication of the name was corrected in Smith (1951). This subspecies is distinguished from *Thamnophis eques megalops* solely on the basis of averaging differences in sub caudal numbers (Conant 2003; Rossman et al. 1996).

**Thamnophis eques virgatenuis**
This subspecies was described by Roger Conant in 1963 and is distinguished by its dark color and exceptionally narrow mid-dorsal stripe (Conant 1963).

**Thamnophis eques cuitzeoensis**
This subspecies was described by Roger Conant in 1964 and is characterized by its uniform and intense black pigmentation (Conant 2003). The dorsum and venter is dark gray to black, with the exception of the chin, throat, and tail, which are white or cream-colored (Conant 2003). The anal plate may be light, dark, or partly both (Conant 2003).

**Thamnophis eques patzcuaroensis**
This subspecies was described by Roger Conant in 1964 and is characterized by a yellowish color on the underside of the head and tail and dark lines cross the anterior edge of each ventral (Conant 2003). They have a striped and spotted appearance and have a mid-dorsal stripe and two lateral stripes – between each of the stripes are two rows of dark spots (Conant 2003).

**Thamnophis eques insperatus**
This subspecies was described by Roger Conant in 1961 and is characterized by its checkerboard appearance, with lateral spots black and alternated with pale grayish areas (Conant 2003). The ventrals are black anteriorly and gray posteriorly (Conant 2003).

**Thamnophis eques obscurus**
This subspecies was described by Roger Conant in 1961 and is characterized by the lack of pale longitudinal dorsal stripes (Conant 2003).

**Thamnophis eques diluvialis**
This subspecies was described by Roger Conant in 1964 and is characterized by conspicuous stripes, with the mid-dorsal stripe being a full three scales wide (Conant 2003).
**Thamnophis eques scotti**
This subspecies was described by Roger Conant in 1965 (Conant 2003).

**Thamnophis eques carmensis**
This subspecies was described by Roger Conant in 1965 and is characterized by a narrow, pale mid-dorsal stripe (Conant 2003).

**Diet**

The diet of the Mexican gartersnake consists of frogs, toads, tadpoles, fish, salamanders (*Ambystoma* spp.), invertebrates, and occasionally lizards and small mammals (Brennan and Holycross 2006; Conant 2003; Drummond and Macias-Garcia 1989; Manjarrez 1998; Van Devender and Lowe 1977; Wallace 2002).

Conant (2003) found that the Mexican gartersnake consumed the following species of native fish in Mexico: bulldog goodeid (*Allophorus robustus*), mesa silverside (*Chirostoma jordani*), blackfin goodeid (*Goodea atripinnis*), jeweled splitfin (*Xenotoca variata*), Skiffia spp., whitefish (*Chirostoma estor*), green goodeid (*Goodea luitpoldi*), barred splitfin (*Chapalichthys encaustus*), goldfish (*Carassius auratus*), and lerma livebear (*Poeciliopsis infans*). Conant (2003) found the Mexican gartersnake consumed adults and tadpoles of the showy leopard frog (*Rana spectabilis*), the plateau tiger salamander (*Ambystoma velasci*), and other species of salamanders (Conant 2003). Drummond and Macias-Garcia (1989) found that the Mexican gartersnake consumed the spiny lizard (*Sceloporus torquatas*) and the Rio Grande leopard frog. Venegas-Barrera and Manjaress (2001) detected a Mexican gartersnake feeding on a Mexican alpine blotched gartersnake (*Thamnophis scalaris*).

In a population in Hildago, Mexico, the Mexican gartersnake primarily consumed earthworms (*Eisenia* spp.), leeches (*Erpobdella punctata* and *Mooreobdella* spp.), and goldfish (Macias-Garcia and Drummond 1988). Individuals also consumed a small amount of Rio Grande adult and tadpole leopard frogs, tiger salamander larvae (*Ambystoma tigrinum*), slugs (*Gastropoda*), and the Jalapan pine vole (*Microtus quasiatet*) (Macias-Garcia and Drummond 1988). Large snakes consumed aquatic vertebrates (fishes, frogs, and salamander larvae), small snakes consumed earthworms, and both small and large snakes consumed leeches (Macias-Garcia and Drummond 1988).

Northern Mexican gartersnakes in Arizona and New Mexico have been found feeding primarily upon leopard frogs (*Lithobates chiricahuensis* and *Lithobates yavapaiensis*), the woodhouse toad, tree frogs (*Hyla* spp.), Gila (*Gila robusta*) and roundtail chubs, earthworms, and other small fish such as the Gila topminnow (*Poeciliopsis occidentalis*), desert pupfish (*Cyprinodon macularius*),
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*Poeciliopsis* spp., and longfin dace (Holm and Lowe 1995; Rosen and Schwalbe 1988). Lemos-Espinal (2013, personal communication) thought that salamanders may be an important food source for northern Mexican gartersnakes in northern Mexico (as quoted in USFWS 2014). Campbell (1934) found one northern Mexican gartersnake consuming a red-spotted toad and a canyon tree frog (*Hyla arenicolor*). Van Devender and Lowe (1977) found individuals feeding on the western spadefoot toad (*Scaphiopus hammondii*) and the northern leopard frog (*Rana pipiens*). D’Orgeix et al. (2013) found individuals feeding on the Mexican spadefoot toad (*Spea multiplicata*) at ephemeral ponds in Arizona in July. The northern Mexican gartersnake will probably consume any native amphibian that is available (Cotten 2015, personal communication).

The northern Mexican gartersnake has been known to consume tadpoles of the American bullfrog, green sunfish (*Lepomis cyanellus*), bluegill (*Lepomis macrochirus*), and other non-native soft-rayed fish such as mosquito fish (*Gambusia affinis*), largemouth bass (*Micropterus salmoides*), and red shiner (*Cyprinella lutrensis*) (Emmons and Nowak 2013; Holm and Lowe 1996; Nowak et al. 2015). Emmons and Nowak (2013) and Nowak et al. (2015) found that individuals partially regurgitated the food source when attempting to eat non-native species.

Occasionally, northern Mexican gartersnakes will consume salamanders, lizards and small mammals; documented prey has been lizards (*Sceloporus* and *Aspidoscelis* spp.), tiger salamanders, and deer mice (*Peromyscus* spp.) (Holm and Lowe 1995; Rosen and Schwalbe 1988). In Arizona, the northern Mexican gartersnake was found primarily where native anurans and prey fish were available (Rosen and Schwalbe 1988). Rosen and Schwalbe (1988) found that native prey species seemed to be more important to the northern Mexican gartersnake than the other species of striped gartersnakes in Arizona. In Mexico, the capture rate of the northern Mexican gartersnake decreased with the decrease of lake levels and available prey (Macias-Garcia and Drummond 1988).

Populations of the Mexican gartersnake may be locally specialized on two to three prey items (Drummond and Macias-Garcia 1989). Drummond and Macias-Garcia (1989) found that in a population in the northern Mexican Plateau, numbers crashed when adult leopard frog populations declined even though tadpoles were present in sufficient numbers, suggesting individuals of that population could not switch from a terrestrial/aquatic foraging style to an entirely aquatic foraging strategy (Drummond and Macias-Garcia 1989).

In the Mexican Plateau, juveniles of the Mexican gartersnake in some populations preyed exclusively on a species of aquatic leech (*Erpobdella punctate*); this species does not pose any harm to the snakes (Drummond and Macias-Garcia 1995). *Haementeria officinalis* is a harmful species of leech that co-occurs with *Erpobdella punctate*; juvenile snakes do not appear to discriminate...
between the two leeches at first but show enhanced discrimination after multiple attempts of trying to ingest *Haementeria officinalis* (Drummond and Macias-Garcia 1995).

There was not a difference in the size of leeches ingested between juveniles and adults, showing that large snakes could handle and capture the smaller prey items (Macias-Garcia and Drummond 1988). However, Drummond and Macias-Garcia (1989) found that snake length and the length of consumed frog were positively correlated. While Mexican gartersnakes have the ability to capture smaller prey, they may prefer larger prey.

Northern Mexican gartersnakes may be more sensitive to lower resource levels than other semiaquatic snakes, as they must feed regularly and heavily to maintain health and gain weight (Rosen et al. 2001). They are also less likely to increase foraging efforts when prey density is low due to increased predation risk (Rosen et al. 2001).

**Habitat**

The Mexican gartersnake is found near permanent water sources and dense vegetation in the Sonoran Desert, thorn scrub, tropical deciduous forests, pinyon-juniper woodlands, riparian areas, marsh areas, mesquite (*Prosopis* spp.), grasslands, oak (*Quercus* spp.) and pine (*Pinus* spp.) areas, and highlands at low to middle elevations (40–2,590 meters; 131–8500 feet) (Brennan and Holycross 2006; NMDGF 2013; Rorabaugh 2008; Rossman et al. 1996; Stebbins 2003; Wallace 2002). It inhabits cienegas, cienega streams, streams, backwaters, lakes, springs, seeps, pools, rivers, riparian woodlands, springs, and ponds with thick bank vegetation (Brennan and Holycross 2006; Degenhardt et al. 1996; Holycross et al. 2006; Rorabaugh 2008; Rosen and Schwalbe 1988; Wallace 2002). They also will occupy artificial sources such as stock tanks, impoundments, and water canals (Conant 2003; Degenhardt et al. 1996; Woodin 1950). The Mexican gartersnake may occupy areas where moist conditions or semipermanent water sources are present (Cotten 2015, personal communication; Degenhardt et al. 1996). It will use rocky or stony areas near water to hide or bask (Conant 2003).

In Arizona, Rosen and Schwalbe (1988) detected the northern Mexican gartersnake in source area wetlands, lowland river riparian forests, woodlands, and upland stream gallery forests.

The wetland sources the northern Mexican gartersnake occupies are cienegas, cienega-streams, and stock tanks in central Arizona (Rosen and Schwalbe 1988). In these areas, it most often uses aquatic vegetation of knot grass (*Paspalum distichum*), spikerush (*Eleocharis* spp.), bulrush (*Scirpus* spp.), and cattail (*Typha* spp.); bank vegetation of deer grass (*Muhlenbergia* spp.) and sacaton...
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(Sporobolus spp.); and riparian trees of Fremont cottonwood (*Populus fremontii*), Goodding’s willow (*Salix gooddingii*), and velvet mesquite (*Prosopis velutina*) (Rosen and Schwalbe 1988). The northern Mexican gartersnake is not necessarily abundant in this type of habitat, but it is widespread throughout central Arizona (Rosen and Schwalbe 1988).

The northern Mexican gartersnake occupies the lowland river riparian woodlands and forests consisting of Fremont cottonwood, willow (*Salix* spp.), seep willow (*Baccharis salicifolis*), mesquite, and a variety of grasses and annual plants, including introduced Bermuda grass (*Cynadon dactylon*) (Rosen and Schwalbe 1988). Individuals use the shallow waters, banks, and riparian habitat along the main stem of the rivers (Rosen and Schwalbe 1988). Nowak et al. (2011) detected the northern Mexican gartersnake at Tavaski Marsh in the Verde Valley in an area of upland weedy forbs, swampy marsh edges, cottonwood/willow trees, cattail/tule marsh (*Schoenoplectus* spp.), and young mesquite.

The northern Mexican gartersnake occupies higher elevation streams that consist of riparian deciduous forests and mixed broadleaf woodlands (Rosen and Schwalbe 1988). However, it is rare in these areas, known to have occurred only in the Sycamore Canyon Wilderness Area, Oak Creek, Big Bonito Creek, and the Gila River in New Mexico (Rosen and Schwalbe 1988).

The northern Mexican gartersnake in New Mexico has been detected around shallow stock tanks and ponds with abundant shore side vegetation (Degenhardt et al. 1996). There have been a few individuals detected along the Gila River and its tributaries (Degenhardt et al. 1996).

In Mexico, the Mexican gartersnake occupies cienegas, streams, lakes, ponds, volcanic lakes, and cattle tanks (Conant 2003; Degenhardt et al. 1996; Rorabaugh 2008). Manjarrez et al. (unpublished data) detected a dense population of the Mexican gartersnake in a flat grassy meadow covered with dense grass and abundant flat rocks surrounded by willows and an ephemeral water source (as quoted in Degenhardt et al. 1996). Rossman (personal observation) has detected the Mexican gartersnake around shallow meadow ponds, streamside vegetation, and cactus and thornbush communities around ponds (as quoted in Rossman et al. 1996).

In Arizona, Schwalbe and Rosen (1988) found that the most important habitat characteristics for the northern Mexican gartersnake were permanent water, dense bank vegetation, and an abundance of prey species. It is found in areas with protected backwaters, braided side channels, beaver ponds, isolated pools near the main stem of the river, edges of dense emergent vegetation, dried up channels, ample downed and vegetative cover, debris dams, and flooded areas (Emmons and Nowak 2013; Servoss et al. 2007). Emmons and Nowak (2013) conducted telemetry on one adult and found it occupied areas that contained dense
emergent vegetation associated with edges of open water channels and pools ranging from 1–2 meters (3.3–6.6 feet) in depth. Nowak et al. (2011) thought that open shallow water adjacent to dense emergent and/or submergent vegetation may be important for breeding activities. Holm and Lowe (1995) caught 83% of juvenile northern gartersnakes in shallow water and 78% of larger individuals in deeper water. The presence of small-diameter trees provides additional habitat complexity, thermoregulatory opportunities, and cover for the northern Mexican gartersnake (USFWS 2014).

The Mexican gartersnake will brumate in steep hills, riverbanks, upland burrows, and cliffs adjacent to riparian areas near permanent water sources (Nowak et al. 2011). Individuals will use small mammal burrows, middens, debris piles, flood debris drifts, riprap, and rock piles as hibernacula (Cotten 2015, personal communication). One telemetered individual was detected using rodent burrows associated with a mesquite bosque and thick grass as a hibernation area (Emmons and Nowak 2013). During the active season, the northern Mexican gartersnake will use any area that provides cover as sheltering areas such as herbaceous vegetation, dense brush, emergent vegetation, holes, root crevices, clusters, and manmade objects (Cotten 2015, personal communication).

The Mexican gartersnake usually stays within 15 meters (50 feet) of a permanent water source but will move farther away on occasion (Rosen and Schwalbe 1988). It has been observed over 100 meters (328 feet) away from the water foraging on land, moving to other water sources, or hibernating (Cotten 2015, personal communication; Drummond and Macias-Garcia 1989; Nowak et al. 2011; Rosen and Schwalbe 1988). Cotten (2015, personal communication) has detected small populations in the absence of perennial water. D’Orgeix et al. (2013) detected individuals at an ephemeral pond in Arizona used by the Mexican spadefoot toad. Holm and Lowe (1995) detected the northern Mexican gartersnake at ephemeral ponds used by the mountain tree frog (Hyla eximia). Gloyd (1937) detected an individual 2 miles away from water under a creosote bush. Conant (2003) and D’Orgeix et al. (2013) thought the Mexican gartersnake may be capable of estivating during the dry periods when water is not available.

The majority of information on habitat preferences of the northern Mexican gartersnake comes from studies that are observational in nature. There have been little robust quantitative habitat studies conducted on the northern Mexican gartersnake. Emmons and Nowak (2013) are currently conducting a study to learn more about the demographics and habitat use of this species in populations that exist in central Arizona.
Draft U.S. Fish and Wildlife Service Primary Constituent Elements

1. Aquatic or riparian habitat that includes perennial or spatially intermittent streams of low to moderate gradient with a flow stream that allows periodic flooding and contains pools and backwaters (USFWS 2013). Lentic wetlands such as livestock tanks, springs, and ciénegas (USFWS 2013). Shoreline habitat that allows for thermoregulation, gestation, shelter, cover, and foraging opportunities, such as boulders, rocks, downed trees and logs, debris jams, leaf litter, and small mammal burrows (USFWS 2013). Aquatic areas that have salinities less than 5 parts per thousand, a pH greater than or equal to 5.6, and a minimal levels of pollutants (USFWS 2013).

2. Terrestrial habitat extending at least 200 meters from a water source that supports, gestation, immigration, emigration, and brumation (extended inactivity) (USFWS 2013).

3. A prey base of viable populations of native amphibians and fish (USFWS 2013).

4. An absence or low levels of non-native fish species of the families Centrarchidae and Ictaluridae, bullfrogs, and crayfish (USFWS 2013).

Breeding

The Mexican gartersnake female gives birth to live young from mid-May through early July or August (Brennan and Holycross 2006; Nowak 2015, personal communication; Rosen and Schwalbe 1988; Stebbins 2003; Wallace 2002). Mating and ovulation occurs in late March through May (Rosen and Schwalbe 1988). Rosen and Schwalbe (1988) found that within populations of the northern Mexican gartersnake, follicular enlargement and high levels of activity were present in the fall, suggesting a fall mating period in which sperm is stored in the females until spring ovulation. Boyarski (2012, personal communication) thought that more research was needed to confirm this hypothesis (as quoted in USFWS 2014). Rosen and Schwalbe (1988) found that the exact time of breeding events vary with elevation. Manjarrez (1998) found that the numbers of births were positively correlated with temperature in a population of Mexican gartersnakes in Mexico.

The female Mexican gartersnake can have up to 25 young during 1 breeding season (Wallace 2002; Woodin 1950). The size and mass of the litter is positively correlated with the length of the female (Manjarrez 1998; Rosen and Schwalbe 1988). Rosen and Schwalbe (1988) studied clutch size for 8 female northern Mexican gartersnakes in Arizona in which clutch size ranged from 8 to 26 young,
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with an average size of 13.6. Nowak and Boyarski (2012) observed a clutch size of 38 young at the Bubbling Ponds Fish Hatchery in Arizona. Manjarrez (1998) estimated the average clutch size to be 11 snakes per litter, ranging from 6 to 17 at a population of Mexican gartersnakes in Mexico. Rosen and Schwalbe (1988) found in Arizona populations of the northern Mexican gartersnake that only one-half the sexually mature females of the population bore young in one year.

Macias-Garcia and Drummond (1988) found that peak birth rates in a population of Mexican gartersnakes in Hildago, Mexico, coincided with the availability of earthworms and leeches. Earthworms and leeches were the primary prey of juveniles in that population (Macias-Garcia and Drummond 1988). Boyarski (2012, personal communication) felt that more research was needed to further validate that birth rates coincide with the availability of prey for juvenile and adult Mexican gartersnakes (as quoted in USFWS 2014).

The female northern Mexican gartersnake bears young in warm micro-environments 5 to 15 meters (17–50 feet) from the water using rock walls, the ground, and sun-warmed sacaton tussocks (Rosen and Schwalbe 1988). The female basks on grass tussocks or rocks during gestation (Rossman et al. 1996). In a lake in Mexico, several pregnant females were observed sunning, with the posterior of their body exposed, probably warming the developing young (Conant 2003).

Demography and Populations

The male Mexican gartersnake matures at 2 years of age (Degenhardt et al. 1996; Rosen and Schwalbe 1988). Females begin reproducing at 2 to 3 years of age and when they reach a total length of 530 to 700 millimeters (21–28 inches) (Degenhardt et al. 1996; Rosen and Schwalbe 1988). In a population in Arizona, individual northern Mexican gartersnakes reached 410 millimeters (16 inches) at 12 months, males reached 550 to 650 millimeters (22–26 inches) at 15 months and then grew slowly, and females begin to reproduce at 550–700 millimeters (22–28 inches) and then continued substantial growth, reaching a larger size than males (Rosen and Schwalbe 1988). In populations in Arizona where the habitat and prey base was poor, juveniles seemed to grow more slowly (Rosen and Schwalbe 1988). Rosen et al. (2001) found that reproduction and growth rates declined when individuals were forced to forage more often for smaller prey because more energy was allocated to intense foraging than to growth and reproduction (Rosen et al. 2001; USFWS 2014).

In Arizona, larger populations of the northern Mexican gartersnake were dominated by yearlings and young adults, and the smaller populations were dominated by older individuals (Rosen and Schwalbe 1988). Low survivorship
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of neonates and yearlings may be a reason for population declines (Holm and Lowe 1995; Rosen and Schwalbe 1988). There is no information on the longevity of the Mexican gartersnake.

Behavior

The Mexican gartersnake is considered a terrestrial aquatic generalist (Drummond and Macias-Garcia 1989). It is active during the warmer months of the year, being the most active from June to September (Degenhardt et al. 1996; Emmons and Nowak 2013; Manjarrez 1998). The Mexican gartersnake hibernates from mid-October to early March (Emmons and Nowak 2013). Active season body temperatures for the Mexican gartersnake range from 22 to 33 degrees Celsius (°C), with an average of 27.3 °C (Conant 2003; Rosen 1991). Holm and Lowe (1995) found that the Mexican gartersnake was active from 14.8–27.8 °C air temperature, 19.0–31.5 °C temperature, and 22.1–22.5 °C water temperature. The Mexican gartersnake is active diurnally and nocturnally and forage when prey is available (Center for Biological Diversity 2003; Holm and Lowe 1995).

Gartersnakes tend to compensate for low temperature environments by intensifying thermoregulation (Rosen 1991). The Mexican gartersnake has been observed basking on reeds, stones, vegetation mats, the ground, logs, and rocks (Conant 2003; Holm and Lowe 1995; Rosen 1991; Servoss et al. 2007). The Mexican gartersnake exhibits lower body temperatures than other species of gartersnake probably due to the habitat they occupy and their tendency to hide in dense vegetation (Rosen 1991).

Rosen (1991) found that the northern Mexican gartersnake spent approximately 60% of the time moving, 13% of the time basking on vegetation, 18% of the time basking on the ground, and 9% of the time under surface cover. Boyarski and Young (2013, personal communication) found that at the Bubbling Ponds Fish Hatchery, telemetered individuals were documented under cover at least 64% of the time and surface active 16% of the time (as quoted in USFWS 2014).

Young and Boyarski (2012a) preliminary data from the population at the Bubbling Ponds Fish Hatchery show that home ranges of the northern Mexican gartersnake vary from 0.7 to 4.2 hectares (1.7 to 10.4 acres), with a mean home range size of 2.51 hectares (6.2 acres) (as quoted in USFWS 2014). Emmons (2014, personal communication) found that along the Verde River, individuals will travel up to 0.6 kilometer (4 miles) a day (as quoted in USFWS 2014). Emmons and Nowak (2013) conducted radio telemetry on one individual and
The northern Mexican gartersnake (Thamnophis eques megalops) found it moved 300 meters to a marsh, remained within the marsh 50 to 100 meters from the shore, and then moved 120 meters to a rodent burrow for hibernation; the individual made several underground movements once in the burrow.

The Mexican gartersnake uses visual and chemical stimuli to detect prey (Drummond and Macias-Garcia 1989). It forages along watercourses and seeks shelter in the thick streamside vegetation (Degenhardt et al. 1996). The Mexican gartersnake primarily forages by using lateral undulation movements combined with resting postures, with the head protruding from the water and the tongue flicking (Drummond and Macias-Garcia 1989). It primarily forages along the shoreline of the water source but occasionally dives in water, forages on the surface of water, and forages on land (Drummond and Macias-Garcia 1989; Holm and Lowe 1995; Macias-Garcia and Drummond 1988).

The Mexican gartersnake was observed demonstrating a wide variety of foraging methods, including ambushing prey in water and on land; active foraging in riffles, vegetation mats, grass and open water; and feeding in areas where there are temporary concentrations of prey (Rosen and Schwalbe 1988). Individuals have been observed hanging from holes between the rocks with their head in the water and catching fish as they swam by and by floating in the water in a looped position, wiggling their tails to catch fish (Conant 2003).

The Mexican gartersnake will flatten its head and body and strike repeatedly when threatened (Degenhardt et al. 1996; Woodin 1950). When handled, it will bite and release a foul-smelling musk from glands located at the base of the tail (Degenhardt et al. 1996). Like other snakes, Mexican gartersnakes have been found upside down with their tails curled and moving, probably to distract attention from the head when in the presence of a predator (Conant 2003). When frightened and near water, the Mexican gartersnake has been known to quickly swim away (Ruthven 1907).

The northern Mexican gartersnake coexists with other species of gartersnakes at certain localities (Rosen and Schwalbe 1988; Tanner 1959). Emmons (2014, personal communication) found that during a cold season, the Mexican gartersnake may use more than one hibernation site and bask occasionally (USFWS 2014).

The Mexican gartersnake can be difficult to detect due to its cryptic and secretive nature; the ability to quickly escape underwater, and the ability to persist in low population densities (USFWS 2014).
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**SAMPLING METHODS**

Methods used to detect and capture northern Mexican gartersnakes have consisted of visual encounter surveys, Gee™ minnow traps, and coverboards (Emmons and Nowak 2013; Holycross et al. 2006). Visual encounter surveys consist of one or more persons walking or wading for at least 1 hour across suitable habitat, overturning boards, rocks, and other cover; survey efforts are described in person-hours (Emmons and Nowak 2013). Minnow traps used are 44.5 centimeters (18 inches) long by 23 centimeters (9 inches) in diameter and contain galvanized steel wire mesh with an inward pointing funnel (Emmons and Nowak 2013; Holycross et al. 2006). They are often partially submerged and covered with grass, leaves, algae, and other plant matter (Holycross et al. 2006). The survey effort is estimated in trap-hours (Emmons and Nowak 2013; Holycross et al. 2006). The coverboards used are typically 60 x 122 centimeters and 2 centimeters (24 x 48 x 0.8 inches) in thickness. The survey effort is described in person-hours (Emmons and Nowak 2013). The northern Mexican gartersnake can be secretive and hard to detect when in low densities and/or dense, structurally complex habitat (Emmons and Nowak 2013; Nowak et al. 2011). Minnow traps appear to be the most successful technique for detecting northern Mexican gartersnakes (Emmons and Nowak 2013).

**THREATS**

The Mexican gartersnake has declined throughout its range due to habitat alteration, habitat loss, dewatering, sedimentation, poor water clarity, reduction in streamside vegetation, non-native species replacing native species, disease, and pollution of streams, wetlands, and riparian areas (AGFD 2012; as summarized from multiple sources in Holycross et al. 2006; Lowe 1985; as summarized from multiple sources in USFWS 2014; Rosen et al. 2001; Wallace 2002). These factors have been caused by water diversions, flood control projects, groundwater pumping, urban pollution, agricultural development, cattle grazing, and the introduction of invasive plant species (Lowe 1985; as summarized from multiple sources in USFWS 2014). Cattle grazing within Mexican gartersnake habitat eliminates the dense cover that is one of the most important habitat characteristics to this species (Rosen and Schwalbe 1988; as summarized from multiple sources in USFWS 2014). Isolated populations in areas of limited habitat are the most vulnerable to impacts from grazing (Rosen and Schwalbe 1988). Increased sedimentation of water sources can lead to the decline or elimination of non-native fish; a reduction of water visibility, which negatively affects the foraging ability of the Mexican gartersnake; and the filling in of intermittent pools required for amphibian reproduction and foraging (as summarized from multiple sources in USFWS 2014). As populations and suitable habitat become more fragmented, re-population of historical habitat is less likely (USFWS 2014).
The introduction of exotic species such as non-native American bullfrogs, northern crayfish, and non-native spiny-rayed fish, which prey on the Mexican gartersnake, have also caused populations to decline (Holycross et al. 2006; NMDGF 2013; Paroz et al. 2009; Rosen et al. 2001; as summarized from multiple sources in USFWS 2014; Rosen and Schwalbe 1988; Wallace 2002).

Habitat loss and non-native species have caused the native fish and frog populations to decline (Brennan and Holycross 2006; Clarkson and Rorabaugh 1989; Hayes and Jennings 1986; Rosen et al. 2001; Wallace 2002). Native fish and frogs are the main food source for the Mexican gartersnake, so the decline of these species has further contributed to the decline of Mexican gartersnake populations (Holm and Lowe 1995; Rosen and Schwalbe 1988; Rosen et al. 2001; as summarized from multiple sources in USFWS 2014; Wallace 2002). Matthews et al. (2002) studied the mountain gartersnake (*Thamnophis elegans elegans*) in the high-elevation Sierra Nevada and indicated a strong relationship between the presence of native amphibians and the mountain gartersnake. Results from the study found that where dramatic amphibian declines have occurred because of introduced trout, populations of the mountain gartersnake were no longer present (Matthews et al. 2002). Jennings et al. (1992) found that native amphibian declines will lead directly to mountain gartersnake declines. Holycross et al. (2006) and Rosen et al. (2001) documented the decline of native amphibians and fish in historical northern Mexican gartersnake habitat in Arizona and New Mexico.

The northern crayfish also has an impact on the Mexican gartersnake by predation on native leopard frogs and native fish species, direct predation on the Mexican gartersnake, and altering habitat by decreasing aquatic and semiaquatic vegetation and increasing erosion (Carpenter 2005; as summarized from multiple sources in USFWS 2014). Crayfish are widespread throughout Arizona in areas that overlap the historical range of the northern Mexican gartersnake and are probably distributed along the entire border region of northern Mexico (Holycross et al. 2006; as summarized from multiple sources in USFWS 2014).

The American bullfrog is a major threat to the Mexican gartersnake (Holm and Lowe 1995; Rosen and Schwalbe 1988; as summarized from multiple sources in USFWS 2014). Individuals are abundant in most southwest riparian areas within the United States and are widespread throughout Mexico; they occupy the same habitat as the Mexican gartersnake (Holycross et al. 2006; Rosen and Schwalbe 1988; as summarized from multiple sources in USFWS 2014). The American bullfrog preys on the juvenile Mexican gartersnake, which greatly impacts juvenile recruitment, and injures the adults (Holm and Lowe 1995; Rosen and Schwalbe 1988; Rosen et al. 2001; as summarized from multiple sources in USFWS 2014). Control programs for the American bullfrog in Mexican gartersnake occupied habitat are successful in increasing juvenile recruitment of
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the Mexican gartersnake, but the control efforts must be ongoing and include egg mass, tadpole, and adult removal, or the American bullfrogs comes back, and juvenile recruitment declines (Rosen et al. 2001).

Non-native predatory fish in the families Centrarchidae and Ictaluridae have the same impact on Mexican gartersnake populations that the American bullfrog has; they consume the same prey items as the Mexican gartersnake, consume the young snakes, and injure the adult snakes (Rosen and Schwalbe 1988; as summarized from multiple sources in USFWS 2014). Non-native predatory fish that prey on the Mexican gartersnake include green sunfish, common carp (*Cyprinus carpio*), largemouth bass, smallmouth bass (*Micropterus dolomieu*), black crappie (*Pomoxis nigromaculatus*), northern pike (*Esox Lucius*), channel catfish (*Ictalurus punctatus*), yellow bullhead (*Amelius natalis*), black bullhead (*Amelius melas*), and rock bass (*Ambloplites rupestris*) (Emmons and Nowak 2013; Nowak et al. 2011; Nowak et al. 2015; Rosen and Schwalbe 1988; Young and Boyarski 2013).

Holycross et al. (2006) surveyed 57 sites for the northern Mexican gartersnake and the narrow-headed gartersnake in southern Arizona, and 33% of the sites contained only bullfrogs, 15% of the sites contained only native leopard frogs, and 5% of the sites contained the American bullfrog and native leopard frogs. Sixty-one percent of the sites were inhabited by crayfish, 33% of the sites contained only non-native fish, 8% of the sites contained only native fish, and both native and non-native fish were detected at 39% of the sites (Holycross et al. 2006). The northern Mexican gartersnake was the most rare where the American bullfrog was the most abundant (Rosen and Schwalbe 1988).

Other potential predators of the northern Mexican gartersnake include the coachwhip (*Masticophis flagellum*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), common black hawk (*Buteo jamaicensis*), zone-tailed hawk (*Buteo albonotatus*), belted kingfisher (*Megaceryle alcyon*), owl species (*Strigidae, Tytonidae*), great blue heron (*Ardea herodias*), green heron (*Butorides virescens*), little blue heron (*Egretta caerulea*), black-crowned night heron (*Nycticorax nycticorax*), American white pelican (*Pelecanus erythrorhynchos*), snowy egret (*Egretta thula*), great egret (*Ardea alba*), cattle egret (*Bubulcus ibis*), common merganser (*Mergus merganser*), belted kingfisher (*Megaceryle alcyon*), river otter (*Lontra canadensis*), raccoon (*Procyon lotor*), skunk species (*Mephitis* spp.), coyote (*Canis latrans*), fox (*Vulpes vulpes*), bobcat (*Lynx rufus*), king snake species (*Lampropeltis* spp.), whipsnake (*Masticophis* spp.), regal ring-necked snake species (*Diadophis punctatus regalis*), and spiny softshell turtle (*Apalone spinifera*) (Brennan and Holycross 2006; Holycross et al. 2006; Rosen and Schwalbe 1988, Nowak et al. 2015). Individuals in smaller populations appear to be more susceptible to predation than individuals in larger populations (Nowak et al. 2011; Rosen and Schwalbe 1988).
The northern Mexican gartersnake has attempted to consume the non-native Chinese mystery snail (*Cipangopaludina chinensis*) at the Bubbling Ponds Fish Hatchery, which may have an adverse effect on survival (Young and Boyarski 2012b). The northern Mexican gartersnake also has attempted to eat juvenile non-native fish species and larval and juvenile bullfrogs; this may have adverse effects on the individual (Emmons and Nowak 2013).

The Mexican gartersnake faces competitive pressure from the checkered gartersnake, as they occupy the same ecological niche (Rosen and Schwalbe 1988; Rosen et al. 2001). The checkered gartersnake tends to out-compete the Mexican gartersnake because it is less susceptible to predation by the American bullfrog (Rosen and Schwalbe 1988; Rosen et al. 2001).

Eleven species of helminth parasites have been detected on the Mexican gartersnake – three Digeneans, one Cestode, one Acanthocephalan, and six Nematodes (Guzman 2008; Jimenez-Ruiz et al. 2002; Perez-Ponce De Leon et al. 2001). Two species of trematodes have been detected on the Mexican gartersnake (La Rue 1917). These parasites may cause mortality in wild populations (La Rue 1917; Perez-Ponce De Leon et al. 2001). Nowak et al. (2014) observed maternal transmission of parasites at the Bubbling Ponds Fish Hatchery in Arizona. A snake fungal disease has emerged in the mid-western and eastern United States; there is no evidence that this disease has affected the Mexican gartersnake (as summarized from multiple sources in USFWS 2014).

The tail of the Mexican gartersnake breaks easily if attacked by a predator but does not grow back (Holm and Lowe 1995; USFWS 2014). Female gartersnakes seem to have a higher frequency of broken tails than males, and adult gartersnakes seem to have a higher frequency of broken tails than juveniles (Fitch 2003). Tail loss in gartersnakes when attacked is often a strategy for escaping mortality (Fitch 2003). However, tail injuries can have a negative effect on the health, longevity, and overall success of the Mexican gartersnake due to infection, slower movement, or lower reproductive potential (as summarized from multiple sources in USFWS 2014).

Mercury, other heavy metals, and other environmental contaminants present in soil, water, and air could bioaccumulate through the food chain and affect the Mexican gartersnake (as summarized from multiple sources in USFWS 2014).

**Activities Within the LCR MSCP Planning Area that Could Affect the Northern Mexican Gartersnake**

The intentional and unintentional release or spread of non-native species, particularly non-native fish, crayfish, and the American bullfrog, has a great
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impact upon native northern Mexican gartersnake populations and their prey species and constitutes the most significant threat (as summarized from multiple sources in USFWS 2014).

Rotenone is a common piscicide (fish poison) used in aquatic areas of the Southwest and along the LCR to remove non-native fish species. Piscicides are a vital tool in removing non-native fish species, subsequently contributing to the recovery of the northern Mexican gartersnake (as summarized from multiple sources in USFWS 2014). If the time period between the application of the piscicide and the restocking of native fish is too long, populations of the northern Mexican gartersnake will be affected by the reduced prey (USFWS 2014). Piscicides also affect the tadpoles of native amphibian species that are a prey species for the northern Mexican gartersnake (as summarized from multiple sources in USFWS 2014). The AGFD’s internal environmental assessment checklist addresses considerations for non-target aquatic reptiles (USFWS 2014).

Electroshocking equipment and trapping are used in fisheries monitoring, management, and research in aquatic areas of the Southwest and along the LCR. Electroshocking is not considered a substantial threat to the northern Mexican gartersnake (USFWS 2014); however, not much research has been done on the topic (USFWS 2014). Minnow traps fully submerged in water that are set to capture aquatic species may accidentally capture, trap, and drown the northern Mexican gartersnake (as summarized from multiple sources in USFWS 2014). Minnow traps are also used for recreational fishing in Arizona and New Mexico (as summarized from multiple sources in USFWS 2014). The northern Mexican gartersnake can also be accidentally captured, trapped, and drowned in underwater funnel traps designed to capture leopard frogs (as summarized from multiple sources in USFWS 2014).

Dewatering or water fluctuation techniques are often used in management of aquatic areas of the Southwest and along the LCR. Dewatering of an aquatic area in occupied habitat would have tremendous effects on populations of northern Mexican gartersnakes by eliminating the prey base and removing a permanent water source (USFWS 2014). Hatchery operations and renovations in occupied northern Mexican gartersnake habitat could have an impact on the populations that inhabit the hatcheries (as summarized from multiple sources in USFWS 2014).

Removal or elimination of important habitat features, such as permanent water sources; dense herbaceous vegetation, including non-native grasses; emergent and submergent aquatic vegetation; riparian trees and shrubs; rock piles and rocky areas; debris piles; downed trees; beaver ponds; areas of shallow water; backwaters; braided side channels; and isolated pools will have a negative effect on the northern Mexican gartersnake (as summarized from multiple sources in USFWS 2014).
High human activity associated with recreation can have an impact on the northern Mexican gartersnake (as summarized from multiple sources in USFWS 2014). It can result in trampling of dense vegetation near water sources, increased probability of fire, and more direct encounters between humans and the northern Mexican gartersnake (Rosen and Schwalbe 1998; as summarized from multiple sources in USFWS 2014). High-intensity wildfires can lead to excessive sedimentation and ash flows in water sources (as summarized from multiple sources in USFWS 2014). Vehicle traffic on roads could pose a threat to northern Mexican gartersnakes, as they could be intentionally or unintentionally run over (Rosen and Schwalbe 1988; as summarized from multiple sources in USFWS 2014). Boyarski (2011) reported that several northern Mexican gartersnake mortalities occurred at the Bubbling Ponds Fish Hatchery when individuals were run over by vehicles (as quoted in USFWS 2014).

Activities associated with maintenance of infrastructure within occupied habitat, such as road maintenance, vehicle traffic, brush and fuel management, canal and drain maintenance, bank line and levee maintenance, facility maintenance, backwater maintenance, construction of additional infrastructure, and other ground-disturbing activities, could have an effect on the northern Mexican gartersnake by removing habitat, directly injuring or killing individuals, and increasing sedimentation in water sources (Bureau of Reclamation 2004a, 2004b). The northern Mexican gartersnake could possibly inhabit the emergent vegetation adjacent to canals. Activities associated with the LCR MSCP within occupied habitat including removing and creating habitat could have an effect on the northern Mexican gartersnake by directly injuring or killing individuals or temporarily removing sheltering, foraging, and wintering habitat (Bureau of Reclamation 2004b).

Net-like mesh, stitching, or other entanglement hazards used in practices such as erosion or sediment control (mulch control netting, erosion control blankets, fiber rolls, silt fences, and turf reinforcement mats), fish research and monitoring (trammel nets and fish seins), and recreational or commercial fishing (discarded fishing nets or seins and seining for baitfish) can kill or injure the Mexican gartersnake (as summarized from multiple sources in USFWS 2014). Two adult Mexican gartersnakes were found dead on the edge of a canal leading to a pumping station in the municipality of Chapala, Jalisco, Mexico, trapped in abandoned, lost, or otherwise discarded fishing gear (Barragan-Ramirez and Ascencio-Arrayga 2013).

**CONSERVATION AND MANAGEMENT**

The AGFD and NMDGF have developed conservation and mitigation programs for the northern Mexican gartersnake (as summarized from multiple sources in USFWS 2014). Captive propagation has been experimented with and has had
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limited success (as summarized from multiple sources in USFWS 2014). The following actions will assist in the conservation of the northern Mexican gartersnake: (1) propagation and restocking of northern Mexican gartersnake populations, (2) removal of non-native fish and bullfrogs within currently occupied and potential habitat, (3) prevention of the transport of non-native aquatic species, (4) restoration of natural streamflow, (5) protection and restoration of currently occupied and potential habitat, (6) reduction of overgrazing, (7) restoration and conservation of populations of native prey species, (8) prevention of the spread of non-native aquatic species, (9) creating education materials to reduce the deliberate or unintentional killing of northern Mexican gartersnakes, (10) better management of live bait collection, (11) the quick restocking of native species to chemically renovated aquatic areas, and (12) removing or preventing the buildup of excessive sediment (AGFD 2012; Holycross et al. 2006; NMDGF 2013; Paroz et al. 2009; Rosen et al. 2001; as summarized from multiple sources in USFWS 2014).

To assist in the conservation of this species in the United States: (1) determine intraspecific phylogeny to facilitate conservation of evolutionary significant units and to provide information for translocation efforts if they occur; (2) increase efforts to accurately determine population size, distribution, and habitat use within the United States and Mexico; (3) determine the effect of prey type and abundance on Mexican gartersnake fecundity, and (4) determine the ability of the Mexican gartersnake to persist in pure natural habitat of various types despite the presence of non-native species (Holycross et al. 2006; Rosen et al. 2001).
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