Appendix A

Current Population Status of Northern Mexican and Narrow-headed Gartersnakes in the United States

Northern Mexican Gartersnake

Upper Gila River Subbasin (Arizona and New Mexico)

Gila River Mainstem—A single historical record for the northern Mexican gartersnake in the Gila River mainstem dates from 1973 in the vicinity of Virden, New Mexico (Fitzgerald 1986, Table 2). Another specimen was discovered and photo-vouchered in August 2002, in a debris pile along the Gila River off Highway 180 in Grant County, New Mexico (Hill 2007, pers. comm.). Subsequent searches for northern Mexican gartersnakes of unknown effort were conducted in the same vicinity in 2006 and 2007, but no individuals were observed (Hill 2007, pers. comm.). Christman and Jennings (2009; p. 3) invested a total of 258 person-search hours and 13,464 trap-hours in 2009 surveying for narrow-headed gartersnakes in two locations along the uppermost reaches of Gila River mainstem and did not detect any northern Mexican gartersnakes. An additional forty person-search hours of narrow-headed gartersnake surveys from 2009–2011 failed to detect any northern Mexican gartersnakes in the upper reaches (Hellekson 2012a, pers. comm.). We are not aware of any reports of leopard frogs from this drainage in recent times but three species of native fish may provide a source of prey for northern Mexican gartersnakes. Nonnative species, including spiny-rayed fish, crayfish, and bullfrogs, occur in various densities along the Gila River (Probst *et al.* 2008, Table 3; Hellekson 2012a, pers. comm.). In particular, channel catfish, flathead catfish, and smallmouth bass were found by Propst *et al.* (1986, pp. 14–31), Springer (1995, pp. 6–10), Jakle (1995, pp. 5–7), and Propst *et al.* (2009, pp. 14–17). The upper reaches of the Gila River supported relatively high densities and diversity of native fish species during the late 1980's through the early 1990s but have since declined in both parameters, most notably in the downstream direction (Paroz *et al.* 2006, pp. 57–58, 65–66). The Gila River is a lengthy stretch of potential habitat for the northern Mexican gartersnake; such large complex systems make it difficult to fully ascertain the status of such a rare and secretive species. Northern Mexican gartersnakes may still occur in the Gila River mainstem in New Mexico as a very low density population where physically suitable habitat occurs along its course.

Spring Canyon—A single historical record for the northern Mexican gartersnake in Spring Canyon dates from 1937 in the vicinity of "Santa Rita" and suggests that historically, habitat and prey species may have been suitable for northern Mexican gartersnakes in Spring Canyon (Fitzgerald 1986, Table 2). We are not aware of any survey efforts for the northern Mexican gartersnake in this drainage in modern times. Harmful nonnative species are widely distributed and locally abundant in many areas of the subbasin and we conclude that the northern Mexican gartersnake is not likely extant in Spring Canyon.

San Francisco River Subbasin (Arizona and New Mexico)

Mule Creek—The northern Mexican gartersnake was historically well known from Mule Creek with records dating from 1977 at the New Mexico State Highway 78 crossing and 1983 at the junction of New Mexico State Highway 78 and U.S. Highway 180 (Fitzgerald 1986, Table 2). Since the mid-1980s, the only substantial survey effort conducted for the northern Mexican gartersnake in the Mule Creek area was a two-year study which began in 2011 (Hotle 2012, pers. comm.). The 2011 survey effort consisted of 224 person-search hours, 494 trap-hours, and the

use of 43 cover boards (survey method utilizing plywood as artificial cover to attract and capture snakes), but no northern Mexican gartersnakes were found as a result of those efforts (Hotle 2012, pers. comm.). Bullfrogs are present in the Mule Creek area, but the drainage has a wholly native fish community and no crayfish (Hotle 2012, pers. comm.; Hellekson 2012a, pers. comm.). We are not aware of any reports of leopard frogs from this drainage in recent times. The history of northern Mexican gartersnake captures from Mule Creek, the native fish community, and absence of crayfish indicate that northern Mexican gartersnakes may still occur in Mule Creek at very low densities where suitable habitat exists. A former robust population in New Mexico, this population has undoubtedly declined over the past several decades.

Mimbres River Subbasin (New Mexico)

Mimbres River—Two historical records for the northern Mexican gartersnake in the Mimbres River are undated, but referenced in Fitzgerald (1986, Table 2) from "Rio Mimbres" and the "Mimbres River Valley, near Swartz Post Office." We presume these records predate the 1980s as no such location exists for Swartz, New Mexico on modern maps. We are not aware of any more recent survey efforts for the northern Mexican gartersnake in this drainage, but GIS analysis indicates that native fish occur in the Mimbres River and Chiricahua leopard frogs might also. We suspect, given the wide distribution of harmful nonnative species in the southwestern United States, that crayfish, bullfrogs, or nonnative, spiny-rayed fish may also occur in the Mimbres River. Although we are not aware of any physical barriers to movement, this drainage is not connected to occupied northern Mexican gartersnake habitat, and we have no reason to suspect the northern Mexican gartersnake is extant in the Mimbres River.

Colorado River Subbasin (Arizona)

Lower Colorado River—Historical records for northern Mexican gartersnakes from the lower Colorado River include two from the Yuma area dated 1889 and 1890 and from near "Fort Mohave" in Mohave County in 1904 which is the most-upstream record along the river (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, Appendix A). We aware of no surveys specifically conducted for northern Mexican gartersnakes along the lower Colorado River in modern history, largely because they have been considered as likely extirpated there for decades due to significant habitat alteration, channelization, and the introduction of harmful nonnative species (Vitt and Ohmart 1978, pp. 35, 67; Ohmart *et al.* 1988, pp. 147–148, Table 47; Rosen and Schwalbe 1988, p. 25). However, Vitt and Ohmart (1978, p. 37) conducted a general reptile and amphibian inventory along the lower Colorado River that consisted of visual searches on foot and by vehicle and found no northern Mexican gartersnakes; no trapping was performed. Bullfrogs are considered abundant throughout the lower Colorado River which likely led to the suspected extirpation of native leopard frogs that were once widespread there (Vitt and Ohmart 1978, p. 44; Clarkson and DeVos 1986, pp. 43–45, 48; Ohmart *et al.* 1988, p. 143). Crayfish are also abundant along the lower Colorado River (Ohmart *et al.* 1988, p. 150; Inman *et al.* 1998, Appendix B) and are commonly found in the stomachs of bullfrogs (Clarkson and DeVos 1986, p. 45). Forty-four species of nonnative fish are known from the Colorado River in high abundance and native fish species have declined precipitously (Ohmart *et al.* 1988, p. 97; Hendrickson and Varela-Romero 1989, p. 481; Minckley *et al.* 2003, Table 1). While there is the potential for northern Mexican gartersnakes to immigrate to the lower Colorado River from

occupied northern Mexican gartersnake habitat in the Bill Williams River, fisheries management policies, the abundance of harmful nonnative species, and significant habitat alteration along the lower Colorado River would likely prohibit the reestablishment of northern Mexican gartersnakes in the lower Colorado River and we consider them extirpated there, where they likely have been for many decades.

Bill Williams River—There are no historical records of northern Mexican gartersnakes from the Bill Williams River according to our files. Jones (2012a, pers. comm.) reported and verified the first record (Cotton *et al*. 2013, p. 111) for the northern Mexican gartersnake in the Bill Williams River Subbasin, an adult female incidentally captured and killed on June 3, 2012, in a funnel trap as part of a lowland leopard frog monitoring project. Nine more individuals were subsequently reported from the same area in 2012 (Jones 2012c, pers. comm.). We are aware of no targeted surveys for northern Mexican gartersnakes that have occurred in this system. K. Blair (2012, pers. comm.) provided a cumulative list of fish species known to occur in the Bill Williams River that includes many species of native and nonnative fishes. Our knowledge of the aquatic community in Bill Williams River suggests that it once supported an almost wholly native fish community that collapsed due to the increased presence of nonnative fish after the construction of the Alamo Lake Dam, which stabilized flows and provided an advantage to nonnative species. Crayfish are known as abundant in the Bill Williams River and nonnative, spiny-rayed fish predominate currently, but bullfrogs curiously appear to be absent. Lowland leopard frogs are present in various densities and likely serve as the primary prey species for northern Mexican gartersnakes in the Bill Williams River. As of 2008, Anderson and Shafroth (2012, p. 333) estimated that 92 beaver dams were present on the river, adding that an estimated 3–4 percent of the river is converted from lotic (flowing water) to lentic (still water) habitat annually when significant flooding does not occur. The creation of pool habitat from beaver dam activity, combined with the existing dense cover found in the riparian corridor, and abundant backwaters along the Bill Williams River, likely benefits the northern Mexican gartersnake by providing excellent foraging conditions and protective cover from nonnative predation. However, beaver dams also provide suitable habitat for several species of nonnative, spiny-rayed fish and crayfish. The 2012 records document the northern Mexican gartersnake as extant in the Bill Williams River.

Agua Fria River Subbasin (Arizona)

Agua Fria River—Several historical records from the 1980s document the northern Mexican gartersnake occurring in the Agua Fria River, from its tributaries above Cordes Junction to approximately Table Mesa Road, which is approximately 40 river miles (65 km) downstream (Holycross *et al.* 2006, p. 66, Appendix A). The last sightings of northern Mexican gartersnakes from the Agua Fria River occurred in the mid-1980s (Holycross *et al.* 2006; pp. 15–18, 66). Surveys for the northern Mexican gartersnake at four locations in 2004 and 2005, totaling 265 person-search hours and 21,672 trap-hours at 11 sites, failed to detect any northern Mexican gartersnakes. Bullfrogs, crayfish, and nonnative, spiny-rayed fish currently dominate portions of the Agua Fria River (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 16–18). Lowland leopard frogs are known to persist in scattered fashion within this subbasin and may be a vital source of prey for northern Mexican gartersnakes. Juvenile or larval bullfrogs as well as nonnative, soft-rayed fish species may also serve as alternate prey sources for adult gartersnakes.

The northern Mexican gartersnake may still occur in the Agua Fria River at very low population densities and may be associated with lowland leopard frog populations.

Little Ash Creek—There are no museum records of the northern Mexican gartersnake from Little Ash Creek, but a specimen was reported found in this stream in 1984 and was retained as a captive (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, p. 19). A 2004 survey for the northern Mexican gartersnake, totaling 19 person-search hours and 768 trap-hours, failed to detect any northern Mexican gartersnakes. In 2012, Emmons and Nowak (2012b, p. 10) spent 7-person search hours and 100 trap nights in Little Ash Creek surveying for northern Mexican gartersnakes and other riparian herpetofauna. Northern Mexican gartersnakes were not detected in that effort, but the presence of abundant bankside vegetation in areas, presence of a robust nonnative, soft-rayed fish population (potential prey items), and previous records led the authors to suspect the species remains present (Emmons and Nowak 2012b, p. 32). Bullfrogs, crayfish, and nonnative, spiny-rayed fish are currently thought to dominate this stream (Holycross *et al.* 2006, p. 20; Emmons and Nowak 2012b, p. 25). GIS analysis indicates that lowland leopard frogs and potentially two native fish species may occur within Little Creek and may provide prey for the northern Mexican gartersnake population likely persisting at a low density.

Salt River Subbasin (Arizona)

Lower Salt River—Six historical records for the northern Mexican gartersnake from the Salt River are from its lower reach below Roosevelt Dam and are dated from 1897–1964 within the now highly-urban areas of Phoenix, Mesa, and Tempe, Arizona (Holycross *et al.* 2006, Appendix A). Precise locations of these records were not specified. Based on the general locations of these historical records, Holycross *et al.* (2006, pp. 2–3) suspected these records were from the lower Salt River and its associated canals. The Salt River is dammed in several locations within its lower reach to form Apache, Canyon, and Saguaro Lakes which has created significant source populations of nonnative, spiny-rayed fish species due to major changes in aquatic habitat and management promoting recreational fishing opportunities. Inman *et al.* (1998, Appendix B) reported crayfish from the Salt River. Consequently, northern Mexican gartersnakes are likely extirpated from this segment. Below Stewart Mountain Dam, both native fish and nonnative, spiny-rayed fish occur (Voeltz 2002, pp. 49–50; Kesner and Marsh 2010, Table 6), but we are not aware of any surveys that have occurred for northern Mexican gartersnakes from that point downstream to Granite Reef where the river is completely diverted into two canals. We are not aware of any reports of leopard frogs from this reach in recent times. The lower Salt River, below Stewart Mountain Dam, is not currently connected to occupied northern Mexican gartersnake habitat. The influence of numerous large reservoirs acting as sources for nonnative, spiny-rayed fish as well as the high-recreation and development pressure from the near-by greater Phoenix metropolitan area leads us to conclude the species is likely extirpated from this reach of the lower Salt River.

Black River—Numerous historical records for the northern Mexican gartersnake document occurrence in the Black River: at the Old Military Trail crossing on the White Mountain Apache Tribe reservation in 1965 (one specimen) and 1967 (three specimens), and near "White Crossing" in 1982 (two specimens) (Holycross *et al.* 2006, Appendix A). There is

also a record from 1965 at Willow Creek Tank which is adjacent to Willow Creek, a small tributary to the Black River on the White Mountain Apache Tribe reservation (Holycross *et al.* 2006, Appendix A). Holycross *et al.* (2006; p. 30) spent a total of 141 person-search hours and 18,200 trap-hours surveying in the Black River below Wildcat Point in 2005 (upstream of the reservation boundary) with no detections of northern Mexican gartersnakes. Crayfish were noted as being in high densities within the surveyed reach, as were both native and nonnative soft-rayed fish species (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, p. 30; Brennan 2007, p. 7; Brennan and Rosen 2009, p. 9). According to our files, there is an approximately 75 river mile (121 km) reach of the Black River on White Mountain Apache Tribe lands that has never been surveyed for northern Mexican gartersnakes. The northern Mexican gartersnake is known from Big Bonito Creek which is a tributary to the Black River and may be contributing individuals to the population. The northern Mexican gartersnake may remain extant in the Black River throughout its length, most likely as a low-density population.

Big Bonito Creek—A single historical record from 1986 for the northern Mexican gartersnake in Big Bonito Creek is documented by Rosen and Schwalbe (1988, Appendix I). In 2004, Holycross *et al.* (2006, pp. 29–30) spent 8 person-search hours in Big Bonito Creek, but did not detect the northern Mexican gartersnake. However, they did detect native suckers, crayfish, and nonnative, spiny-rayed fish. Big Bonito Creek is on White Mountain Apache Tribal lands and we are not aware of any other surveys of this drainage beyond the seven person-search hour effort in 1986 (Rosen and Schwalbe 1988, Appendix I) and that of Holycross *et al.* (2006, pp. 29–30). The northern Mexican gartersnake is known from the Black River, of which Big Bonito Creek is a tributary, and may be contributing individuals to the population. The northern Mexican gartersnake may still occur in Big Bonito Creek, likely as a low-density population.

Tonto Creek—The first record for northern Mexican gartersnakes from Tonto Creek was from 1995 in the vicinity of Kayler Butte at the Arizona State Highway 188 crossing (Holycross *et al.* 2006, p. 42; Appendix A). Surveys of Tonto Creek in 2004 and 2005, totaling 299 person-search hours and 21,199 trap-hours, resulted in the capture of 17 northern Mexican gartersnakes (Holycross *et al.* 2006, pp. 40–44). Burger (2010, p. 1) documented an additional three records from July, 2010, along Tonto Creek from Gisela south to near Roosevelt Lake at the A-Cross road crossing. Two northern Mexican gartersnakes were observed in 2010 near the A-Cross Road crossing along the lowermost reach of Tonto Creek at Roosevelt Lake, as well as another in the same area in 2011 (Madera-Yagla 2010, p. 6; 2011, p. 6). Native fish species persist in Tonto Creek, but bullfrogs, crayfish, and nonnative, spiny-rayed fish are also present, with crayfish noted as abundant in one segment (Voeltz 2002, pp. 58–60; Holycross *et al.* 2006, pp. 40–44; Wallace *et al.* 2008; pp. 243–244). Recent records confirm the northern Mexican gartersnake as extant in Tonto.

Verde River Subbasin (Arizona)

Upper Verde River—Above Horseshoe Dam, several historical and current records exist for northern Mexican gartersnakes. Rosen and Schwalbe (1988, Appendix I) document records from 1986 at Cottonwood (just below Dead Horse Ranch State Park), Camp Verde, the Houston Creek confluence, and one mile above the Verde River in Horse Creek (a tributary to Horseshoe

Reservoir). Another 14 records within this reach dating to 1884 are provided in Holycross *et al.* (2006, Appendix A). Surveys for the northern Mexican gartersnake within this reach in 2004 and 2005 totaled 173 person-search hours and 18,910 trap-hours. This effort documented one northern Mexican gartersnake referenced below (Holycross *et al.* 2006, p. 28). Another 120 person-search hour effort was made in the Verde River within the Verde Valley (including Dead Horse Ranch State Park) in 2007 with no detections of northern Mexican gartersnakes (GCWG 2007, p. 2). In 2009, Nowak (2009, Table 1) invested 68 person-search hours and 314 trap-night (trap-hours not reported) of survey effort in the upper Verde River above Clarkdale and at the confluence with Sycamore Creek, but had no detections of northern Mexican gartersnakes. Recent records include two northern Mexican gartersnake neonates from Tuzigoot National Monument in 2009 and 2010 (Nowak, 2011, pers. comm.; Nowak *et al.* 2011, Table 1), an adult female and juvenile male from the Verde River just downstream of the Interstate 17 crossing in 2012 (Emmons 2012, pers. comm.), and several records from Dead Horse Ranch State Park in 2004 and 2012 (Holycross *et al.* 2006, p. 28; Nowak 2012, pers. comm.). Emmons and Nowak (2012, p. 2) conducted the most recent sampling effort for northern Mexican gartersnakes in the upper Verde River area; from May – September 2012. The five sites surveyed along the Verde River in this effort were Dead Horse Ranch State Park; Pecks Lake on Freeport McMoRan property; Tavasci Marsh in Tuzigoot National Monument; the Verde River at the Salt River Project property east of the Interstate 17 bridge; the Verde River Greenway adjacent to Deadhorse Ranch State Park; and Tuzigoot National Monument (Emmons and Nowak 2012, p. 2). This survey effort (including a site on Oak Creek) totaled 47.65 person-search hours, 70,632 coverboard hours, and 477.74 trap-hours resulting in the combined capture of 49 individual northern Mexican gartersnakes (Emmons and Nowak 2012, p. 5). Capture rates from this effort were reported as 319 trap-hours per snake captured at the Salt River Project site, 1,247 trap-hours per snake at Dead Horse Ranch State Park, and 1,963 trap-hours per snake at the Verde River Greenway (Emmons and Nowak 2013, p. 14). Detailed survey results are provided in Emmons and Nowak (2012, Table 1).

The uppermost historical record from the Verde River appears to be in the proximity of Sycamore Creek, but less survey effort has been made in the reach upstream of there. The Verde River upstream of Horseshoe Dam supports both native and nonnative aquatic communities and the fish community appears to generally transition from native to nonnative in the downstream direction in this reach (Voeltz 2002, pp. 70–71; Holycross *et al.* 2006, pp. 26–29). Numerous researchers have documented nonnative, spiny-rayed species such as channel catfish, flathead catfish, and smallmouth basin the Verde River (Minckley 1993, pp. 7–13; Jahrke and Clark 1999, pp. 2–7; Rinne 2004, pp. 1–2; Bahm and Robinson 2009b, pp. 1–4; Robinson and Crowder 2009, pp. 3–5). Emmons and Nowak (2012, p. 5) provided their data on harmful nonnative species detections from the upper Verde River region in 2012: green sunfish (n = 3435); bluegill (n=347); smallmouth bass (n=257); largemouth bass (n = 210); yellow bullhead (n = 23); rock bass (*Ambloplites rupestris*, n=10); crayfish (n = 336); and bullfrogs in all life stages (n = 779). Prey species were detected in far fewer numbers: desert sucker (n=11), speckled dace (n=1), 117 Woodhouse's toads (n = 2 adults and 115+ tadpoles), and one canyon treefrog tadpole (Emmons and Nowak 2012, p. 5). Inman *et al.* (1998, Appendix B) reported crayfish from the Verde River. The Verde River represents a large, complex, and difficult area to survey for a secretive species such as the northern Mexican gartersnake, but these records document that at least a low-

density, but reproducing and potentially viable, northern Mexican gartersnake population occurs within the upper Verde River.

Oak Creek—Historical and recent records from Oak Creek include a 1975 record from near Midgely Bridge, numerous, recent records from the Page Springs and Bubbling Ponds State Fish Hatcheries located adjacent to Oak Creek, and two specimens observed in Oak Creek in 2012 at the Page Spring Cellars and Vineyard; the latter two locations are downstream of Midgely Bridge (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, p. 23, Boyarski 2011, pp. 1–3; Nowak, 2012, pers. comm.; Emmons and Nowak 2013, p. 5). A significant amount of survey effort since the mid-1980s has been expended for narrow-headed gartersnakes along Oak Creek from Midgely Bridge, upstream through Oak Creek Canyon, the results of which are captured in our discussion of the status of narrow-headed gartersnakes below. No northern Mexican gartersnakes were detected as part of those efforts. Oak Creek is comprised of two general sections: (1) The upper portion, above Midgely Bridge within Oak Creek Canyon, where Oak Creek is a steep-walled, canyon-bound stream that alternates between riffles, pools, and runs, with occasional side channels and backwaters; and (2) a lower portion, downstream of Midgely Bridge, that is dominated by runs and pools with more sinuosity and a wider floodplain (Nowak and Santana-Bendix 2002, pp. 7–8). Within Oak Creek Canyon, there are no known records for the northern Mexican gartersnake above Midgely Bridge, despite considerable survey attention on the narrow-headed gartersnake over the past two decades. A lack of records from the upper, heavily surveyed portion of Oak Creek suggests the northern Mexican gartersnake probably never occurred there.

The population of northern Mexican gartersnakes at the hatcheries appears stable despite an abundant bullfrog population there as well as documented predation by largemouth bass (Young and Boyarski 2013, pp. 159–160), possibly as a result of heavily vegetated habitat that may provide protection from predation and allow recruitment into the population. Undoubtedly, this population acts as a source population for the adjacent reach of Oak Creek below Midgely Bridge. The Verde River, to which Oak Creek is a tributary, is also occupied, may also be a source of individuals occurring in Oak Creek. Nowak and Santana-Bendix (2002, Table 3) document a shift in Oak Creek from a largely native fish community upstream of Midgely Bridge, to a community dominated by nonnative, spiny-rayed fish species downstream of Midgely Bridge to the confluence of the Verde River. The presence of the nonnative fish species likely keeps the northern Mexican gartersnake population at low to very low densities in Oak Creek proper. Based on recent records, we consider the northern Mexican gartersnake to be extant in Oak Creek, from Midgely Bridge to the confluence with the Verde River, likely as a low-density population, likely supplemented by emigration from the known population core at the Page Springs State Fish Hatchery adjacent to Oak Creek.

Spring Creek—A single historical record from 1986 for the northern Mexican gartersnake in Spring Creek is documented by Rosen and Schwalbe (1988, Appendix I). A survey for the northern Mexican gartersnake in 2004, totaling approximately eight person-search hours, failed to detect any northern Mexican gartersnakes. However, this effort did detect four species of native fish, as well as over 20 lowland leopard frogs (Holycross *et al.* 2006, p. 25), which are important prey species. Crayfish were "visually abundant" according to surveyors, but bullfrogs and nonnative, spiny-rayed fish were not detected (Holycross *et al.* 2006, p. 25).

Spring Creek is a tributary to Oak Creek; the confluence is approximately 4.75 river miles (7.6 km) downstream of the Bubbling Ponds and Page Springs Fish Hatcheries which act as a source population of northern Mexican gartersnakes to Oak Creek, and may be a source of individuals to Spring Creek. The northern Mexican gartersnake may be extant in Spring Creek, possibly as a low-density population.

Sycamore Creek—Two historical records dated 1954 for the northern Mexican gartersnake from Sycamore Creek, approximately 1.5 river miles (2.4 km) upstream from its confluence with the Verde River, are referenced in Holycross *et al.* 2006 (Appendix A). A survey for the species in 2004, totaling 17 person-search hours and 162 trap-hours, failed to detect any northern Mexican gartersnakes, but did detect bullfrogs, crayfish, and nonnative, spiny-rayed fish (Holycross *et al.* 2006, p. 25). The perennial reach of Sycamore Creek extends from Parsons Spring to the Verde River confluence, a distance of approximately 4.3 river miles (6.9 km). Almost 50 years have passed since the last detection of a northern Mexican gartersnake was made in Sycamore Creek and we do not consider the species as extant in Sycamore Creek.

Santa Cruz River Subbasin (Arizona)

Upper Santa Cruz River/San Rafael Valley Subbasin— Several historical records document the northern Mexican gartersnake from tanks and springs within the San Rafael Valley. Rosen and Schwalbe (1988, Appendix I) documented nine individuals from Bog Hole Wildlife Management Area in 1986, three records from Sharp Spring in the years 1958, 1975, and 1986, and a single record from Upper 13 Reservoir, located in the vicinity of the eastern base of the adjacent Patagonia Mountains in 1985. Other records include observations in the vicinity of Lochiel, Arizona, in 1975 and 1977, as well as numerous records dated 1958, 1975, and 2000 from Sheehy Spring and the upper Santa Cruz River that flows through the San Rafael Valley (Rosen *et al.* 2001, p. 17, Appendix I; Holycross *et al.* 2006, Appendix A). One neonatal northern Mexican gartersnake observation, and possibly a second, though unconfirmed, was made at Pasture 9 Tank in the San Rafael Valley in 2012 during ranid (of the family Ranidae) frog surveys (Akins 2012, pers. comm.) and two additional records for an adult female and an adult male were reported at the Forest Service 799 Tank (Jones 2012d, pers. comm.). These observations confirm that the northern Mexican gartersnake is using isolated stock tanks in the San Rafael Valley and that reproduction is occurring.

Recent records from the upper Santa Cruz River in the San Rafael Valley include observations from 2006 (Stingelin *et al*. 2006, Table 1.3) and survey results reported in Stingelin *et al.* (2009, p. 33), which documented a total capture of 55 northern Mexican gartersnakes in 2008. Of this total, 51 gartersnakes were adults, one was a juvenile, and three were neonates which might indicate recruitment problems within this population as a result of bullfrog predation on the younger northern Mexican gartersnake age classes (Stingelin *et al.* 2009, p. 33). Another record of an adult was reported from the upper Santa Cruz River in the San Rafael Valley in 2010 (Rorabaugh 2010, pers. comm.). In 2012, 24 northern Mexican gartersnakes were trapped from the upper Santa Cruz River in an effort consisting of 9,090 traps hours at a capture rate of one snake every 378.75 trap hours; one of the 24 individuals captured was a neonate (Lashway 2012, pers. comm.). Of these 24 individuals captured, one was a recapture

from the 2008 monitoring effort reported in Stingelin *et al*. (2009). Native fish, bullfrogs, and nonnative fish inhabit several wetland areas in the San Rafael Valley, including the upper Santa Cruz River (Rosen *et al.* 2001, p. 17, Appendix I). Sonoran tiger salamanders (*Ambystoma mavortium stebbinsi*) also contribute to the prey base of northern Mexican gartersnakes in this area. Photo-documentation from the years 1999, 2001, and 2005 from several photo points along the upper Santa Cruz River depicted in Stingelin *et al*. (2006, Figure 3.1) reflect a trend of less water and more vegetation along the upper Santa Cruz River in recent years.

The foraging ecology of northern Mexican gartersnakes and past records suggest individuals move throughout the San Rafael Valley as they seek to explore springs, tanks and other wetlands for prey. The upper Santa Cruz River likely serves as a source for these individuals. We consider the upper Santa Cruz River, as well as tanks, springs, and wetlands with physically suitable northern Mexican gartersnake habitat, within the greater San Rafael Valley to be occupied by the northern Mexican gartersnake based on historical and recent records, as well as our understanding of the species' foraging ecology.

Redrock Canyon—We know of two photo vouchers of northern Mexican gartersnakes from Redrock Canyon, a tributary of Sonoita Creek, found while conducting fish (Jones 2008, pers. comm.) and bullfrog (Jones, 2012, pers. comm.) surveys in 2008. One specimen was a juvenile and the other was an adult. Redrock Canyon has never been formally surveyed for northern Mexican gartersnakes according to our files. These photo vouchers document that, at least recently, the northern Mexican gartersnake has reproduced in that area. Perennial water sources are located throughout Redrock Canyon in the form of streams, springs, tanks, and cienegas (US Bureau of Reclamation 2008, p. 2). Redrock Canyon supports four species of native fish, and Chiricahua leopard frogs and Sonora tiger salamanders have been reported (USBOR 2008, p. 5). Redrock Canyon has also been occupied historically by several species of nonnative, spiny-rayed fish (the origin of which was traced to illegal releases into local stock tanks) and bullfrogs, but the most recent observations suggest only bullfrogs remain conspicuous throughout the subbasin (USBOR 2008, pp. 6–7). Recent records confirm the northern Mexican gartersnake remains extant in Redrock Canyon.

Sonoita Creek—Two records of northern Mexican gartersnakes from 1954 and 1974 from Sonoita Creek document the species there historically (Rosen *et al.* 1988, Appendix I; Holycross *et al.* 2006, Appendix A). Turner (2007, pp. 1–5) found no northern Mexican gartersnakes in a 204 person-search-hour, 5,472 trap-hour survey effort in the Sonoita Creek State Natural Area. Crayfish, bullfrogs, and nonnative fish were observed by Turner (2007, p. 41) which likely emigrate from Patagonia Lake from which Sonoita Creek feeds. The length of time since the last records for northern Mexican gartersnakes as well as the persistent influence of harmful nonnative species supported by Patagonia Lake suggest the species is likely extirpated from Sonoita Creek.

Scotia Canyon—There are numerous records of the northern Mexican gartersnake from Scotia Canyon in the Huachuca Mountains area which are dated 1981, 1987, 1993, 2000, 2008, and 2009; many of which occurred at the Peterson Ranch Ponds (Rosen and Schwalbe 1988, Appendix I; Holm and Lowe 1995, Appendix B; Rosen *et al.* 2001, pp. 15–16, Appendix I; Holycross *et al.* 2006, Appendix A; Frederick 2008b, 2010 pers. comm.). Scotia Canyon was

intensively resurveyed for northern Mexican gartersnakes by Rosen *et al.* (2001, pp. 15–16). In comparing capture rates of northern Mexican gartersnakes from Holm and Lowe (1995, pp. 27–35) to capture rate data from 1980–1982, northern Mexican gartersnake populations in this area appear to have declined based on reduced capture rates in 1993, and even lower capture rates in 2000 (Boyarski 2008c, p. 1). In 2008, Scotia Canyon was again resurveyed for northern Mexican gartersnakes with 32 person-search hours and 912 trap-hours with no detections of the target species. Also in 2008, a multi-agency, multi-year effort was initiated within a five mi (8 km) radius of Scotia Canyon, including the Peterson Ranch Ponds and vicinity, to eradicate bullfrogs and reestablish Chiricahua leopard frogs (Frederick 2008, 2008b, pers. comm.). This effort included many surveys of herpetofauna (reptiles and amphibians) to identify the presence of bullfrogs for eradication and monitor the status of reintroduced Chiricahua leopard frogs. As a result of repeated surveys in the area, a single, large adult northern Mexican gartersnake was observed in 2008 and again in 2009; the first observations of northern Mexican gartersnakes in over eight years of informal surveys at this site (Frederick 2008b, pers. comm.; Frederick 2010, pers. comm.). These observations were the last known for the northern Mexican gartersnake in Scotia Canyon, and suggest that the species continues to occur in the upper Scotia Canyon area in low densities. With the reintroduction of Chiricahua leopard frogs to the Peterson Ranch Ponds in 2009 and their subsequent reproduction in 2010, we expect the northern Mexican gartersnake population will persist, and possibly improve, due to improved availability of prey and reduced predation by harmful nonnative species.

Parker Canyon—Historical records for the northern Mexican gartersnake in Parker Canyon were from Parker Canyon Lake in 1967, 1968, and 1986 and from Parker Canyon in 1973 (presumably in perennial reach below Parker Canyon Lake Dam) (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, Appendix A). We are not aware of any dedicated northern Mexican gartersnake survey effort in Parker Canyon. The only survey we know of for Parker Canyon Lake was the Rosen and Schwalbe (1988) effort in 1986 that consisted of 3 person-search hours and resulted in the observation an adult male northern Mexican gartersnake approximately 100 feet (30 m) from the shore of the northeastern part of the lake, under a rock. Parker Canyon Lake is managed as a warm water fishery supporting several species of nonnative, spiny-rayed fish species, as well as rainbow trout, and the lake is re-stocked with nonnative fish regularly by the AGFD for recreational purposes. Parker Canyon below Parker Canyon Lake dam is best described as a spatially intermittent stream with several pools. There is approximately one river mi (1.6 km) of permanent water below the dam, and then the channel is ephemeral for approximately 4.5 river mi (7.2 km) to another perennial reach approximately 0.25 river mi (0.4 km) in length. It then, once again, becomes ephemeral until it joins the upper Santa Cruz River in the San Rafael Valley. The perennial reach below the Parker Canyon dam contains bullfrogs, crayfish, and nonnative, spiny-rayed fish species. Lower Parker Canyon also maintained longfin dace as of 2003 (Stefferud and Stefferud 2004, p. 433). Individual northern Mexican gartersnakes may migrate into Parker Canyon from populations that occur in Scotia Canyon or the San Rafael Valley which suggests the species could be extant in Parker Canyon, likely as a low-density population.

Las Cienegas National Conservation Area and Cienega Creek Natural Preserve—Several records for the northern Mexican gartersnake in the Las Cienegas National Conservation Area have been documented in the literature, predominantly from Cienega Creek, the first dating

to 1986 (Rosen and Schwalbe 1988, Appendix I). Other records from Cienega Creek are dated 1994, 1996, 1999, 2000, (Rosen *et al.* 2001, Appendix I; Holycross *et al.* 2006, Appendix A). In 2007 and 2008, more than 2,300 trap-hours were required per snake captured in this area (Caldwell 2008a, pers. comm.; 2008b, pers. comm.; Servoss *et al.* 2007, p. 1–12), compared with Rosen and Caldwell (2004, p. 21, Table 2) capture rates of 561 trap-hours per snake in this same area in 2002 and 2003. This is a more than four-fold increase in the effort needed to capture northern Mexican gartersnakes. In 2011, 19,000 trap-hours were invested, which resulted in the capture of 6 individual northern Mexican gartersnakes from Cienega Creek. Another individual was observed while conducting frog surveys in this area (Hall 2011, pers. comm.). Cienega Creek maintains surface flow in two reaches; from its headwaters to just downstream of "the Narrows;" and from the confluence with Mescal Wash to just downstream of the Colossal Cave Road crossing in Vail, Arizona. The upper portion of the creek has historically been occupied by bullfrogs, but continues to support a native fish community, as well as both Chiricahua and lowland leopard frogs (Rosen *et al.* 2001, Appendix I). Conservation and recovery efforts for native aquatic species in the area have reduced the influence of harmful nonnative species. Nearly 40 newborn northern Mexican gartersnakes were produced in captivity and released in the Las Cienegas National Conservation Area in 2012.

In addition to Cienega Creek, the Las Cienegas National Conservation Area supports several tanks, springs, and wetlands that provide physically suitable northern Mexican gartersnake habitat and that may be used by northern Mexican gartersnakes sporadically as they emigrate from Cienega Creek and explore new foraging opportunities in the area. According to GIS analysis, Mattie Canyon, a tributary of Cienega Creek also supports suitable northern Mexican gartersnake habitat as a well as a native prey base. The lower perennial portion of Cienega Creek runs through Pima County's 3,979 ac (1,610 ha) Cienega Creek Natural Preserve for approximately 12 river miles (19.3 km). We are aware of two recent photo vouchers of northern Mexican gartersnakes from this reach in 1997 and 2001, and consider the species extant there (Caldwell 2012, pers. comm.). This reach supports a native fish community (Timmons *et al*. 2013, Table 1), as well as lowland leopard frogs, although there is a persistent threat of bullfrog invasion from a nearby house pond that continues to contribute immigrant bullfrogs to Cienega Creek. Despite this source, bullfrog numbers have remained somewhat low in recent years (Caldwell 2012, pers. comm.). The 2011 trapping effort in the Las Cienegas National Conservation Area equates to 3,167 trap-hours per snake and provides evidence that while extant, the northern Mexican gartersnake still exists in the Las Cienegas National Conservation Area as a low-density population that appears to also still be in decline.

Lower Santa Cruz River—Several historical records from the lower Santa Cruz River exist: one in the vicinity of Tubac, Arizona dated 1942, another dated 1956 from near the Potrero Creek confluence, three from the Santa Cruz River at Tucson dated 1912, and several others simply labeled as "Tucson" from 1891–1893 (Rosen and Schwalbe 1988, Appendix I; Holycross *et al.* 2006, Appendix A). The Santa Cruz River headwaters are located in the San Rafael Valley where the river flows south into Mexico, bends to the west, and then flows due north, back into the United States just east of Nogales, Arizona. There are no obvious barriers to northern Mexican gartersnake movement along its course from the San Rafael Valley to north of Nogales. Rosen and Schwalbe (1988, Appendix I) performed northern Mexican gartersnake surveys of the lower Santa Cruz on three different days spanning the years of 1985 and 1986; no northern

Mexican gartersnakes were found, but bullfrogs were noted as "super abundant." Abbate *et al.* (2007, p. 5) spent 90 person-search hours and approximately 935 trap-hours surveying for northern Mexican gartersnakes along the lower Santa Cruz River from the Trico-Marana Road Bridge downstream to the Arizona Army National Guard Training facility, but no northern Mexican gartersnakes were detected.

Several northern Mexican gartersnake records have been reported from areas near the Santa Cruz River in Mexico on two private ranches, Rancho El Arribabi and Rancho Los Fresnos from 2005–2011, although the Santa Cruz River itself was not surveyed (Rorabaugh *et al.*, *In Press*, pp. 10–11). Records for the northern Mexican gartersnake from these ranches were reported from the Arroyo Los Fresnos, Los Fresnos Cienega (1990 record), and along the Río Cocospera (Rorabaugh *et al.*, *In Press*, pp. 10-11). Prior to the mid-1800s, the lower Santa Cruz was characterized as having a narrow, meandering channel within an active floodplain with cienegas present along its course (Lacher 1996, pp. 16–17), likely providing excellent habitat for northern Mexican gartersnakes along its entire course. Currently, the lower Santa Cruz River upstream of (south of) Tucson only maintains perennial (effluent dependent) flow for approximately 14 river miles (22.5 km), from the Nogales International Wastewater Treatment Plant downstream to the Chavez Siding Road crossing, as a result of discharges from the plant at a rate of 23 cubic feet per second (cfs), supporting an aquatic vertebrate community that consists of longfin dace, mosquitofish, and bullfrogs (AGFD 2011, pp. 1, 5). Research suggests that treated effluent from the plant contributes to hydrologic "clogging" (reduced hydraulic conductivity of the streambed) in this reach from the creation of a schmutzdecke (a nearly impermeable, anaerobic layer of organic material) that reduces aquifer recharge (Lacher 1996, p. 32; Treese *et al.* 2009, p. 1052). Ultimately, such hydrologic clogging adversely affects the recruitment and maintenance of riparian plant species that are dependent on proper functioning of the hyporheic zone (zone where mixing of shallow groundwater and surface water occurs) and does not allow for the development of habitat for prey species. We do not consider the northern Mexican gartersnake to be extant in the lower Santa Cruz River, upstream of the International Border.

Buenos Aires National Wildlife Refuge—Historical records document occurrence of the northern Mexican gartersnake at the Buenos Aires National Wildlife Refuge (BANWR). Five historical records for the northern Mexican gartersnake dated 1970 are from Arivaca Cienega; a large and heavily vegetated wetland. A June 13, 1985, survey failed to detect the species there, but noted that bullfrogs were "extremely abundant" at this location (Rosen and Schwalbe 1988, Appendix I). A significant survey effort consisting of trapping and visual searches occurred at the Arivaca Cienega in both 1993 and 2000 (the last surveys that we know of in the area), documenting that bullfrogs remained abundant, but also confirmed the presence a single juvenile northern Mexican gartersnake in 2000 (Rosen *et al.* 2001, Appendix I). The observation of this juvenile suggests that at least some level of reproduction had occurred and may still be occurring. The presence of dense cover probably helps any remaining northern Mexican gartersnakes to avoid predation. Arivaca Cienega is found within the eastern-most portion of the BANWR and, in terms of northern Mexican gartersnake movement, Arivaca Cienega is connected, via Arivaca Creek and nearby associated drainages, to the larger, more contiguous block of BANWR lands and associated wetlands in the Altar Valley to the west. In recent years, there has been a concerted management effort on the BANWR to recover the Chiricahua leopard

frog in an array of tanks (known as the "central tanks" which include Carpenter, Rock, State, Triangle, New Round Hill, Banado, Choffo, Barrel Cactus, Sufrido, Hito, Morley, McKay, and Chongo Tanks) and their associated drainages, all of which have been designated as critical habitat for the Chiricahua leopard frog. As a result, it is likely that any northern Mexican gartersnakes that successfully immigrate into the central tanks area of the BANWR have an increased chance of persistence because of improved available habitat and a stable prey base in an area that is likely free of nonnative predators. We consider the northern Mexican gartersnake to be extant as a low-density population on the BANWR based on historical and recent records and the abundance of available habitat in the vicinity of the most recent record.

San Pedro River Subbasin (Arizona)

Bear Creek—Three historical records exist for northern Mexican gartersnake in Bear Creek in the Huachuca Mountains: one from 1968 from "Bear Creek;" one from 1973 from "near Miller Peak," which is likely from or near Bear Spring at approximately 7,500 ft (2,286 m) elevation; and the last from 1987 near the Montezuma Pass Road crossing (Holycross *et al.* 2006, Appendix A). We are not aware of the occurrence of any targeted surveys for northern Mexican gartersnakes in this drainage. Stefferud and Stefferud (2004, pp. 73–87) documented a native aquatic community based on their 2003 surveys, specifically noting longfin dace as abundant. They suggested this drainage as a place where native fish recovery projects are desirable based on the abundance of suitable habitat and absence of nonnative species. A recent, but brief, visit to Bear Canyon by a Service employee confirmed the presence of native fish species. However, crayfish were also seen in large numbers in some pools, but bullfrogs were not observed in the drainage. Bear Creek is somewhat isolated from major perennial sources of nonnative species, which may indicate why a largely native community persists. Based on 1) historical records; 2) the absence of any substantial, targeted survey effort; 3) the presence of a native fish community; and 4) the abundance of physically suitable habitat, we consider Bear Creek to be occupied by northern Mexican gartersnakes, possibly as a low-density population that remains threatened by crayfish.

San Pedro River—Numerous historical records document the occurrence of the northern Mexican gartersnake in the upper San Pedro River, upstream (south) of Interstate 10: Lewis Springs (1919; 1986, two records; 1996, photo-voucher in AGFD Heritage database), Hereford (1920, five records), "2 East Palimonas" (1959), and Arizona State Highway 90 crossing (1965; 1986, two records) (Rosen and Schwalbe 1988, Appendix I; Rosen *et al.* 2001, p. 21, Appendix I; Holycross *et al.* 2006, Appendix A). Rosen *et al.* (2001, Appendix I) surveyed the upper San Pedro River in 1996, 1998, and 2000 at the Arizona State Highway 90 crossing, in 1998 at Lewis Springs, and 1996 at Curtis Flat, and documented crayfish, bullfrogs, nonnative, spiny-rayed fish, as well as two species of native fish, all occurring at various densities along their survey routes. However, they did not detect any northern Mexican gartersnakes. Kesner and Marsh (2010, Table 4) also found both native fish, as well as nonnative, spiny-rayed fish, in the upper San Pedro River, although native fish or nonnative, soft-rayed fish outnumbered harmful nonnative fish species significantly. Jakle (1992, pp. 3–5) and Minckley (1987, pp. 2, 16) also reported nonnative, spiny-rayed species such as channel catfish, flathead catfish, and smallmouth basin the San Pedro River. These survey efforts included approximately 12 cumulative person-search hours at Highway 90, five person-search hours at Lewis Springs, and three person-search

hours at Curtis Flat (Rosen *et al.* 2001, Appendix I). Inman *et al.* (1998, Appendix B) reported crayfish from the San Pedro River.

The lower San Pedro River (north of I-10) was surveyed for northern Mexican gartersnakes from 1996–2000. Rosen *et al.* (2001, Appendix I) surveyed four locations along the lower San Pedro River: at Cascabel in 1996 (three person-search hours), at the San Manuel crossing in 1999 (45 minutes), at the Dudleyville crossing in 2000 (four person-search hours), and in the Bingham Cienega area, adjacent to and within the lower San Pedro River, in 1999 (20 minutes) and 2000 (three person-search hours). One bullfrog was seen at Cascabel and another at Bingham Cienega; one crayfish and one channel catfish were seen at the Dudleyville crossing (Rosen *et al.* 2001, Appendix I). Otherwise, robust populations of lowland leopard frogs and longfin dace were seen at nearly all survey locations (Rosen *et al.* 2001, Appendix I) which document a largely native prey species community for northern Mexican gartersnakes. Kesner and Marsh (2010, Table 4) found native fish generally dominate over nonnative, spiny-rayed fish in the lower San Pedro River. In total, approximately 11 person-search hours have been invested in surveying the entire lower San Pedro River, a large and structurally complex system, since 1996. The northern Mexican gartersnake is likely extant in low density populations along the San Pedro River from the International Border to its confluence with the Gila River.

Babocomari River and Cienega—In the past, the Babocomari River and Cienega was considered by Rosen and Schwalbe (1988, Appendix I) as a possible regional stronghold for northern Mexican gartersnakes, based on personal communications with past investigators (Rosen *et al.* 2001, p. 18). Consequently, several historical records for the species exist for this area. The first species record is dated 1892, labeled "Babocomari," and likely occurred at the cienega; subsequent records from 1958 and 1986 also document the species there (Rosen and Schwalbe 1988, Appendix I). Other historical records from 1958 document the species at "Elgin" (Holycross *et al.* 2006, Appendix A,) and we presume that to mean the upper Babocomari River. The last known record for the lower Babocomari River was from 1985 at the Sanders Road crossing, approximately 3.3 river miles (5.3 km) upstream of the San Pedro River confluence (Rosen and Schwalbe 1988, Appendix I). Several surveys, of varying effort, of both the cienega and the river conducted in 2000 failed to detect the northern Mexican gartersnake (Rosen *et al.* 2001, pp. 18–19, Appendix I). The cienega was surveyed intensively in 2000, consisting of visual searches and trapping, which documented bullfrogs and nonnative, spiny-rayed fish as abundant and crayfish as common. Surveys from the mid-1980s failed to detect bullfrogs at the cienega, but did detect several species of nonnative, spiny-rayed fish. This suggests that, post-1986, bullfrogs either naturally colonized the Babocomari system in a regional dispersal event or they were artificially introduced. Despite the influence of harmful nonnative predators in the Babocomari system, northern Mexican gartersnakes could immigrate from regional source populations along the San Pedro River or from the Canelo Hills-Sonoita Grasslands area and intermittently exist as low density populations.

Canelo Hills-Sonoita Grasslands Area—The Canelo Hills-Sonoita grasslands area encompasses several streams, cienegas, and wetlands owned or managed by the Appleton-Whittell Research Ranch, the Nature Conservancy (Canelo Hills Cienega Preserve), and the Coronado National Forest. Rosen and Schwalbe (1988, Appendix I) and Holycross *et al.* (2006, Appendix A) report localities in this area where records for northern Mexican gartersnakes exist:

Finley Tank (1985–1986, numerous), Turkey Creek (1 record from 1985, 11 records from 1986), and O'Donnell Creek (four records from 1974, three records from 1986). The last known significant survey effort for northern Mexican gartersnakes from this region is that of Rosen *et al.* (2001, Appendix I), which included Turkey Creek, O'Donnell Creek, Finley Tank, various tanks and springs connected to Post Canyon, and two tanks in the area of Elgin, Arizona in 1996 and 2000. Visual search surveys consisting of 10 person-search hours in Turkey Creek produced no records of riparian herpetofauna, largely because the creek was dry during part of that effort (Rosen *et al.* 2001, Appendix I). Thirteen person-search hours were invested in O'Donnell Creek in 2000, yielding observations of Chiricahua leopard frogs, crayfish, and nonnative, spiny-rayed fish, but no northern Mexican gartersnakes (Rosen *et al.* 2001, Appendix I). Stefferud and Stefferud (2004, p. 418) reported the presence of three species of native fish after renovation activities removed green sunfish from O'Donnell Creek. Finley Tank was surveyed with both visual searches and trap arrays in 1996 and 2000, which documented 27 northern Mexican gartersnakes and four bullfrogs (Rosen *et al.* 2001, Appendix I). Several tanks and springs associated with Post Canyon were surveyed in 2000 by visual searches and trap arrays, which documented several populations of Chiricahua leopard frogs, but no northern Mexican gartersnakes or nonnative species of concern. Rosen *et al.* (2001, Appendix I) and Stefferud (2004, p. 455) reported the presence of lowland leopard frogs from several pools within Post Canyon. d'Orgeix (2011, pp. 20–21) conducted a three-year field study (2007–2009) on the northern Mexican gartersnake populations at Finley Tank, Southwest Spring (immediately above Finley Tank), Post Canyon, O'Donnell Creek, and at two nearby tanks (Telles and Pronghorn). Visual searches, coverboard arrays, and trapping techniques were used, which documented 29 northern Mexican gartersnakes; 25 at Finely Tank, 2 at Southwest Spring, and 2 in Post Canyon (d'Orgeix 2011, pp. 20–21). Five more adult northern Mexican gartersnakes were observed in 2012 foraging in a flooded area of lower O'Donnell Canyon (d'Orgeix *et al*., In Prep.). Northern Mexican gartersnake are likely extant throughout this greater area exploiting seasonally available habitat and foraging opportunities, immigrating and emigrating from sites as necessary and available.

Rio Yaqui Subbasin (Arizona)

San Bernardino National Wildlife Refuge—Numerous historical records for the northern Mexican gartersnake at the San Bernardino National Wildlife Refuge (SBNWR) (1939; 2 specimens), (1950; 2 specimens), (1954; 2 specimens), (1956; 1 specimen), (1957; 2 specimens), (1958; 3 specimens), (1959; 1 specimen), (1961; 9 specimens), (1985; 2 specimens), (1986; 8 specimens), (1993; 1 specimen), (1994; 1 specimen), (1995; 2 specimens), and (1997; 2 specimens), is evidence that the species formerly maintained a robust population there (Rosen and Schwalbe 1988, pp. 23, Appendix I; Holycross *et al.* 2006, Appendix A). USFWS (2012, Table G2b), an annual report compiled by the SBNWR, lists the northern Mexican gartersnake as a resident of the refuge with the last known record for the species occurring in Black Draw in 2005 (USFWS 2012, p. 109). The SBNWR was the subject of intensive research and survey effort for the northern Mexican gartersnake during the 1980s and 1990s. Approximately nine days (person-search hours not reported) were spent surveying the SBNWR in 1985 and 1986 (Rosen and Schwalbe 1988, Appendix I) resulting the capture of 10 large adults. Gartersnakes in general were studied at the SBNWR from 1985–1986 and 1992–1999 in a survey effort that totaled 58,560 trap-hours, resulting in the detection of 148 northern Mexican gartersnakes

(Rosen *et al.* 2001, p. 6). In 1999, approximately four person-search hours of survey effort led to no detections of northern Mexican gartersnakes (Rosen *et al.* 2001, Appendix I). The last known record of northern Mexican gartersnakes from the SBNWR is from 1999 (Rosen *et al.* 2001, p. 6). Although vast amounts of physically suitable northern Mexican gartersnake habitat exist within the SBNWR, bullfrogs, noted as "super abundant" during the mid-1980s, completely dominate the SBNWR today (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). However, five species of native fish persist on the refuge and are likely important prey for northern Mexican gartersnakes on the refuge. There is also the possibility that northern Mexican gartersnakes occur in Mexico, downstream in the Rio Yaqui drainage, immediately adjacent to the SBNWR, but we have no records in our files to confirm. We consider the northern Mexican gartersnake as extant on the San Bernardino National Wildlife Refuge, likely as a very low density population.

Narrow-headed Gartersnake

Upper Gila River Subbasin (Arizona and New Mexico)

West Fork Gila River—Historical records for the narrow-headed gartersnake are dated 1952, 1958, and 1984 near Gila Cliff Dwellings National Monument, 1984 nine river mi (5.6 km) upstream of there, and at White Rock Canyon the same year (Fitzgerald 1986, Table 2). Powell *et al.* (2006, p. 23) detected a single narrow-headed gartersnake in the West Fork Gila River in 2002. Subsequent surveys from 2009–2011 detected six narrow-headed gartersnakes as a result of 28 cumulative person-search hours of effort (Hellekson 2012a, pers. comm.). Pettinger and Yori (2011, p. 11) detected two narrow-headed gartersnakes in the West Fork Gila River in 2011. Brown trout (considered more predatory than other nonnative trout species, but also serve as prey for narrow-headed gartersnakes) are suspected to be the most abundant nonnative fish in this area, but several species of nonnative, spiny-rayed fish (Riley and Clarkson 2005, p. 6; Paroz *et al.* 2006, p. 64; 2009, p. 12; Propst *et al.* 2009, pp. 7–13) and bullfrogs occur. The latter were most conspicuous along glides, runs, and pools (Hellekson 2012a, pers. comm.). Crayfish have not been detected and native fish species persist in the West Fork Gila River (Hellekson 2012a, pers. comm.). Seven species of native fish, including headwater chub (Clarkson and Marsh 2013, p. 4), provide foraging options, however native fish densities were noted to have declined for the 10 years preceding and including 2005 as a result of effects from wildfires (Paroz *et al.* 2006, p. 57). Population trends in native fish species in the West Fork Gila River subsequent to 2005 are less certain. A natural fish barrier in the West Fork Gila River provides some level of protection against upstream movements of nonnative fish and allows the persistence of native fish, as a prey base for the narrow-headed gartersnake, above the natural barrier. Both historical and recent records for the narrow-headed gartersnake document the species occurring in the West Fork Gila River, possibly as a low-density population exposed to the effects of harmful nonnative species.

Middle Fork Gila River—We found four historical records for the narrow-headed gartersnake in the Middle Fork Gila River at Snow Creek (1958), at "Trotter Place" (1970) (Fitzgerald 1986, Table 2), and two additional records from the confluence with the West Fork Gila River in 1989. The species was recently documented in the Middle Fork Gila River in 2008 and 2010 (Hellekson 2012a, pers. comm.). A 54 person-search hour cumulative survey effort in the Middle Fork Gila River from 2009–2011 resulted in the detection of 26 narrow-headed gartersnakes, which were all found in the upper portion; however, more search effort was made in that reach. The number of recent detections of narrow-headed gartersnakes from the upper reach of the Middle Fork Gila River clearly documents the species is extant in this area as of 2011. The Middle Fork Gila River contains headwater chub, and six other native fish species (Clarkson and Marsh 2013, pp. 1, 8) as prey for narrow-headed gartersnakes. However, the lower reach of the Middle Fork Gila River is significantly affected by nonnative, spiny-rayed fish species and bullfrogs, which were both considered abundant, and crayfish were also detected (Hellekson 2012a, pers. comm.). According to Paroz *et al.* (2006, p. 63) nonnative fish accounted for an insignificant percentage of the overall fishery biomass in the Middle Fork Gila River in 1988, but by 2005, nonnative fish species expanded their percentage of overall biomass by a 2:1 ratio over native species. Smallmouth bass and yellow bullhead appeared consistently present in all sample years from 1988–2005 (Paroz *et al*. 2006, p. 59) and channel catfish,

flathead catfish have been reported in addition to smallmouth bass (Paroz *et al.* 2009, p. 12; Propst *et al.* 2009, pp. 7–13). At least 10 narrow-headed gartersnakes from the Middle Fork Gila River were salvaged in June and July 2012, due to a significant risk of fish kills from subsequent ash and sediment flows generated by the 2012 Whitewater-Baldy Complex Fire. However, it is improbable to assume that salvage efforts collected every individual that occurs in the drainage. Based on the recent detections and stable population history in the Middle Fork Gila River, we believe that a post-salvage population remains extant and may rebound in the mid- to long-term, when subbasin conditions stabilize and fish begin to recolonize the stream or are otherwise reintroduced through restoration efforts. In the short- to mid-term, we anticipate the density of the narrow-headed gartersnake population to be at low density in the Middle Fork Gila River.

East Fork Gila River Mainstem—Two historical records for the narrow-headed gartersnake are dated 1949 (Fitzgerald 1986, Table 2). The last known record for the species from the East Fork Gila River is from 2006, when an individual was detected by fisheries biologists (Hellekson 2012a, pers. comm.). No targeted surveys for narrow-headed gartersnakes have occurred there since a 13.5 person-search hour effort in 1985, which failed to detect the species (Fitzgerald 1986, Table 4). From 1988–2005, the number of native fish species ranged from 2–6 in the East Fork Gila River (Paroz *et al*. 2006, p. 31) which is important for a narrow-headed gartersnake prey base. However, Paroz *et al*. (2006, pp. 38, 42) found that headwater chub and Sonora sucker densities were declining in the East Fork Gila River; both of which are likely important prey species for narrow-headed gartersnakes. Several species of nonnative, spiny-rayed fish, bullfrogs, and crayfish are known to be abundant in the East Fork Gila River (Hellekson 2012a, pers. comm.). Paroz *et al*. (2006, pp. 57, 59) found smallmouth bass to be the most common and consistently present nonnative fish species in the East Fork Gila River, but channel and flathead catfish may occur (Paroz *et al.* 2009, p. 12; Propst *et al.* 2009, pp. 7–13). Probst *et al.* (2008, Table 3) documents the persistence of native fish species in the East Fork Gila River. We conclude that the narrow-headed gartersnake still occurs in the East Fork Gila River, where a persisting native fishery is likely key to their survival. The abundance of nonnative, spiny-rayed fish, bullfrogs, and crayfish may be keeping gartersnake population densities low, however.

Gila River Mainstem—Two historical records for the narrow-headed gartersnake are dated 1973 and 1977 from the Gila River at 5 mi (3.1 km) east of Virden and at Cottonwood Canyon, respectively (Fitzgerald 1986, Table 2). Other museum records document one record from 1994 and 13 more from 1995 from the Lower Box of the Gila River; approximately 10 river miles (16.1 km) upstream of Virden, New Mexico. Kindsher *et al.* (2008, pp. 23, 38) reported one narrow-headed gartersnake detection in 2006 and four detections in 2007 along the Gila River mainstem, just downstream of the Mangas Creek confluence. Christman and Jennings (2009, p. 3) invested a total of 258 person-search hours and 13,464 trap-hours and only captured three narrow-headed gartersnakes, all from the upper Gila River near the Heart Bar Wildlife Management Area in 2009. Another survey effort, consisting of 40 person-search hours from 2009–2011, failed to detect the species from the reach extending from Little Creek to the Gila Bird Area (Hellekson 2012a, pers. comm.). Nonnative species, including spiny-rayed fish, crayfish, and bullfrogs, occur in various densities along the Gila River, as do native fish species (Probst *et al.* 2008, Table 3; Hellekson 2012a, pers. comm.). In particular, channel catfish, flathead catfish, and smallmouth bass were found by Propst *et al.* (1986, pp. 14–31), Springer (1995, pp. 6–10), Jakle (1995, pp. 5–7), Propst *et al.* (2009, pp. 14–17). The upper reaches of the Gila River supported relatively high densities and diversity of native fish species during the late 1980s through the early 1990s but have since declined in both parameters, most notably in the downstream direction (Paroz *et al.* 2006, pp. 57–58, 65–66). The Gila River is too long and complex to adequately assess the status of narrow-headed gartersnakes along its entire course without substantial survey efforts. Such efforts have not occurred to our knowledge, but records from 2009 document the species as extant in the upper reach. Additionally, a robust collection of records from the middle-lower reach of the Gila River, as recently as 1995, suggests the species occurs along the entire Gila River into Arizona where suitable habitat occurs, likely as declining, low-density populations because of the presence of nonnative species at various densities along its course.

Snow Lake/Snow Creek— A historical record from 1958 places the narrow-headed gartersnake at Snow Creek at the confluence with the Middle Fork Gila River (Fitzgerald 1986, Table 2). The species was most recently seen at Snow Lake in 2012, which is approximately a mile upstream of the Middle Fork Gila River, along Snow Creek (Hellekson 2012b, pers. comm.). Snow Creek is a spatially and seasonally intermittent stream that may provide a dispersal route for individuals between Snow Lake and the Middle Fork Gila River. Snow Lake is managed as a sport fishery, and stocked annually with trout measuring equal to or greater than 9 in (228.6 mm) (Hellekson 2012b, pers. comm.) which are too big for narrow-headed gartersnakes to use as prey. The lake itself is too warm and potentially too polluted to support natural trout reproduction which limits the prey available to gartersnakes (Hellekson 2012b, pers. comm.). The only remaining fish known from Snow Lake are carp, green sunfish, and occasionally fathead minnows. The limited prey, presence of harmful nonnative species, and suboptimal habitat suggests that it is unlikely that Snow Lake and Snow Creek support year-round populations of narrow-headed gartersnakes but that the species may occasionally visit the area as likely emigrants from the Middle Fork Gila River.

Gilita Creek—According to our files, there are no historical records for narrow-headed gartersnakes from Gilita Creek, but an adult female was captured there in 2009 in a survey effort consisting of 9.5 person-search hours (Hellekson 2012a, pers. comm.). No nonnative species were detected during that effort, with the exception of rainbow and brown trout which could be used as prey. This is the only known targeted survey effort for narrow-headed gartersnakes in Gilita Creek. We considered the recent detection of the narrow-headed gartersnake along with the presence of physically suitable narrow-headed gartersnake habitat, and the largely native aquatic community that occurs in Gilita Creek as evidence that the narrow-headed gartersnake likely remains extant there.

Iron Creek—One historical museum record from 1935 documents the narrow-headed gartersnake at the confluence of Iron Creek and the Middle Fork Gila River, and a neonate was captured in Iron Creek in 2009, in a survey effort consisting of 9.5 person-search hours (Hellekson 2012a, pers. comm.). No nonnative species were detected in that effort. This is the only known targeted survey effort for narrow-headed gartersnakes in Iron Creek. With this recent detection of a narrow-headed gartersnake, the presence of physically suitable narrow-headed gartersnake habitat, and the largely native aquatic community that occurs in Iron Creek, we conclude that the narrow-headed gartersnake likely remains extant.

Little Creek—According to museum records, two historical records document the narrow-headed gartersnake in Little Creek; a record from 1985 at the New Mexico State Highway 15 crossing, and another at the confluence of Little Creek and the Gila River mainstem in 1994. One survey effort, consisting of approximately 31 person-search hours from 2009–2010, found four neonatal narrow-headed gartersnakes and three adults (Hellekson 2012a, pers. comm.). During that effort, bullfrogs were detected, but crayfish or nonnative, spiny-rayed fish species were not detected. Riley and Clarkson (2005, p. 4) documented Gila trout, longfin dace, speckled dace, Sonora sucker, and desert sucker as native species found in Little Creek. Harmful nonnative species such as black bullheads, yellow bullheads, green sunfish, and smallmouth bass are found in the West Fork Gila River at the confluence with Little Creek (Riley and Clarkson 2005, p. 4). Factors such as the recent detection of the narrow-headed gartersnake, the presence of physically suitable narrow-headed gartersnake habitat, and limited diversity of nonnatives observed in Little Creek during the most-recent survey effort, provide evidence that Little Creek is occupied by the narrow-headed gartersnake.

Turkey Creek—Two historical records from 1985 document the narrow-headed gartersnake in Turkey Creek; one at one mile above Hot Springs and another near Brush Canyon (Fitzgerald 1986, Table 2). Fitzgerald (1986, Table 4) logged 18 person-search hours in 1985 and detected six narrow-headed gartersnakes in that effort. This locality was again surveyed in 2010, with approximately 14 person-search hours of effort, but there were no detections of narrow-headed gartersnakes (Hellekson 2012a, pers. comm.). Prior to 2003, Turkey Creek was significantly invaded by nonnative, spiny-rayed fish, but the 2003 Dry Lakes Fire produced significant ash and sedimentation of the stream which led to a fish kill (Hellekson 2012a, pers. comm.). Recent fisheries surveys have since documented a rebound of native fish species, and there were no detections of crayfish or bullfrogs in 2010 (Hellekson 2012a, pers. comm.), although Riley and Clarkson (2005, p. 7) and Clarkson and Marsh (2013, p. 8) list smallmouth bass as inhabitants of Turkey Creek. Native fish thought to occur in Turkey Creek include Gila chub, speckled dace, desert sucker, and Sonora sucker (Riley and Clarkson 2005, p. 7). The narrow-headed gartersnake population in the Gila River may provide individual emigrants into Turkey Creek. The presence of native fish species is likely an important factor in maintaining at least a low density population of narrow-headed gartersnakes along Turkey Creek.

Beaver Creek—Narrow-headed gartersnakes were historically documented from Beaver Creek from two records in 1949. The area was again surveyed in 1985 by Fitzgerald (1986, Table 4), with approximately two person-search hours of effort, but no detections of narrow-headed gartersnakes were made. We are not aware of any surveys of Beaver Creek for narrow-headed gartersnakes that have been conducted since that time. According to L. Hellekson (2012, pers. comm.), Beaver Creek supports nonnative, spiny-rayed fish, bullfrogs, and crayfish in abundance. Threats from these harmful nonnative species, and the amount of time since the last known record for narrow-headed gartersnake in Beaver Creek suggest the narrow-headed gartersnake is likely extirpated from this stream.

Black Canyon—According to our files, there are no historical museum records for narrow-headed gartersnakes from Black Canyon. Fitzgerald (1986, Table 4) spent approximately one person-search hour surveying Black Canyon in 1985, but did not detect the species. In 2009, three narrow-headed gartersnakes were detected in Black Canyon, and another was detected in 2010 (Hellekson 2012a, pers. comm.). No harmful nonnative species were detected in 50 person-search hours of survey effort from 2009–2011 (Hellekson 2012a, pers. comm.). The narrow-headed gartersnake population in the Gila River may provide individual emigrants into Black Canyon. Recent detections and the presence of a healthy native prey community is evidence the species remains extant in Black Canyon. However, the relatively few captures per search effort suggests the species may occur there as a low-density population.

Taylor Creek—We found no historical museum records for narrow-headed gartersnakes from Taylor Creek, which feeds Wall Lake at its upper end, but several historical records document the species at Wall Lake dated 1958 and 1960 (Fitzgerald 1986; Table 2) and suggests that the species likely historically occurred in Taylor Creek, upstream of Wall Lake. Fleharty (1967, p. 208) included the lower-most one mile of Taylor Creek in his narrow-headed gartersnake study area, where he found 29 individuals, although he did not differentiate where in the study area each specimen was detected. Fitzgerald (1986, Table 4) surveyed Taylor Creek in 1985 for less than one person-search hour in 1985, but did not encounter any narrow-headed gartersnakes during his visit. We are not aware of any surveys of Taylor Creek for narrow-headed gartersnakes since that time. According to L. Hellekson (2012, pers. comm.), Taylor Creek supports nonnative, spiny-rayed fish, and bullfrogs and crayfish are abundant in the stream. Wall Lake, operated as a privately-owned warm water sport fishery, has likely led to the extirpation of narrow-headed gartersnakes in that stream, and likely precludes any chances for their reoccupation.

Diamond Creek—According to our files, there are no historical records for narrow-headed gartersnakes from Diamond Creek. From 2009–2011, Diamond Creek was surveyed with approximately 56 person-search hours of effort resulting in the detection of 34 narrow-headed gartersnakes (Hellekson 2012a, pers. comm.). Native fish species persist in Diamond Creek, despite the presence of nonnative, spiny-rayed fish and the abundance of crayfish (Hellekson 2012a, pers. comm.). According to L. Hellekson (2012, pers. comm.), Diamond Creek may represent the densest population of narrow-headed gartersnakes in New Mexico that is threatened by the presence of harmful nonnative species.

San Francisco River Subbasin (Arizona and New Mexico)

Tularosa River—Two historical records for narrow-headed gartersnakes from 1984 document the species in the Tularosa River (Fitzgerald 1986, Table 2; Hellekson 2012a, pers. comm.). Fitzgerald (1986, Table 4) spent a cumulative survey effort of 15 person-search hours in 1985–1986 in the Tularosa River and detected three narrow-headed gartersnakes. Jennings and Christman (2010, p. 2) detected a total of 92 narrow-headed gartersnakes along the Tularosa River in 2010 in a survey effort consisting of 309 person-search hours and 2,007 trap-nights (trap-hours not reported). Hellekson (2012, pers. comm.) spent 75 person-search hours surveying for narrow-headed gartersnakes from 2009–2011 and detected 28 narrow-headed gartersnakes in that effort. A diverse and abundant native fish community (Paroz *et al.* 2006, p. 35, Figure 20) is likely responsible for the density of the resident narrow-headed gartersnake population. This native fish community is threatened however by the presence of nonnative, spiny-rayed fish species including channel catfish, flathead catfish, and smallmouth bass (Paroz *et al.* 2009, p. 12; Propst *et al.* 2009, pp. 7–13). Bullfrogs and crayfish are present, but nonnative, spiny-rayed fish appear to be uncommon (Hellekson 2012a, pers. comm.). Numerous, recent detections confirm that the narrow-headed gartersnake is extant in the Tularosa River, where they currently remain reliably detected.

Whitewater Creek—There are numerous records for the narrow-headed gartersnake from Whitewater Creek. According to Fitzgerald (1986, Table 2) and our files, the species was documented in Whitewater Creek in 1984 (n=1), 1985 (n=1), 1986 (n=3), 1996 (n=2), undated

(n=1), and 1999 (n=2). Recent records include 2009 (n=5), 2010 (n=9), and 2011 (n=5) (Hellekson 2012a, pers. comm.). Survey efforts from 2009–2011, consisting of approximately 20 person-search hours, also detected nonnative, spiny-rayed fish in the lower reach of Whitewater Creek near Glenwood, New Mexico, but no other nonnative species were observed (Hellekson 2012a, pers. comm.). At least 30 narrow-headed gartersnakes from Whitewater Creek were salvaged in June and July 2012, due to a significant risk of fish kills from subsequent ash and sediment flows generated by the 2012 Whitewater-Baldy Complex Fire. However, it is improbable to assume that salvage efforts collected every individual that occurs in the drainage. Based on the recent detections and stable population history in Whitewater Creek, we believe that a post-salvage population remains extant in Whitewater Creek and may rebound in the mid- to long-term, when subbasin conditions stabilize and fish begin to recolonize the stream or are otherwise reintroduced through restoration efforts. Immediately after the salvage effort and subsequent, expected fish kills, we anticipate the density of the narrow-headed gartersnake population to be at low density.

San Francisco River (Arizona and New Mexico)—Many historical records for the narrow-headed gartersnake document the species in the San Francisco River. According to Fitzgerald (1986, Table 2) and our files, the species was documented at various locales along the San Francisco River in New Mexico in 1939 (n=1), 1950 (n=1), 1977 (n=1), 1984 (n=2), 1986 (n=1), 1987 (n=3), 1988 (n=2), 1989 (n=1), 1995 (n=12), 1996 (n=10), 1997 (n=1), 1998 (n=9), and 1999 (n=2). An array of native fish species (Paroz *et al.* 2006, p. 35, Figure 20) present in the San Francisco River as of 2005 was likely very important to the persistence of narrow-headed gartersnakes there. Crayfish, bullfrogs, and nonnative, spiny-rayed fish are present at various densities throughout the drainage, as are at least three species of native fish (Inman *et al.* 1998, Appendix B; Holycross *et al.* 2006, pp. 49–50; Hibbitts *et al.* 2009, pp. 465–466; Hellekson 2012a, pers. comm.). Papoulias *et al.* (1989, pp. 77–80) and Propst *et al.* (2009, pp. 5–6) specifically reported harmful nonnative, spiny-rayed species such as channel catfish, flathead catfish, and smallmouth bass in the San Francisco River. Fitzgerald (1986, Table 4) spent approximately 19 person-search hours surveying for narrow-headed gartersnakes in the San Francisco River in 1985 and 1986, and documented three narrow-headed gartersnakes in that effort. Hibbitts *et al.* (2009, pp. 462–464) documented a precipitous decline of narrow-headed gartersnakes from the vicinity of the San Francisco River Hot Springs, from a total of 328 captures in 1995 (two visits) and 1996 (four visits), to zero captures in 2004 (two visits), with a total, cumulative trapping effort of 29,280 trap-hours. Holycross *et al.* (2006, pp. 49–50) returned to survey the San Francisco River at Alma Bridge and the Hot Springs in 2005, and invested approximately 88 person-search hours and 9,800 trap-hours at these locations with no detections of narrow-headed gartersnakes. More recent survey efforts from 2009–2011, consisting of approximately 100 person-search hours, reconfirmed the species as extant with documentation of three narrow-headed gartersnakes from the San Francisco River in New Mexico (Hellekson 2012a, pers. comm.). According to our files, we are not aware of any historical records for narrow-headed gartersnakes from the lower San Francisco River in Arizona. However, that reach has never been surveyed according to our files and we have no reason at this time to suspect that narrow-headed gartersnakes are not extant throughout the San Francisco River where suitable habitat occurs. Recent records document the narrow-headed gartersnake as extant as a low density population in the San Francisco River but the documented significant decline of a formerly healthy population is of serious concern.

Negrito Creek—A single historical record for the narrow-headed gartersnake in Negrito Creek dates from 1977 (Fitzgerald 1986, Table 2). Hellekson (2012, pers. comm.) conducted 3 person-search hours in 2009 and another 3.5 person-search hours in 2010 surveying for the narrow-headed gartersnake in mainstem Negrito Creek with no detections. Bullfrogs are present, but nonnative, spiny-rayed fish and crayfish were not detected in that effort (Hellekson 2012a, pers. comm.). Four species of native fish are thought to persist in Negrito Creek. The length of time since the last record of a narrow-headed gartersnake suggests the species may be extirpated from Negrito Creek although survey effort has been limited.

South Fork Negrito Creek—According to our files, the first record for the South Fork Negrito Creek was in 2006. Since that time, Hellekson (2012, pers. comm.) spent nearly 40 person-search hours in South Fork Negrito Creek from 2009–2011, and observed three narrow-headed gartersnakes; bullfrogs and crayfish were also detected. These recent detections confirm the narrow-headed gartersnake is extant in South Fork Negrito Creek, likely as a low density population based on the search effort per capture.

Blue River—According to information in our files, there are several historical and recent records of narrow-headed gartersnakes from the Blue River from 1964 (n=1), 1969 (n=3), 1988 (n=1), 1995 (n=2), 1998 (n=1), 2005 (n=2), and 2007 (n=1) (Rosen and Schwalbe 1988, Appendix II; Holycross *et al.* 2006, Appendix C). Fernandez and Rosen (1996, p. 69) reported 12 detections of narrow-headed gartersnakes in 1987 from the Blue River, and stated that narrow-headed gartersnake densities appeared higher along its lower reach. Holycross *et al.* (2006, pp. 45–46) spent a total, cumulative survey effort of approximately 175 person-search hours and 19,465 trap-hours at two sites in 2004 and 2005, with seven captures of narrow-headed gartersnakes. A narrow-headed gartersnake was also observed in the Blue River in 2009 during fisheries surveys (Crowder 2009, pers. comm.). The fish community of the Blue River is largely native and rainbow trout also provide prey. Crayfish and nonnative, spiny-rayed fish have also been detected in the Blue River (Crowder 2009, pers. comm.). Specifically, ASU (1994, multiple reports; 1995, multiple reports) and Clarkson *et al.* (2008, pp. 3–4) reported nonnative, spiny-rayed species such as channel catfish, flathead catfish, and smallmouth bass in the Blue River. Bullfrogs were not detected (Holycross *et al.* 2006, pp. 45–46). Recent detections indicate that the narrow-headed gartersnake remains extant in the Blue River.

Dry Blue Creek (Arizona and New Mexico)—According to our files, the first record for narrow-headed gartersnakes in Dry Blue Creek was in 2010. Hellekson (2012, pers. comm.) spent nearly 12 person-search hours in Dry Blue Creek in 2010 and observed one narrow-headed gartersnake; bullfrogs and nonnative, spiny-rayed fish were also detected, but crayfish were not. As of 2005, the resident fish community and prey base for narrow-headed gartersnakes in Dry Blue Creek included loach minnow, speckled dace, desert sucker, and Sonora sucker (Riley and Clarkson 2005, p. 10), however populations may be depressed from the effects of ash and sediment flows as a result of the 2011 Wallow Fire. The narrow-headed gartersnake population in the Blue River may contribute individuals to this population. We consider the narrow-headed gartersnake to be extant in Dry Blue Creek, likely as a low-density population.

Campbell Blue Creek (Arizona and New Mexico)—The first museum record for narrow-

headed gartersnakes in Campbell Blue Creek was in 2000, according to our files. Hellekson (2012, pers. comm.) spent nearly 16 person-search hours in Campbell Blue Creek in 2010 and observed four narrow-headed gartersnakes; crayfish were noted as abundant and bullfrogs were detected in that effort, but nonnative, spiny-rayed fish were not. The resident fish community and prey base for narrow-headed gartersnakes in Campbell Blue Creek may be depressed from the effects of ash and sediment flows as a result of the 2011 Wallow Fire. Both the Blue River and Dry Blue Creek populations may contribute individuals to this population. We consider the narrow-headed gartersnake to be extant in the Campbell Blue Creek, likely as a low-density population.

Saliz Creek—According to our files, there are no historical records for the narrow-headed gartersnake from Saliz Creek. Hellekson (2012, pers. comm.) spent approximately 10 person-search hours in Saliz Creek in from 2009–2011, but did not detect any narrow-headed gartersnakes in that effort; bullfrogs, crayfish, and nonnative, spiny-rayed fish were detected, with the latter in greater densities downstream near the confluence with the San Francisco River. Part of the Hellekson (2012, pers. comm.) survey effort was conducted on a cool, cloudy day that may have suppressed surface activity of narrow-headed gartersnakes. Narrow-headed gartersnakes from Whitewater Creek were salvaged in June 2012, due to a significant risk of fish kills from subsequent ash and sediment flows generated by the 2012 Whitewater-Baldy Complex Fire. A portion of salvaged individuals were translocated to Saliz Creek. Emigration from the San Francisco River population may also augment this population. Native fish documented from Saliz Creek include speckled dace, desert sucker, and Sonora sucker with longfin dace possibly inhabiting the lower reach (Riley and Clarkson 2005, p. 10). We consider the narrow-headed gartersnake to be extant in Saliz Creek.

Eagle Creek—According to our files, as well as information from Rosen and Schwalbe (1988, Appendix II), Fernandez and Rosen (1997, p. 59), and Holycross *et al.* (2006, Appendix C), narrow-headed gartersnakes are historically well known from Eagle Creek, with records dating to 1934 (n=2), 1964 (n=1), 1983 (n=2), 1987 (several), 1988 (n=1), and 1991 (n=1). The narrow-headed gartersnake was observed as abundant in 1987 in Eagle Creek, with 29 detections of varying densities; the highest density population was reported from the lower reach of Eagle Creek (Fernandez and Rosen 1996, p. 69). Three areas along Eagle Creek were visited by Holycross *et al.* (2006, pp. 47–48, 60): Honeymoon Campground (2004), P-Bar Ranch (2005), and the Phelps Dodge pumping plant (2004) with a total, cumulative survey effort of approximately 138 person-search hours and 19,660 trap-hours, with no detections of narrow-headed gartersnakes. Nonnative, spiny-rayed fish and crayfish are abundant in Eagle Creek, but bullfrogs have not been reported (Holycross *et al.* 2006, pp. 47–48; Karam *et al.* 2009, pp. 2–3). Specifically, Marsh *et al.* (2003, p. 667), ASU (2008, multiple reports), and Bahm and Robinson (2009, pp. 2–6) reported nonnative, spiny-rayed species such as channel catfish, flathead catfish, and smallmouth bass in Eagle Creek. Eagle Creek is known to support at least six species of native fish (Fernandez and Rosen 1996, p. 71; Holycross *et al.* 2006, p. 47; Turner and List 2007, p. 9). Surveys have not occurred on the uppermost reaches of Eagle Creek located on the San Carlos Apache Indian Reservation but we have no reason to suspect that narrow-headed gartersnakes do not occur there where suitable habitat persists. The notable decline of this once-reliable population of narrow-headed gartersnakes is of serious concern. However, their history in Eagle Creek suggests the species remains extant there, likely as a very low-density population, possibly augmented from emigration of individuals from the San Francisco River.

Upper Salt River Subbasin (Arizona)

Black River—Numerous historical records document the narrow-headed gartersnake in the Black River: 1874 (n=1), 1953 (n=1), 1956 (n=1), 1962 (n=1), 1965 (n=3), 1967 (n=1), 1969 (n=4), 1971 (n=1), 1982 (n=1), 1988 (n=11), 1989 (n=1), 1995 (n=5), and 2005 (n=1) (Fernandez and Rosen 1996, p. 54–55; Holycross *et al.* 2006, Appendices C and D). Holycross *et al.* (2006, p. 30) spent a total of 141 person-search hours and 18,200 trap hours in 2005 surveying for narrow-headed gartersnakes in the Black River below Wildcat Point (upstream of the reservation boundary) and captured nine narrow-headed gartersnakes. Fifteen narrow-headed gartersnakes were captured in a 2007 survey effort that consisted of approximately 96 person-search hours and 9,300 trap-hours (Brennan 2007, p. 5). Brennan and Rosen (2009, p. 7) surveyed the Black River in Arizona in 2009, with a total investment of effort that consisted of approximately 54 person-search hours and 2,442 trap-hours, which resulted in the capture of 19 narrow-headed gartersnakes. Crayfish are reported in high densities in the Black River (Fernandez and Rosen 1996, pp. 54–55; Inman *et al.* 1998, Appendix B; Brennan 2007, Table 2). Nonnative, spiny-rayed fish also occur, as do both native and nonnative soft-rayed fish species (Holycross *et al.* 2006, p. 30; Brennan 2007, Table 2; Brennan and Rosen 2009, p. 9). Dense stands of willows were also observed overhanging the stream channel; an important structural component to suitable narrow-headed gartersnake habitat (Holycross *et al.* 2006, p. 30). Holycross *et al.* (2006, p. 34) also dedicated 16 person-search hours and 656 trap-hours in their 2004 survey of the East Fork of the Black River, which detected crayfish and rainbow trout; no narrow-headed gartersnakes were captured. There is an approximate 75 river mile (121 km) reach of the Black River on White Mountain Apache Tribe lands that has never been surveyed

for narrow-headed gartersnakes, according to our files, but we have no reason to suspect the species does not occur there where suitable habitat occurs. Big Bonito Creek and the Salt River may contribute emigrating individuals to the Black River. We consider the narrow-headed gartersnake to be extant in the Black River, likely as a low density population.

White River—Historical records of the narrow-headed gartersnake in the White River include the years 1874 (n=1), 1950 (n=1), 1964 (N=1), 1965 (n=1), 1967 (n=1), and 1986 (n=1) (Rosen and Schwalbe 1988, Appendix II; Holycross *et al.* 2006, Appendix C). The only survey effort in the White River occurred in 1986, and consisted of nearly seven person-search hours that resulted in the 1986 record (Rosen and Schwalbe 1988, Appendix II). The entire White River, occurs within White Mountain Apache Tribal lands, which has historically prevented surveyor access. Voeltz (2002, p. 50) documented the presence of native chubs in the White River as late as 1988, which may indicate that native fish species may still persist. The Black and Salt rivers may contribute individuals to this population through natural emigration. The best available information suggests that the narrow-headed gartersnake is extant along the White River based on historical records for the species itself and that for native fish. The exact status of the population is difficult to discern because of limited survey access and limited survey data.

Diamond Creek—According to Holycross *et al.* (2006, p. 5) and Rosen and Schwalbe (1988, Appendix II), a historical record dated 1986 for the narrow-headed gartersnake documents the species in Diamond Creek. Diamond Creek exists solely on White Mountain Apache Tribal lands, and has been surveyed for a total of 3 person-search hours in that 1986 effort. We have no information on the aquatic community of Diamond Creek. The North Fork of the White River may contribute individuals to this population through natural emigration. There is a historical record for the narrow-headed gartersnake from the last known survey and no additional information to suggest the species has been extirpated from Diamond Creek, therefore we consider it extant, with no other information on population viability.

Tonto Creek (tributary to Big Bonita Creek)— According to Holycross *et al.* (2006, p. 5) and Rosen and Schwalbe (1988, Appendix II), a historical record dated 1915 for the narrow-headed gartersnake documents the species in Tonto Creek, a tributary of Big Bonito Creek. Tonto Creek exists solely on White Mountain Apache Tribal lands, and has never been surveyed, according to our files. We have no information on the aquatic community of Tonto Creek. Almost 100 years has passed since the last known record for narrow-headed gartersnakes in Tonto Creek on the White Mountain Apache Reservation, although survey data are conspicuously lacking. There is the possibility that harmful nonnative species are widely distributed on the reservation, as is the case largely throughout the distribution of the narrow-headed gartersnake. The length of time passed since the last reported record suggests the narrow-headed gartersnake may be extirpated from Tonto Creek.

Canyon Creek—The first historical record for the narrow-headed gartersnake appears to be in 1986, from approximately 2.25 miles (3.6 km) upstream of the confluence with the Salt River on White Mountain Apache Tribal lands (Rosen and Schwalbe 1988, Appendix II). Additional reports to the AGFD's Heritage Database document the species in upper and lower Canyon Creek during the 1980s, and as late as 1991 (Holycross *et al.* 2006, pp. 5, 31–32). Approximately 33 river miles (53 km) of Canyon Creek, from its confluence with the Salt River to the reservation boundary, occur on White Mountain Apache Tribal lands and are, therefore, largely inaccessible for surveys. Eleven person-search hours of survey effort in 1986 is the total effort made in Canyon Creek on tribal lands, and is the source of the 1986 record; no nonnative species were detected (Rosen and Schwalbe 1988, Appendix II). Holycross *et al.* (2006, pp. 31–32) conducted three surveys of Canyon Creek, upstream of White Mountain Apache Tribe lands in 2004–2005, with a combined survey effort of 36 person-search hours and 90 trap-hours, with no detections of narrow-headed gartersnakes. Native fish were detected, as were nonnative trout (Holycross *et al.* 2006, pp. 31–32), which serve as prey species. No nonnative, spiny-rayed fish, crayfish, or bullfrogs were detected in these surveys efforts (Holycross *et al.* 2006, pp. 31–32). The physical habitat looked "ideal" for narrow-headed gartersnakes, with cobble stream substrates and adequate streamside vegetation that included watercress and willow (Holycross *et al.* 2006, pp. 31–32, 57). Individuals from the Salt River may disperse into Canyon Creek and augment that population. We consider the narrow-headed gartersnake to be extant along Canyon Creek, possibly as a low-density population.

Upper Salt River—The narrow-headed gartersnake was known from the Salt River, upstream of Arizona State Highway 288, according to historical records dated 1967 (n=1), 1971 (n=1), 1978 (n=1), and 1985 (n=1) (Hulse 1973, p. 281; Rosen and Schwalbe 1988, Appendix II; Holycross *et al.* 2006, pp. 5, 38–39). Narrow-headed gartersnakes were historically seen in "large numbers" along Gleason Flat, upstream of the Arizona State Highway 288 crossing, on the upper Salt River according to fisheries biologists (Fernandez and Rosen 1996, p. 72). Rosen and Schwalbe (1988, Appendix II) surveyed the upper Salt River in 1986, with approximately two person-search hours of effort at night in one location, and did not detect any narrow-headed gartersnakes. Holycross *et al.* (2006, pp. 38–39) spent 120 person-search hours and 1,525 trap-hours in the upper Salt River during 2004 and 2005, with no detections of narrow-headed gartersnakes. The Salt River represents a large, complex, and difficult area to survey, which makes detections difficult and population status difficult to confirm. Native fish and lowland leopard frogs occur, as do nonnative, spiny-rayed fish species and crayfish; no bullfrogs have recently been detected in surveyed reaches (Inman *et al.* (1998, Appendix B; Voeltz 2002, pp. 49–50; Holycross *et al.* 2006, pp. 38–39). An approximately 30 river mile (48.3 km) reach of the upper Salt River traverses through the White Mountain Apache and the San Carlos Apache reservations, where access restrictions have prohibited surveys and data are difficult to obtain. Populations in the White River, Black River, Carrizo Creek, and Canyon Creek may contribute individuals to the upper Salt River population through dispersal mechanisms. We consider the narrow-headed gartersnake to be extant along the upper Salt River, upstream of the Arizona State Highway 288 crossing; likely as a low-density population.

Cibecue Creek—There are no museum records for narrow-headed gartersnakes in Cibecue Creek, according to our files, but Holycross *et al.* (2006; p. 5) reports observation records of narrow-headed gartersnakes from the years spanning 1960 to 1991. Cibecue Creek exists wholly on White Mountain Apache Tribal lands, which has historically limited survey access. Rosen and Schwalbe (1988, Appendix III) surveyed Cibecue Creek in 1986 for a cumulative 17 person-search hour effort (the last known survey of this stream), but did not detect narrow-headed gartersnakes. They did native fish species, the presence of which is also supported by Voeltz (2002, p. 55). This population may be augmented from dispersing individuals from the Salt River. We consider the narrow-headed gartersnake to be extant along Cibeque Creek but have little information on the viability of that population based on limited survey access and limited data.

Carrizo Creek—There are no museum records for narrow-headed gartersnakes in Carrizo Creek, according to our files, but Holycross *et al.* (2006; p. 5) report observation records for narrow-headed gartersnakes from the 1980s, and a photo voucher from 1997. In 1987, several narrow-headed gartersnakes were detected at the main road crossing of Carrizo Creek and the species was noted as being in abundance along all perennial reaches of Carrizo Creek (Fernandez and Rosen 1996, p. 72). Carrizo Creek exists wholly on White Mountain Apache Tribal lands, which has historically limited survey access. Rosen and Schwalbe (1988, Appendix III) surveyed Carrizo Creek in 1986 for 0.5 person-search hours (the last known survey of this stream), but did not detect narrow-headed gartersnakes. However, they did observe native fish species, the presence of which is also supported by Voeltz (2002, p. 52). Historical and recent sight records (including a 1997 photo voucher) document that narrow-headed gartersnakes occurred in Carrizo Creek and data suggesting native fish species may also occur provide evidence that narrow-headed gartersnakes may still occur there. We have little information on the viability of that population based on limited survey access and limited data

Big Bonito Creek—There are two historical records of the narrow-headed gartersnake dated 1957 from Big Bonito Creek (Holycross *et al.* 2006, Appendix C). In 2004, Holycross *et al.* (2006, pp. 29–30, 56) spent 8 person-search hours in Big Bonito Creek, but did not detect the narrow-headed gartersnake. They did detect crayfish and nonnative, spiny-rayed fish were observed as abundant. Big Bonito Creek is on White Mountain Apache Tribal lands, where survey access has been historically limited. We are not aware of any other surveys of this drainage beyond the 11 person-search hour effort in 1986 (Rosen and Schwalbe 1988, Appendices I and III) and that of Holycross *et al.* (2006, pp. 29–30). Rosen and Schwalbe (1988, Appendix III) reported a robust native fish community in Big Bonito Creek in the mid 1980s, but observations by Holycross *et al.* (2006, pp. 29–30, 56) suggest that nonnative, spiny-rayed fish now dominate. Therefore, given the length of time since the last record for narrow-headed gartersnakes and the poor status of their prey community in Big Bonito Creek, we conclude that the species is likely extirpated from Big Bonito Creek.

Haigler Creek—Haigler Creek was surveyed by Holycross *et al.* (2006, p. 35) in 2004 with 14 person-search hours and 646 trap-hours of effort. There are three unvouchered, but reliable, observation records of narrow-headed gartersnakes from Haigler Creek during the early 1990s (Holycross *et al.* 2006, p. 35). The fish community in Haigler Creek consists of both native fish and nonnative trout, which indicates a prey base for the narrow-headed gartersnake is present, but crayfish were also present in numbers. No nonnative, spiny-rayed fish or bullfrogs were detected by Holycross *et al.* (2006, p. 35). Narrow-headed gartersnakes may disperse into Haigler Creek from occupied Tonto Creek and augment the population. We conclude that the narrow-headed gartersnake is likely still present along Haigler Creek, likely as a low-density population.

Houston Creek—There is one photo-vouchered record for narrow-headed gartersnakes in Houston Creek from 2005, according to Holycross *et al.* (2006; Appendix C). Houston Creek was surveyed in 2004 and 2005 by Holycross *et al.* (2006, pp. 35–36) with an effort that totaled 15 person-search hours. No narrow-headed gartersnakes were detected, but native fish, crayfish, and nonnative, spiny-rayed fish were observed. Survey conditions were poor in 2004, with limited visibility in the water due to recent flooding. Houston Creek is largely dry above Gibson Creek, but presents physically suitable narrow-headed gartersnake habitat below that point (Holycross *et al.* 2006, pp. 35–36). Narrow-headed gartersnakes may disperse into Houston Creek from occupied Tonto Creek and augment the population. We are not aware of any other targeted surveys for narrow-headed gartersnakes in Houston Creek. We conclude that the narrow-headed gartersnake is likely still present along Houston Creek, likely as a low-density population.

Tonto Creek (tributary to Salt River)— Previous records of the narrow-headed gartersnake in Tonto Creek consist of one neonate narrow-headed gartersnake that was captured in the area of the Rye Creek confluence (2005), and two historical records from the area of Kayler Butte (1988) (Holycross *et al.* 2006, p. 43). Holycross *et al.* (2006, pp. 40–44) surveyed Tonto Creek from the headwaters to approximately Gisela, Arizona for narrow-headed gartersnakes in 2004 and 2005. Approximately 302 person-search hours and 21,200 trap-hours were invested in this effort that resulted in the detection of a single neonatal narrow-headed gartersnake (Rye Creek confluence record). In 2008, Burger (2008, p. 1) spent 75 person-search hours surveying for narrow-headed gartersnakes in Tonto Creek from Bear Flat Campground to the confluence with Haigler Creek, but did not detect any narrow-headed gartersnakes. Tonto Creek is known to be heavily occupied by a suite of nonnative species including bullfrogs, crayfish, and a host of nonnative fishes (Holycross *et al.* 2006, p. 59; Burger 2008, pp.1, 4; Wallace *et al.* 2008; pp. 243–244), but native fish species still occur and, in some reaches, are well-represented (Voeltz 2002, pp. 58–60; Burger 2008, pp.1, 4). Structurally, the habitat was considered generally suitable for narrow-headed gartersnakes by the surveyors, and Holycross *et al.* (2006, p. 59) suggested that significant declines in the narrow-headed gartersnake population have occurred in Tonto Creek since the 1980s; demonstrated by their significant survey effort and limited captures. We consider the narrow-headed gartersnake to be extant in Tonto Creek, likely as a low-density population.

Deer Creek— Although there are no historical museum records of narrow-headed gartersnakes from Deer Creek, a reliable, but unvouchered, observation record and additional

vouchers from nearby Tonto Creek led Holycross *et al.* (2006, p. 57) to the conclusion that narrow-headed gartersnakes occurred in Deer Creek as recently as 1995. Upon arrival at this survey location in 2004, Holycross *et al.* (2006, p. 34) found the drainage to be dry, with limited access due to access restrictions resulting from the Willow Fire that was burning in the area at that time. The unreliability of flows in this creek, coupled with the effects of sedimentation to the fish community that presumably occurred there from the 2005 Willow Fire, suggests the species was likely extirpated from this drainage as of 2005. No subsequent surveys have been conducted in Deer Creek since 2005, and we are uncertain whether flows have been reestablished in that drainage. If flow has returned, and native fish have recolonized, Tonto Creek may be serving as a source population of narrow-headed gartersnakes for Deer Creek where the species may occur as a low-density population, but we have no recent information to confirm this and treat this stream as unoccupied at this time.

Verde River Subbasin (Arizona)

Upper Verde River—Above Horseshoe Dam, there are several, recent and vouchered records of the narrow-headed gartersnakes in the upper Verde River. The first was from 2001 at Mormon Pocket, between Perkinsville and the confluence with Sycamore Creek, followed by a 2005 record from the confluence of Fossil Creek (Holycross *et al.* 2006, Appendix C). Prior to that time, several reliable, but unvouchered, records for the species were reported from the upper Verde River: near Bear Siding (1986 and 2000), near Childs (1986), and near Clarkdale (1988 and 1995) (Holycross *et al.* 2006, p. 4). In 2009, Nowak (2009, Table 1) invested 68 person-search hours and 314 trap-night (trap-hours not reported) of survey effort in the upper Verde River above Clarkdale and at the confluence with Sycamore Creek, but had no detections of narrow-headed gartersnakes. In 2010, a neonatal narrow-headed gartersnake was observed near Prospect Point and another (age not specified) was possibly seen (Emmons *et al.* 2011, p. 14; Emmons and Nowak 2012a, p. 310; Emmons and Nowak 2012b, pp. 12-14, 19). Two additional records (neonate and sub-adult) were reported in this same area in 2012 (Emmons 2012, pers. comm.). Surveys for the narrow-headed gartersnake in 2004 and 2005, within this reach, totaled 154 person-search hours and 18,145 trap-hours, with no detections of narrow-headed gartersnakes (Holycross *et al.* 2006, p. 26–28). Another 120 person-search hour effort was made in the Verde River within the Verde Valley (including Dead Horse Ranch State Park) in 2007, with no detections of narrow-headed gartersnakes (Gartersnake Conservation Working Group 2007, p. 2). In 2012, Emmons and Nowak (2013, Table 1) invested 103 person-search hours and 25,860 trap-hours surveying for the northern Mexican gartersnake at the Verde River at the Salt River Project property east of the Interstate 17 bridge and the Verde River Greenway adjacent to Deadhorse Ranch State Park. No narrow-headed gartersnakes were detected in this effort, although trap locations likely focused on the habitat preferences of the northern Mexican gartersnake.

The Verde River upstream of Horseshoe Dam supports both native and nonnative fish communities, with at least six species of native fish having been reported (Turner and List 2007, p. 9; Emmons and Nowak 2012b, pp. 11–14). The upper Verde River appears to generally transition from native to nonnative in the downstream direction, to Horseshoe Dam (Voeltz 2002, pp. 70–71; Holycross *et al.* 2006, pp. 26–29). Numerous researchers have documented nonnative, spiny-rayed species such as channel catfish, flathead catfish, and smallmouth basin the Verde River (Minckley 1993, pp. 7–13; Jahrke and Clark 1999, pp. 2–7; Rinne 2004, pp. 1–2; Bahm and Robinson 2009b, pp. 1–4; Robinson and Crowder 2009, pp. 3–5). Emmons and Nowak (2012, p. 5) provided their data on harmful nonnative species detections from the upper Verde River region in 2012: green sunfish (n = 3435); bluegill (n=347); smallmouth bass (n=257); largemouth bass (n = 210); yellow bullhead (n = 23); rock bass (*Ambloplites rupestris*, n=10); crayfish (n = 336); and bullfrogs in all life stages (n = 779). Prey species were detected in far fewer numbers: desert sucker (n=11) and speckled dace (n=1) (Emmons and Nowak 2012, p. 5) Inman *et al.* (1998, Appendix B) reported crayfish from the Verde River. The Verde River represents a large, complex, and difficult area to survey, but recent records document that at least a low-density, but reproducing, population of narrow-headed gartersnakes occurs within this reach of the Verde River.

Oak Creek—Supporting perhaps the most robust and well-studied population of narrow-headed gartersnakes in Arizona, Oak Creek boasts approximately 176 historical and recent records dating back to 1912, and represents the locality where over 80 percent of all Arizona specimens were collected (Holycross *et al.* 2006, p. 4, Appendix C). Nowak and Santana-Bendix (2002, pp. 12–13) spent a total of 640 person-search hours and 1,542 trap-nights (number of traps multiplied by the number of nights they were opened) surveying Oak Creek, from the Pumphouse Wash confluence, downstream to the Lower Oak Creek Estates, located south of Cornville, Arizona. This effort resulted in the capture of 129 individual narrow-headed gartersnakes (Nowak and Santana-Bendix 2002, p. 15). Nowak (2006, p. 7) invested 511 person-search hours in 2004 and 2005, surveying for narrow-headed gartersnakes in Oak Creek. This effort resulted in 124 detections of the species, which likely includes an unknown number of recaptures. Brennan and Rosen (2009, p. 11) surveyed Oak Creek in 2009, with a total investment of effort equaling approximately 132 person-search hours, which resulted in the capture of 72 narrow-headed gartersnakes. Survey results, from the lower-most transect near Midgely Bridge, confirmed that the narrow-headed gartersnake continues to exist at very low densities in lower Oak Creek (Brennan and Rosen 2009, p. 13). Nowak and Santana-Bendix (2002, Table 3) documented a shift in Oak Creek from a largely native fish community upstream of Midgely Bridge to a community dominated by nonnative, spiny-rayed fish species downstream of Midgely Bridge. Bullfrogs and crayfish occur in the lower reach of Oak Creek (Nowak 2006; p. 27) and crayfish densities grade from low to high in the downstream direction from Slide Rock State Park (Brennan and Rosen 2009, pp. 14–16). Nowak (2006, p. 10) demonstrates population reductions in narrow-headed gartersnakes and fewer snakes per person-search hour effort, as compared to that of Rosen and Schwalbe (1988, Appendix II) in this same area. Narrow-headed gartersnake populations reach their highest densities in the upper-most reaches of Oak Creek Canyon, including West Fork Oak Creek and its confluence with Oak Creek. Downstream of that reach, population densities gradually decrease until Midgely Bridge, where the species is very rarely detected (Nowak 2006, p. 10). From Midgely Bridge downstream to the confluence with the Verde River, narrow-headed gartersnakes likely exist as a

low, to very low density population, but is likely supported by occasional emigrants from Oak Creek Canyon or from the Verde River.

East Verde River—We are aware of a single historical museum record in 1981 (Holycross *et al.* 2006, Appendix C) of narrow-headed gartersnakes from the East Verde River, but numerous observation records are reported from 1985–1986 (n=12) (Rosen and Schwalbe 1988, Appendix II) and 1992 (n=1) (Sredl *et al.* 1995, p. 5). These records indicate the species once occurred in the East Verde River, but has apparently declined. Rosen and Schwalbe (1988, Appendix II) invested approximately 20 person-search hours from 1985–1986 surveying the East Verde River, which produced 12 observation records for narrow-headed gartersnakes. Recruitment problems for narrow-headed gartersnakes were observed in the East Verde River during the mid-1980s; evidenced by detections that where dominated by the largest age class (Rosen and Schwalbe 1988, p. 45). Holycross *et al.* (2006, pp. 21–22) spent 182 person-search hours and 20,757 trap-hours from 2004–2005 surveying the East Verde River with no observations of narrow-headed gartersnakes. Native fish species persist (Voeltz 2002, p. 76) in the presence of nonnative, spiny-rayed fish and abundant crayfish, although no bullfrogs were detected. Turner and List (2007, p. 9) reported that at least six species of native fish are known from the East Verde. Narrow-headed gartersnakes may disperse into the East Verde from the occupied Verde River to augment the population. This population likely occurs as a low to very low density population.