# ARROYO TOAD
# (*Anaxyrus californicus*)

# SPECIES REPORT

**Arroyo Toad (*Anaxyrus californicus*)**
(*Photo by permission of Will Flaxington*)

**Male Arroyo Toad** (*Photo by USFWS*)

U.S. Fish and Wildlife Service
Ventura Fish and Wildlife Office, Ventura, California

March 24, 2014 - Final

## EXECUTIVE SUMMARY

The arroyo toad is a small, stocky, warty toad that is found in coastal and desert drainages in central and southern California, and Baja California, México. The arroyo toad has evolved in an ecosystem that is inherently quite dynamic, with marked seasonal and annual fluctuations in climatic regimes, particularly rainfall. Natural climatic variations as well as other random events such as fires and drought, coupled with the species' specialized habitat requirements are likely to lead to annual fluctuations in arroyo toad population sizes. The distribution of the arroyo toad also appears to be restricted naturally as a result of specific habitat requirements for breeding and development. These natural restrictions, coupled with the small sizes of many arroyo toad populations, make them particularly vulnerable to the negative effects of human-induced changes to their habitats.

There are several human-related activities that affect the hydrology of arroyo toad stream habitats and can destroy or severely modify the dynamic nature of the riparian systems upon which arroyo toads depend for reproduction, development, and survival. Human activities that affect water quality, the amount and timing of non-flood flows, or the frequency and intensity of floods; affect riparian plant communities; or alter sedimentation dynamics can reduce or eliminate the suitability of stream channels for arroyo toad breeding habitat. Degradation or loss of surrounding uplands reduces and eliminates foraging and overwintering habitat. The effects of such activities may not become apparent until years later when the habitat finally becomes sufficiently degraded that arroyo toads can no longer reproduce and survive. These negative human-related activities include urban development and agriculture within and adjacent to riparian habitats, dam building and the resultant reservoirs, water flow manipulations, sand and gravel mining, suction dredge mining, road placement across and within stream terraces, livestock grazing, off-highway vehicle use of roads and stream channels, the placement of campgrounds in arroyo toad habitat (especially on stream terraces), and the use of stream channels and terraces for other recreational activities.

Besides physical habitat alteration, the stabilization of water flows and riparian vegetation also benefits a number of nonnative species of plants and aquatic predators. These plants and animals, once they are established, tend to become widespread and build up large populations, which result in the loss of arroyo toads either indirectly through the degradation of habitat or directly through predation. The invasion of nonnative plants can alter the fire regimes, leading to intense fires in the riparian zones that can result in direct mortality and loss of foraging and sheltering habitat for arroyo toads.

The purpose of this species report is to prepare an objective report detailing the best available information about the species, including information about the species' life history, distribution, habitat, abundance, viability, threats, and conservation efforts to reduce impacts from current threats. Our original listing of a species as an endangered species or a threatened species is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Endangered Species Act of 1973, as amended, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In this species report, we consider the best available scientific and commercial data on the species, and we focus on new information available since the species status was last reviewed in 2009.

## INTRODUCTION

The arroyo toad, *Anaxyrus californicus,* inhabits rivers and streams of coastal southern California, from Monterey County southward into northern Baja California, México. In the United States, the arroyo toad was listed as an endangered species on December 16, 1994 (59 FR 64859). The reasons for the arroyo toad listing were loss of habitat coupled with habitat modifications due to the manipulation of water levels in many central and southern California streams and rivers, as well as predation from introduced aquatic species (Jennings and Hayes 1994, p. 56). These threats, together with the limited natural occurrence of the arroyo toad (it was thought to remain in only eight drainages) and small populations that are susceptible to severe reduction in numbers due to collection and naturally occurring random events (such as extended droughts), resulted in the Service first including this animal as a Category 2 candidate species on September 18, 1985 (50 FR 37958), before subsequently listing the species as an endangered species in 1994. The species is also endangered under the California Endangered Species Act (CESA) (California Fish and Game Code §2050). The Global Amphibian Assessment lists the species as endangered (IUCN, Conservation International, and NatureServe 2008).

The arroyo toad has recently been listed as an endangered species in México (Lovich *in litt.* 2010). Arroyo toad populations receive additional protection on lands within the Mexican national park system, such as the Parque Nacional Sierra San Pedro Mártir that is located in northwestern Baja California (Lovich 2009, p. 8). However, arroyo toad populations occurring elsewhere in México are vulnerable to land use and urbanization throughout their range in northern Baja California (Lovich 2009, p. 8).

The arroyo toad is a small, stocky, warty toad that is about 2 to 3 inches (in) (5.1 to 7.6 centimeters (cm)) in length (Stebbins 2003, p. 212). The skin of this toad is light olive green, gray, or light brown in color with a light-colored stripe shaped like a “V” across the head and eyelids. The belly is white or buff colored, usually without spots. Arroyo toads are found in low gradient, medium-to-large streams and rivers with intermittent and perennial flow in coastal and desert drainages in central and southern California, and Baja California, Mexico. Arroyo toads occupy aquatic, riparian, and upland habitats in the remaining suitable drainages within its range. Arroyo toads are breeding habitat specialists and require slow-moving streams that are composed of sandy soils with sandy streamside terraces (Sweet 1992, p. 23–28). Reproduction is dependent upon the availability of very shallow, still, or low-flow pools in which breeding, egg-laying, and tadpole development occur. Suitable habitat for the arroyo toad is created and maintained by periodic flooding and scouring that modify stream channels, redistribute channel sediments, and alter pool location and form. These habitat requirements are largely dependent upon natural hydrological cycles and scouring events (Madden-Smith *et al*. 2003, p. 3).

Because the arroyo toad has specialized breeding habitat requirements, it is particularly vulnerable to habitat destruction and alteration due to short- and long-term changes in river hydrology, including construction of dams and water diversions. The arroyo toad is also impacted by the alteration of riparian wetland habitats from agriculture and urbanization, construction of roads, site-specific damage by off-highway vehicle use and other recreational activities, overgrazing, and mining activities. Arroyo toads are also impacted by nonnative predators, particularly American bullfrogs (*Lithobates catesbeianus*) and predatory fish, drought, periodic fire and fire suppression, and climate change (Sweet 1992, p. 189; Jennings and Hayes 1994, p. 57; Campbell *et al.* 1996, p. 2). As described below in the Threats section of this report, some events or activities clearly have resulted in permanent loss of habitat, while others have caused degradation or temporary habitat loss; the latter may be reversed through ongoing conservation measures and implementation of appropriate recovery actions.

## SPECIES LIFE HISTORY

*Reproductive Biology*

When warm rainy conditions occur in January, February, and March in California and Mexico, arroyo toads become active and begin to forage on stream terraces and in channel margins. Breeding usually begins in late March at lower elevations but male calling peaks in early to mid-April and extends through late May, sometimes even into late June and July (Sweet 1992, p. 50; Lovich 2009, pp. 1–2). Because male toads stand on the substrate to call and their throats must be above water, eggs are laid in very shallow water. Each male toad emits a loud trill from his chosen calling site at night to attract females and may breed with several females in a season; however, female arroyo toads release their entire clutch of eggs as a single breeding effort and probably do not produce a second clutch during the mating season (Sweet 1992, p. 49 and 135; Campbell *et al.* 1996, p. 11). Female arroyo toads lay their eggs in water about 4 in (10 cm) deep, but not greater than 6 in (15 cm) deep, over substrates of sand, gravel, or cobble in open sites such as overflow pools, old flood channels, and shallow pools along streams (Sweet 1992, p. 37).

***Fig. 1.*** *Arroyo toad egg clutches.* (*Photograph by USFWS*)

***Fig. 2.*** *Close-up of arroyo toad egg clutches.* (*Photo by permission, Mark Capelli, NOAA*)

Arroyo toad eggs hatch in 4 to 5 days, and tadpoles are essentially immobile for an additional 5 to 6 days (Sweet 1992, pp. 71–72). Tadpole development requires shallow pools with minimal current and little or no emergent vegetation. Heavily shaded pools are generally unsuitable for larval and juvenile arroyo toads (first-year toads) because of lower water and soil temperatures and poor algal mat development. Tadpoles disperse from the pool margin into the surrounding shallow water where they spend an average of 10 weeks before they metamorphose into juvenile toads (Sweet 1992, p. 50).

The timing of arroyo toad tadpole metamorphosis is highly variable. In warm dry years, the peak of metamorphosis in smaller streams occurs from late April to mid-May; in cooler, wetter years, the peak may be shifted into June and July (Holland 2000 *in litt.*, p. 8). In larger systems, such as the Santa Margarita River, breeding and hence metamorphosis often lags behind the smaller systems by 3 weeks to a month – from late April to June and early July (Holland 2000 *in litt.*, p. 8). After metamorphosis, juvenile arroyo toads remain on the bordering banks of the pools to feed until the pool dries out, usually from 8 to 12 weeks, but sometimes up to 4 months depending on the pool site and rainfall conditions. Most males become sexually mature by the following spring, but females generally do not become sexually mature until over 2 years of age (Sweet 1992, p. 52).

***Fig. 3.*** *Arroyo toad tadpole. Note cryptic coloring that blends with fine gravels.* (*Photograph by USFWS*)

***Fig. 4.*** *Arroyo toad underbelly, white with no spots.* (*Photograph by USFWS*)

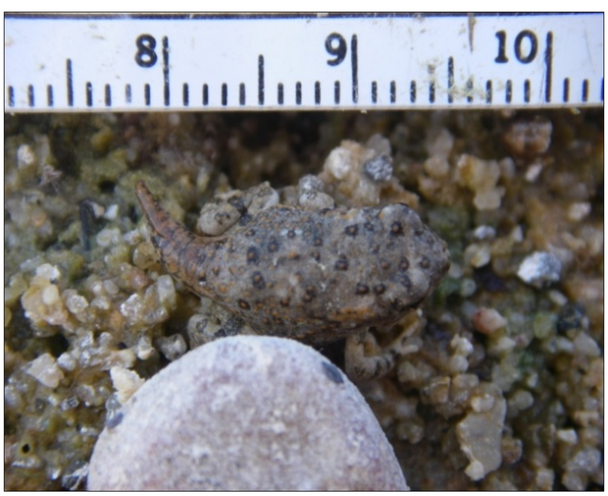



***Fig. 5.*** *Arroyo toad tadpole nearing metamorphosis.* (*Photograph by USFWS*)

***Fig. 6.*** *Arroyo toad juvenile.* (*Photograph by USFWS*)

*Food*

Arroyo toad tadpoles feed on loose organic material such as interstitial algae, bacteria, and diatoms (Sweet 1992, p. 82; Jennings and Hayes 1994, p. 56). Juvenile arroyo toads feed on ants almost exclusively (Sweet 1992, p. 99). Adult arroyo toads feed at night, probably on a wide variety of insects and arthropods including ants, beetles, spiders, larvae, and caterpillars. When foraging, arroyo toads are often found around the drip lines of oak trees. These areas often lack vegetation, yet have levels of prey that will support arroyo toads (Sweet 1992, pp. 45–46).


***Fig. 7.*** *Arroyo toad scat.*
(*Photograph by USFWS*)


***Fig. 8.*** *Arroyo toad scat crushed to show ants.* (*Photograph by USFWS*)

*Cover or Shelter*

Adult and subadult arroyo toads (second year toads not in breeding status) seek shelter during the day and other periods of inactivity by burrowing into upland terraces, along old flood channels, and often in the soils below the canopy edge of willows (*Salix* spp.) or cottonwoods (*Populus fremontii*). They usually burrow into dry or slightly damp fine sand and may even use burrows constructed by other animals or seek temporary shelter under rocks or debris. Arroyo toads usually remain burrowed during daylight hours, and they emerge during early evening hours to forage (Sweet 1992, pp. 11, 42).

To prevent dehydration during hot or dry times of the year, arroyo toads will go into estivation (a state of dormancy somewhat similar to hibernation) in their burrows (Ramirez 2003, pp. 100–102). They will emerge temporarily in response to disturbance or to precipitation events to forage or hydrate but will generally stay in their burrows starting in the late summer from mid-August to January (Ramirez 2003, p. 101).

*Movement*

Arroyo toads move between the stream and upland foraging sites, as well as up and down the stream corridor to find suitable breeding pools. Adults and subadult arroyo toads spend much of their lives in riparian and upland habitats adjacent to breeding locations (Campbell *et al.* 1996, pp. 12–13).

Arroyo toad movements vary between watersheds or river reaches in response to different hydrological regimes (Griffin *et al.* 1999, p. 11). In broad floodplain river systems, arroyo toads searching for suitable egg-laying sites may have to move across parallel stream channels. Cristianitos Creek and Talega Creek in Orange County and the lower San Mateo River in San Diego County are examples of this type of broad floodplain river system because of their wide, sandy floodplains where the river flows into several channels during floods. Despite river depths of 24 in (60 cm) and swift currents, Griffin *et al.* (1999, p. 21) observed numerous arroyo toads crossing Talega Creek and the lower San Mateo River, confirming these river systems are not a barrier to arroyo toad dispersal. In one case, a female arroyo toad traveled 919 feet (ft) (280 meters (m)) across the San Mateo Campground into upland native habitat; in another instance, a female was found 558 ft (170 m) from the San Mateo River under cover of mulefat scrub (Griffin *et al.* 1999, p. 20). Arroyo toads were also recorded moving in both up- and downstream directions, including one female arroyo toad that traveled upstream more than 492 ft (150 m) in a single night to a breeding pool. Griffin *et al.* 1999 (p. 46) found that both male and female arroyo toads moved more into upland habitats after completing individual breeding activity.

In contrast, for watersheds with relatively narrower, steeper-sided drainages with their structure of alternating riffles and pools (such as the Piru and Sespe Creek watersheds in Ventura County), arroyo toads searching for breeding pools tend to move in both up- and downstream directions rather than laterally (Griffin *et al.* 1999, p. 11). In a study on Mono Creek, Sweet (1993, pp. 24–65), concluded that female arroyo toads became relatively sedentary as they matured whereas males tended to travel up- and downstream fairly often during the breeding season. This study also suggested that most juvenile arroyo toads disperse away from their natal pools about a year after metamorphosis (Sweet 1993, p. 65). In fact, numerous subadult and adult arroyo toads were observed moving up- and downstream as much as 0.5 mi (0.8 km) and over 0.6 mi (1 km) in some cases (Sweet 1993, p. 1). Arroyo toads in these watersheds also move away from the stream channel into terrace and upland native habitats. On lower Piru Creek, Sweet (1992, pp. 42–45) observed two adult males under oaks that were 200 ft (61 m) away from the stream channel.

*Taxonomy*

The scientific name of the arroyo toad (*Anaxyrus californicus) was* changed from *Bufo californicus* to *Anaxyrus californicus* and is supported by the phylogenetic analysis of comparative anatomical and molecular genetic data for amphibians presented by Frost *et al.* (2006, p. 363). This taxonomic name change is also accepted by the scientific community (Frost *et al.* 2008, p. 3). On December 16, 1994, we published a final rule listing the arroyo southwestern toad (*Bufo microscaphus californicus*) as an endangered species (59 FR 64859). This animal, originally described as *Bufo cognatus californicus* (Camp 1915), has consistently been treated as a distinct taxon. However, its rank as a subspecies or species, and its taxonomic affiliations with other species have changed several times since it was first described. Myers (1930, p. 75) elevated it to species rank as *Bufo californicus* citing morphological, vocalization, and ecological data to distinguish it from *B. cognatus*. Subsequent to Myers's paper, other authors again relegated the animal to subspecies rank aligned with various other species of *Bufo.* The name in use at the time of listing, *Bufo microscaphus californicus,* was published by Stebbins (1951, p. 275).

Since the arroyo toad was listed, Frost *et al.* (2006, p. 363) segregated the Nearctic taxa of *Bufo* as the genus *Anaxyrus* and published the combination name, *Anaxyrus californicus*, the arroyo toad. This treatment is accepted by the Committee on Standard English and Scientific Names of the American Society of Ichthyologists and Herpetologists, the Herpetologists' League, and the Society for the Study of Amphibians and Reptiles (Frost *et al.* 2008, p. 3). In light of these taxonomic changes and their acceptance by the above scientific authorities, the name *Anaxyrus californicus* is applied to the arroyo toad in this species report and future documents. This change does not alter the description or distribution of the animals. This taxonomic and nomenclatural change acceptance was first announced in our proposed rule to designate critical habitat for the arroyo toad published on October 13, 2009 (74 FR 52612) and finalized in the List of Threatened and Endangered Wildlife (50 CFR 17.11) on February 9, 2011 (76 FR 7246).

## HABITAT REQUIREMENTS

The most important factors in determining habitat suitability for arroyo toads appear to be stream order, elevation, and floodplain width (Sweet 1992, pp. 24–26; Griffin *et al.* 1999, pp. 1–3). Stream order ranks the size and potential power of streams. The smallest channels in a watershed with no tributaries are referred to as first-order streams. When two first-order streams unite, they form a second-order stream; when two second-order streams unite, they form a third-order stream, and so on. Fifth- and sixth-order streams are usually larger rivers, while first- and second-order streams are often small, steep, or intermittent.

Arroyo toads tend to be located at the lower end of third- to sixth- order stream segments where the coarsest sediments are lacking due to low water power, but where flow rates are great enough to keep silt and clay suspended (Sweet 1992, pp. 24–26). According to Campbell *et al.* (1996, p. 13), arroyo toads are found in large river systems because larger watersheds have the power to erode the landscape laterally as well as vertically. As the stream bed widens, the power of the river decreases, reducing its ability to move large volumes of material. Sediment deposition decreases local stream gradient producing a meandering channel. In these channels, the power of flood waters become laterally directed, forming channel and terrace systems which can change annually as sections are scoured or filled by winter floods. The characteristics of these stream sections provide for near perennial flow and persistence of shallow pools into at least mid-summer (Sweet 1992, p. 26). Arroyo toads breed and deposit egg masses in these shallow, sandy pools, which are usually bordered by sand and gravel flood terraces. However, small arroyo toad populations are found along first- and second- order streams at elevations up to 4,600 ft (1,402 meters (m)) (Griffin *et al.* 1999, p. 1).

Large winter flood regimes are important for sediment transport and stream rejuvenation processes that maintain open foraging and breeding habitats with sparsely vegetated terraces and sand/gravel flats. These periodic flood flows create channel types that support elevated alluvial terraces and level pool formation with sand and gravel substrates. Intermediate flows are also important in providing sand deposition into pools after scour events (Sandburg 2008, p. 6).

### *Breeding Habitat*

Streams where arroyo toads breed have low-gradient sections of slow-moving current with shallow pools, nearby sandbars, and adjacent stream terraces, and have either intermittent or perennial streamflow. These streams typically experience periodic flooding that scours vegetation and replenishes fine sediments. Arroyo toads breed in the quiet margins of these open streams, avoiding sites with deep or swift water, tree canopy cover, or steeply incised banks (Sweet 1992, p. 28). Arroyo toad egg clutches must be laid entirely or mostly in water less than 4 in (10 cm) deep with minimal current velocity (less than 2 in (5 cm) per second) because egg strands are not attached to any substrate features (see Figures 1 and 2) and can be swept away by even very small currents (Sweet 1992, p. 57).

The substrate in habitats preferred by arroyo toads consists primarily of sand, fine gravel, or friable soil, with varying amounts of large gravel, cobble, and boulders. Larvae occupy shallow areas of open streambeds on substrates ranging from silt to cobble, with preferences for sand or gravel. Areas that are used by juveniles consist primarily of sand or fine gravel bars adjacent to stabilized sandy terraces and oak flats. Juvenile arroyo toads require areas that are damp and have some vegetation cover (less than 10 percent), which offer refugia from predators and thermal characteristics that are required for juvenile survival and rapid growth (Campbell *et al.* 1996, p. 12).

*Upland Habitat*

Outside of the breeding season, arroyo toads are essentially terrestrial. Riparian habitats used for foraging and burrowing include sand bars, alluvial terraces, and streamside benches that lack vegetation, or have low-to-moderate vegetative cover composed predominantly of California sycamore (*Platanus racemosa*), coast live oak (*Quercus agrifolia*), mulefat (*Baccharis* spp.), cottonwoods, and willow (Campbell *et al.* 1996, pp. 12–13). Upland habitats used by arroyo toads during both the breeding and non-breeding seasons include alluvial scrub, coastal sage scrub, chaparral, grassland, and oak woodland (Holland 1995, p. 5; Griffin *et al.* 1999, p. 28).

*Burrows and Estivation Habitat*

In habitat utilization studies conducted by Ramirez (2007, pp. 11–14) from 1999 to 2006 in the West Fork Mojave River and Grass Valley Creek areas, arroyo toads were generally found burrowed within sandy or loamy substrates with no associated canopy cover, or within mulefat scrub or arroyo willow (*Salix lasiolepis*) patches. The majority of individuals tracked in these studies burrowed immediately adjacent to the active channel or on sandy terraces within riparian habitat located within flood-prone areas; however, toads were also found to use upland habitats up to 1,063 ft (324 m) from the active channel (Ramirez 2007, p. 13). In his 2005 study, Ramirez (2007, p. 93) observed several arroyo toad individuals burrowed in stable terrace habitats dominated by Great Basin sage scrub and Utah junipers (*Juniperus osteosperma*). At Little Rock Creek on the desert slopes of the San Gabriel Mountains, arroyo toads burrowed in areas closest to the creek that retained higher soil saturation and were cooler (Ramirez 2002, p. 50). Griffin *et al.* (1999, p. 45) noted that sands are the preferred burrowing substrate for both male and female arroyo toads, confirming the importance of natural hydrologic regimes that maintain sand and fine sediment deposition across the floodplain.

***Fig. 9.*** *Suitable arroyo toad breeding habitat on upper Sespe Creek.*
(*Photograph by permission, Mark Capelli, NOAA*)

***Fig. 10.*** *Suitable tadpole hatchling habitat.*
(*Photograph by USFWS*)

***Fig. 11.*** *Arroyo toad breeding pool in Castaic Creek.*
(*Photograph by USFWS*)

***Fig. 12.*** *Arroyo toad resting on silt-covered stream substrate in Sespe Creek.* (*Photo by permission, Mark Capelli, NOAA*).

## SPECIES RANGE, DISTRIBUTION, AND ABUNDANCE

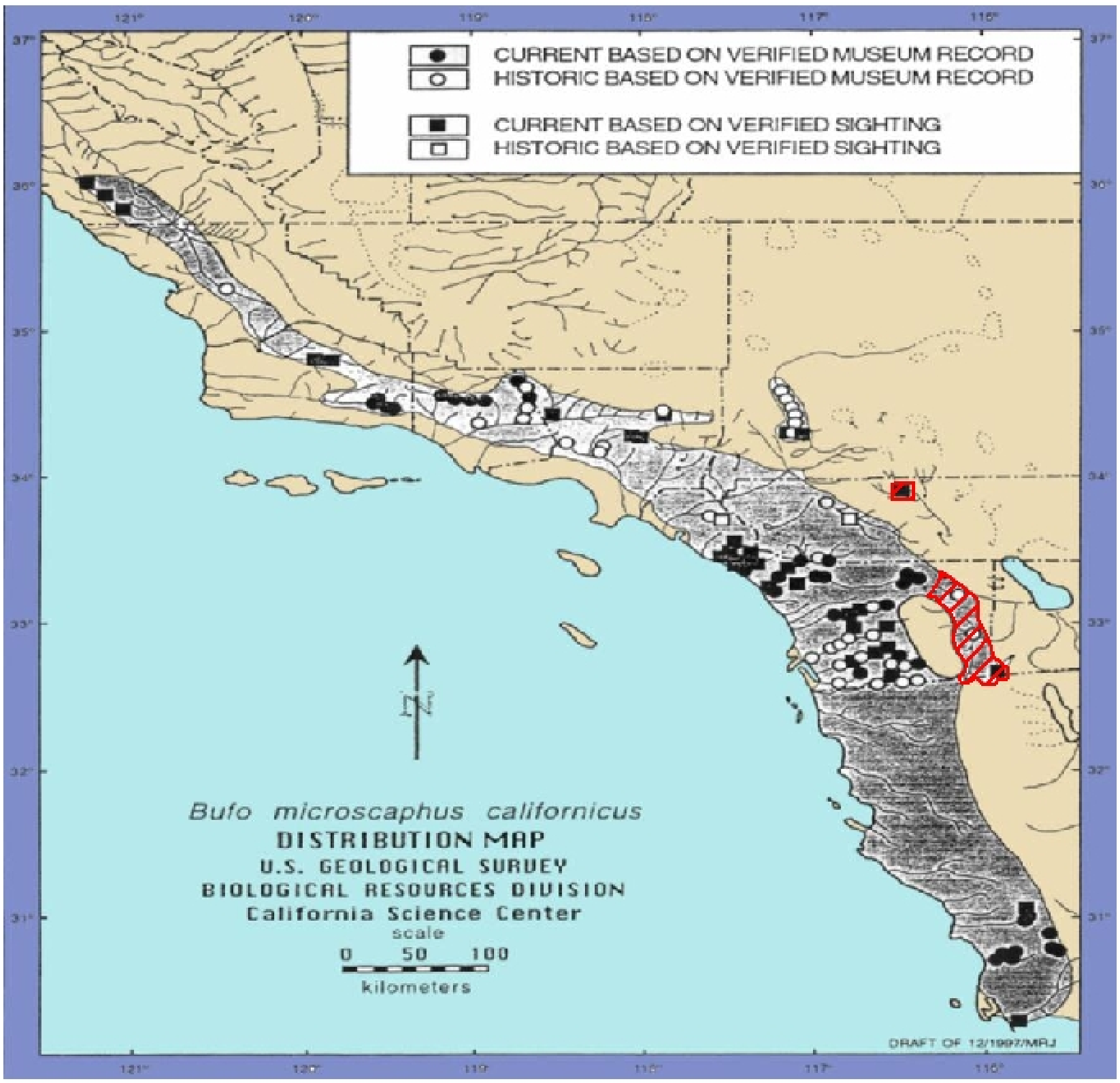
*Historic Range*

The arroyo toad was once relatively abundant in coastal central and southern California. The first documentation of arroyo toads was by Camp (1915) who described a specimen collected at Santa Paula, Ventura County, California, followed by Miller and Miller (1936) who collected three museum specimens of arroyo toads from the Salinas River near the city of Santa Margarita in San Luis Obispo County, California. At that time, arroyo toads were known to occur in coastal drainages in central and southern California from the upper Salinas River system in Monterey and San Luis Obispo Counties; south through the Santa Maria and Santa Ynez River basins in Santa Barbara County; the Santa Clara River basin in Ventura County; the Los Angeles River basin in Los Angeles County; the coastal drainages of Orange, Riverside, and San Diego Counties; and south to the Arroyo San Simeon system in Baja California, México (Map 1) (Sweet 1992, p. 18; Service 1999, p. 12). According to the literature and museum records, arroyo toads were known to occur in 7 of 14 major streams in northwestern Baja California (Lovich 2009, p. 84).

Jennings and Hayes (1994, p. 57) are most commonly cited as documenting a decline of 76 percent of arroyo toad populations throughout the species' range due to loss of habitat and hydrological alterations to stream systems as a result of dam construction and flood control. This figure was based on studies done in the early 1990s by Sam Sweet (Jennings and Hayes 1994, p. 57) that addressed the natural history and status of arroyo toad populations on a portion of the species' range on the Los Padres National Forest. Sweet (1992, p. 18) estimated that the arroyo toad had occupied 295 stream miles of suitable habitat in California (318 miles including México), based on his review of recorded localities and distribution of suitable habitat. His figures in 1992 revealed that arroyo toads then remained on approximately 73.5 miles of streams, indicating a decline of 75.1 percent of their historic range. Sweet (1992, p. 19) estimated that the distribution of arroyo toads on the Los Padres National Forest had been reduced by over 40 percent in the last 70 years, based on historical records and the estimated extent of suitable toad habitat that had been degraded by dams and downstream habitat alteration. Of the 15 populations south of the Los Padres National Forest, 1 remained on the Angeles National Forest, 1 on the San Bernardino National Forest, and 5 on the Cleveland National Forest. Sweet believed only two of the San Diego County populations included more than 15-20 adult toads, all others being on the order of 5-10 adults each (Sweet 1992, p. 18).

The Salinas River population in San Luis Obispo County was extirpated in 1941 by construction of the Salinas Dam and its reservoir; arroyo toads have not since been documented in San Luis Obispo County (Service 1999, p.12). At the time of listing in 1994 (59 FR 64859), arroyo toads were believed to be extant in 22 populations within 8 drainages in the United States. Specific populations in México were not discussed. The northernmost population in the range was thought to be in the Sisquoc River, Santa Barbara County. The species was also thought to be extirpated in Monterey County; however, subsequent to listing, arroyo toads were discovered in Monterey County on the San Antonio River at Fort Hunter Liggett Military Reservation (Fort Hunter Liggett) in 1996 (Hancock 2009, p. 9). The Fort Hunter Liggett population is approximately 93 mi (150 km) northwest of the Sisquoc River population, so this discovery increased the known range of the arroyo toad (Hancock 2009, p. 10). Conversely, the Fort Hunter Liggett population may have once extended to the Salinas River, but the construction of the San Antonio Dam in 1963 has isolated the population and likely contracted the extent of the range considerably (Hancock 2009, p. 10).

We believed the range extended eastward into the deserts of Riverside, San Diego, and Imperial counties at the time of listing (See pg. 64862 in 59 FR 64859; Campbell *et al.* 1996, pp. 4, 41, 43). We have since confirmed that these populations were misidentified (Ervin and Beaman 2010, p. 4; 76 FR 7252; Ervin *et al.* 2013). Therefore, corrections of the historic range since listing removes arroyo toad's range from Imperial County and decreases the range in Riverside and San Diego Counties. This correction is depicted in Map 1.



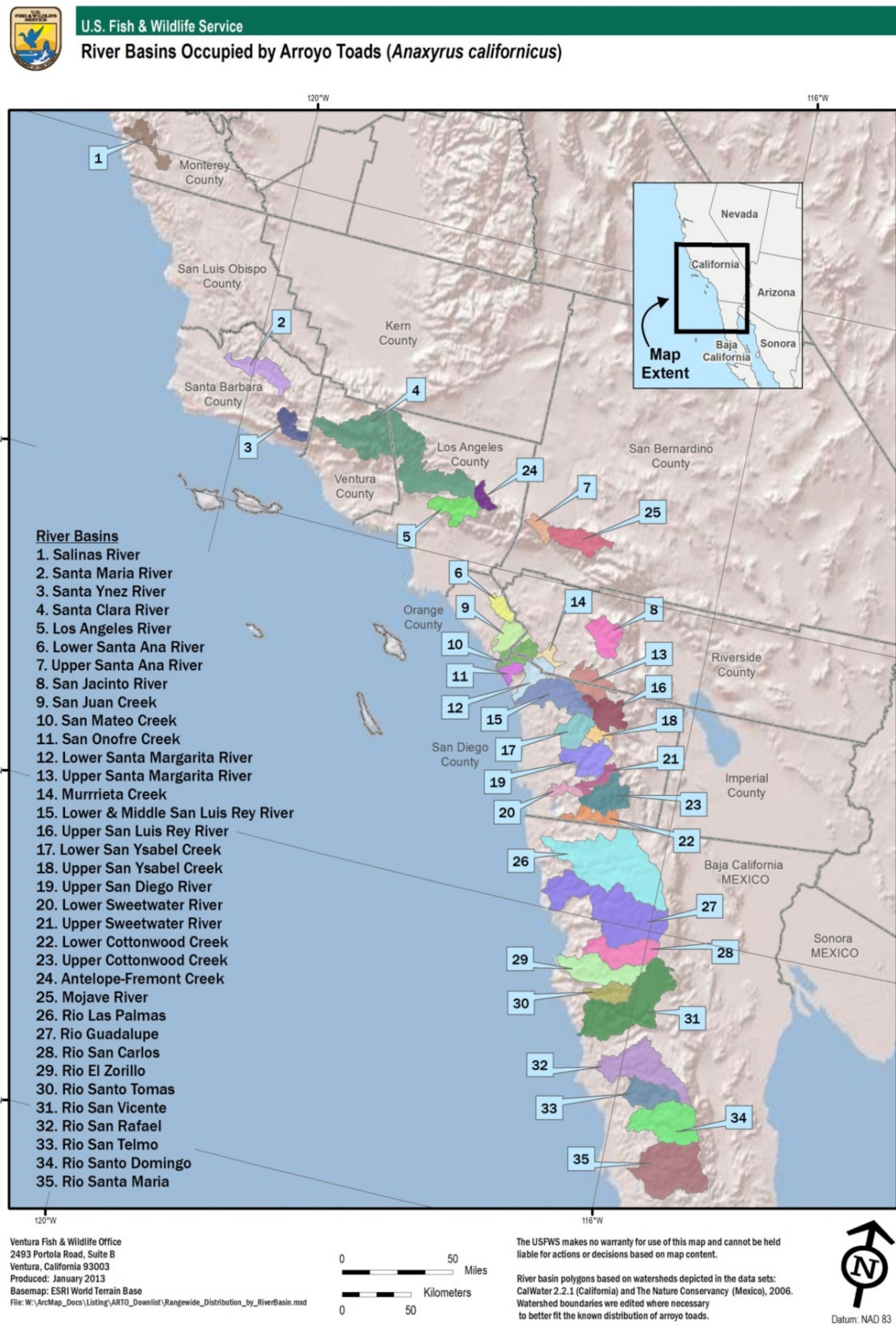

***Map 1.*** *Approximate range map for arroyo toads as depicted in the recovery plan, with updates based on new range information (modified from Sweet 1992, p. 2; Jennings and Hayes 1994, p. 55; Lovich 2009, p. 3; Ervin and Beaman 2010, p. 4; 76 FR 7252).*

*Range in Recovery Plan and Current Range*

Arroyo toads are limited to isolated populations primarily in the headwaters of coastal streams along the central and southern coast of California and southward to Rio Santa Maria near San Quintin in northwestern Baja California, México (Lovich 2009, p. 62). Arroyo toads are still extant within the range they occupied historically and at the time of listing (Map 2), but data indicates that the species has continued to decline in numbers and in area occupied within its current range (Jennings and Hayes 1994, p. 57; Sweet 1992, pp. 18–19). Although Jennings and Hayes (1994, p. 57) estimated that arroyo toads had been eliminated from 76 percent of their historical range, subsequent discoveries of new localities and remnant populations reduce this figure to about 65 percent (Lanoo 2005, p. 4).

Currently, we consider the population on Fort Hunter Liggett in Monterey County to represent the northernmost limit of the species' range. The arroyo toad population on Fort Hunter Liggett occupies 17 mi (26.7 km) of the San Antonio River; suitable habitat for arroyo toads has not been located in any other stream system in Monterey County (Hancock 2009, pp. 9–10). From there to the México border, arroyo toads have been detected in 24 other river basins in Santa Barbara, Ventura, Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties (Map 2). The species also occurs on the desert slopes of the San Gabriel Mountains (in Little Rock Creek in Los Angeles County) and the San Bernardino Mountains (in the Mojave River and in its tributaries, Little Horsethief Creek and Deep Creek, in San Bernardino County) (Hitchcock *et al.*, 2004, pp. 1–40). Since the toad was listed, several new populations have been found within the extant range as a result of increased search efforts. In Riverside County, a small population was detected within Murrieta Creek basin in 2001 (WRCRCA 2006, p. 5). In Baja California, surveys have identified several newly recognized populations and the first records of the species in the Rio Las Palmas, Rio El Zorillo, and Rio Santo Tomas (Lovich 2009, pp. 74–97) (Map 2).

The species' range depicted in Map 1 (from the recovery plan) has several notable distributional gaps: a 93-mi (150 km) gap between the San Antonio River and the Sisquoc River populations, a gap between the populations in the uppermost reaches of the Los Angeles River and lower Santa Ana River far to the south in Orange County, and a gap between United States populations and Baja California populations. This apparent distribution gap in Baja California is no longer accurate. Many rivers in northern Baja California are now known to be occupied by arroyo toads (Lovich 2009, p. 3). This patchy distribution of arroyo toads is not fully understood but is most likely due to the effects of urban development and other manmade modifications to river corridors and arroyo toad habitat throughout its range (Lovich 2009, p. 1). Map 2 shows the current occupancy of arroyo toads by river basin through the United States and México.




***Map 2.*** *Current River Basin Occurrences of Arroyo Toads in the U.S. and Baja California, Mexico.*

*Distribution*

Although arroyo toads may be found along relatively long stretches of some creeks and rivers, suitable breeding or upland habitat may not occur throughout the entire distance. The proportion of suitable habitat may change during the year and from year to year, depending on climatic conditions, fires, other natural events (storms, floods), or human-related events. Because habitat conditions are variable across space and time, it is difficult to estimate the exact distribution of arroyo toads or the extent of suitable habitat in any particular drainage system at a given time.

The highly variable nature of arroyo toad habitat results in similar levels of variation in population density. Arroyo toad densities can range from fewer than 25 to over 200 adults over different stretches of the same stream (Bloom *in litt.* 1998, p. 2). When listed in 1994, only 6 of the 22 extant populations in the United States were known to contain more than a dozen adults (59 FR 64859). At present, most of the populations are still small, averaging 10 to 12 breeding adults at a given locality (see Table 1). In 2002 and 2003, the United States Geological Survey (USGS) conducted focused surveys for the arroyo toad within nine watersheds of San Diego County, eight of which fell within the San Diego County Multiple Species Conservation Program boundaries. Daytime arroyo toad habitat surveys were conducted at 39 sites, 18 of which were also surveyed at night. Although mark-recapture data were not collected and it was not possible to make population estimates, 18 was the largest number of arroyo toads detected at any site during the course of the entire study (Madden-Smith *et al.* 2005, p. 1).

The timing of breeding appears to vary as well at different elevations because arroyo toads are dependent on temperature and rainfall conditions to create and sustain suitable breeding pools (Lovich 2009, p. 10). In his study of arroyo toads on the Los Padres National Forest, Sweet (1992, pp. 50–51) noted that the species would typically breed and its young develop between February and July of a given year. However, Welsh (1988, *in* Griffin *et al.* 1999, p. 1) found juvenile arroyo toads at several high elevation locations (8,200 feet) in the Sierra San Pedro Mártir in Baja California as late as July and August. Cunningham (1962, pp. 255–260) noted breeding later in the year at higher elevations, where thermal and metabolic requirements of arroyo toads necessitate a strategy to breed later in the year when temperatures are warmer (Lovich 2009, pp. 9–10).

The species is likely restricted naturally as a result of specific habitat requirements for breeding and development (Service 1999, p. 39). These natural restrictions and the ephemeral nature of its habitat (both in space and time), coupled with the small sizes of many arroyo toad populations, make the species particularly vulnerable to the negative effects of human-induced changes to their habitat (Jennings and Hayes 1994, p. 57).

*Arroyo Toad Occurrences – Definitions of Terms*

Definitions are provided here for terms that are used in Table 1 below. Additional or more specialized terms are defined as necessary in later sections of this report.

**Occurrence:** An area of land and/or water in which a species or ecosystem is, or was, present (Master 2009, p. 5). For purposes of this report, an occurrence is a river basin containing one or more extant arroyo toad populations on rivers and streams that are within that river basin; the river basin itself is counted as a single occurrence of arroyo toads.

**Site Location:** Rivers or streams occupied by arroyo toads that are within one river basin.

**Number of Individuals Observed and Other Notes:** Population counts from various sources or methodologies (*e.g.*, population estimates, presence/absence surveys, incidental observations). We are defining "recently" as within the last 5 to 6 years, based on the known life span of the arroyo toad.

**Current Status of Population:**

> **Extant:** Arroyo toad population at a site location has been verified recently (within the last 5 to 6 years) as still existing;
>
> **Extirpated:** Adequate surveys by one or more experienced observers at times and under conditions appropriate for the species at the site location, or other persuasive evidence, indicate that the species no longer exists there or that the habitat or environment of the site location has been destroyed to such an extent that it can no longer support the species;
>
> **Presumed Extant:** Arroyo toads have not been found recently (within the last 5 to 6 years) despite a search by an experienced observer at a time and under conditions appropriate at the site location where it was previously reported, but recent information from such observers or other individuals with local expertise suggests that arroyo toads still might be confirmed to exist at that site location with additional field survey efforts;
>
> **Unknown:** Site location within an occurrence that has not been surveyed recently (within the last 5 to 6 years) during a time period and under conditions appropriate for the species at the location where it was previously reported.

***Table 1.*** *Arroyo toad river basin occurrences showing what is currently known about the distribution, size, and status of arroyo toad populations in occupied streams and rivers within each river basin.*

| Recovery Unit | Occurrence | Site Location | Land Ownership | Number of Individuals Observed and Other Notes | Current Status of Population |
|---|---|---|---|---|---|
| **Northern Recovery Unit** | 1. **Salinas River Basin**, Monterey and San Luis Obispo Counties | San Antonio River, detected along 17 miles above Lake San Antonio, Monterey County. | Fort Hunter Liggett Military Reservation | 2005 - 6 adults, 53 juveniles captured and relocated for Sam Jones Bridge retrofit (Hancock 2009, p. 16); 2008 – 19 juveniles relocated for Nacimiento Bridge retrofit (Hancock 2009, p. 16). | Extant |
| | | Salinas River near City of Santa Margarita, San Luis Obispo County. | Private | Population was discovered in 1936; 3 museum specimens were collected (Miller and Miller 1936) | Extirpated by dam construction in 1940s |
| | 2. **Santa Maria River Basin**, Santa Barbara County | Sisquoc River, from Manzana Creek junction to Sycamore Campground, (approx. 9 miles in length). | Private; U.S. Forest Service (USFS) | 1993 – 1 adult, 1 clutch at Water Canyon Camp; 1994 – 3+ adults at Miller Camp (CNDDB 2010, Occ. Num. 51). 1 adult – 1999-2000 surveys (Hubbartt and Murphey 2005). Adults present in 2007 (Snyder-Velto 2013a, pers. obs) | Presumed Extant |
| | 3**. Santa Ynez River Basin**, Santa Barbara County | Upper Santa Ynez River, above Gibraltar Reservoir in scattered locations along 8.6 miles. | USFS; Montecito Water District | 1992 – 12+ adults, 60 juveniles observed, estimated population size approximately 600 (CNDDB 2010, Occ. Num. 11). Breeding confirmed in 2000 (Hubbartt and Murphey 2005). These toads have been intensively studied from 1989 to 1993 (see Sweet 1992, pp. 1-198; 1993, pp. 1-73) and monitored by Forest Service staff in most of the last 15 years (Sweet 2007a). | Extant |
| | | Mono Creek and Indian Creek from their confluences with Santa Ynez River upstream for 3.5 miles. | USFS | 1993 – Indian Creek to Mono Creek junction: 50+ adults and 23 clutches, estimated population size ~250; 1993 – Mono Creek, 300+ adults observed and 52 clutches, estimated populations size ~450 (CNDDB 2010, Occ. Num. 10). Breeding confirmed in 2000 (Hubbartt and Murphey 2005). Monitored by Forest Service staff in most of the last 15 years (Sweet 2007a). | Extant |
| | | Agua Caliente Creek | USFS | No data available. | Unknown |

| | | | | | |
|---|---|---|---|---|---|
| | 4. **Santa Clara River Basin**, Ventura and Los Angeles Counties | Santa Clara River | Private; Local | 2001 – 2 larvae and 1 metamorph at Bear Canyon confluence, 6 miles upstream of Solemint (CNDDB 2010, Occ. Num. 48). 2005-2006 –none detected at any of 11 study areas during focused surveys on mainstem and tributaries (Hovore *et al.* 2008, p. 33). | Presumed Extirpated from Castaic Creek downstream to Ventura County line (Bloom Biological 2007) |
| | | Lion Creek | USFS | Lion Campground closed to the public by Los Padres National Forest. 2010 surveys – 14 clutches (Sweet 2012); 2011 surveys – 42 clutches (Sweet 2012). | Unknown |
| | | Sespe Creek, from Hot Springs Canyon upstream to mouth of Tule Creek (approx. 15 miles in length). | USFS | Fluctuated from 130 to 250 adults during 1980's-1990's surveys (Sweet 1992); Breeding confirmed in 2000 (Hubbartt and Murphey 2005). 2011 surveys – (Beaver campground downstream to a large pool) – 51 clutches (Sweet 2012). | Extant |
| | | Upper Piru Creek (from headwaters of Pyramid Lake upstream to Bear Gulch) | USFS, United Water Conservation District, Private | Upper Piru Creek contains approximately 80-100 adults (Service 1999). In 2009, 13 egg strings found near Hardluck Campground (USFS 2013a); 8 adults detected south of campground by Sam Sweet in June 2012 survey (USFS 2013a). | Extant |
| | | Lower Piru Creek (Blue Point Campground upstream to Lower Piru Gorge) | | Breeding confirmed in 2000 (Hubbartt and Murphey 2005). 2010 spring surveys – 25 clutches (Sweet 2012); 2011 spring surveys – 6 clutches (Sweet 2012). | Extant |
| | | Agua Blanca Creek, lower 1 mile section | USFS | 1992 – 8 adults, 6 clutches (CNDDB 2010, Occ. Num. 18); Breeding confirmed in 2000 (Hubbartt and Murphey 2005). 2010 spring surveys – 8 clutches (Sweet 2012); 2011spring surveys – 50 clutches (Sweet 2012). | Extant |

| | | | | | |
|---|---|---|---|---|---|
| | | Castaic Creek, below Castaic Dam for 2 miles and above the reservoir for 1 mile to Fish Creek. | USFS, Castaic Water Department | 1992 – 1 juvenile observed on damp algae mat; 1996 – 3 adults observed between Power Plant and Fish Canyon; 1996 – 2 adults and 1 juvenile observed; 2001– 2 males, 33 females, juveniles, tadpoles, and eggs observed.; 2009 – 1 female observed in Basin 3 above the reservoir (LADWP 2009); 2011– 2,000 tadpoles, no juveniles, 5 adults (USFS 2011).. | Extant |
| | | San Francisquito Creek | USFS | 1 adult male heard calling in 1997; Negative surveys since 1999 (White and Leatherman 2001; Compliance Biology 2004; Ecological Sciences 2005). | Presumed extirpated based on 14 years of negative surveys |
| | 5. **Los Angeles River Basin**, Los Angeles County | Upper Big Tujunga Creek, for about 6 miles above the dam | USFS | 2001 – 1 adult male and 1 female, numerous juveniles and tadpoles (CNDDB 2010, Occ. Num. 89); 2011 – 1 juvenile, 33 adults (USFS 2011); 2012 – 27 toads observed, all size class distribution: YOY, juveniles, adults (Welch 2012 pers. comm.). | Extant |
| | | Alder Creek | USFS | Known to occur in Alder Creek, Lynx Gulch Creek and Upper Big Tujunga Creek from approximately 0.5 miles upstream of the confluence with Alder Creek to Colby Bridge (USFS 2012b); 2011 – protocol surveys between the 3N27crossing and upper end of Big Tujunga Reservoir – one adult arroyo toad observed (USFS 2012b). | Extant |
| | | Arroyo Seco | USFS | No data available. | Unknown |
| **Southern Recovery Unit** | **6. Lower Santa Ana River Basin,** Orange County | Santiago Creek | Private (OC Central-Coastal NCCP[1]) | 1990 – 4 to 6 individuals; 2005 – 1 adult (Haase *in litt*. 2005; (CNDDB 2012, Occ. Num. 4). | Unknown because no surveys conducted recently. |
| | | Silverado Creek | Private (OC Central-Coastal NCCP[1)], USFS[2] | 1998 – Juveniles observed; 2005 – 25 to 35 larvae; 2008 – 29 larvae (Glen Lukos Associates 2005; Haase *in litt*. 2008; USFS 2009). | Unknown because larvae identification was not conclusive. |
| | 7. **Upper Santa Ana River Basin**, San Bernardino County | Cajon Wash | Private, USFS | 2000 – 1 adult, 8 larvae; 2005 – 60+ juveniles; 2007 – 1 adult (CNDDB 2012, Occ. Nums. 93, 119). | Unknown because documentation history includes only a few records with low |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | numbers of individuals and high disturbance of habitat. |
| | 8. **San Jacinto River Basin**, Riverside County | San Jacinto River | Private (WRC MSHCP[1]), Bureau of Land Management (BLM), USFS | 2000 – 1 adult male calling; No detections in 2005 and 2010 (Ortega *in litt*. 2001; WRCRCA 2006; WRCRCA 2011). | Presumed Extant because comprehensive survey conducted in one year only (2010) and good habitat noted; only one record exists. |
| | | Bautista Creek | Private (WRC MSHCP[1]), State, BLM, USFS | 2002 to 2003 – 12 adults, 7 larvae, 10 tadpole clusters; 2010 – 205 to 258 individuals (Hitchcock *et al.* 2004; MSHCP BMP GIS data 2011). | Extant |
| | 9. **San Juan Creek Basin**, Orange and Riverside Counties | San Juan Creek, from I-5 to Upper San Juan Campground, and Bell Canyon | Private (OC So. Subregion HCP[1]), Local, USFS | Private land: 1995 – 8 individuals, 2 adults; 2001 – 41 adults, 350+ juveniles, 100+ tadpoles (CNDDB 2012, Occ. Nums. 2, 108). Public land: 1974 – 14 juveniles; 1992 – 4 adults; 2001 – 5 adults, 12 juveniles; 2010 – 213 adults, larvae, tadpoles (CNDDB 2012, Occ. Nums. 1, 3, 6; LSA 2012). | Extant |
| | | Trabuco Creek | Private (OC So. Subregion HCP[1]), Local, USFS | 1998 – Several larvae observed (Holland, pers. comm. 2005). | Unknown because no comprehensive surveys since 1998. |
| | 10. **San Mateo Creek Basin**, Orange, Riverside, and San Diego Counties | Cristianitos Creek, Gabino Creek, La Paz Creek, Talega Creek | Private (OC So. Subregion HCP[1]), Camp Pendleton | Private land: 1995 – 23 individuals; 1998 – 32 individuals; 2001 – 241 individuals; 2005 – 688 individuals; 2010 – 7 individuals (USFWS GIS data 2012). | Extant |
| | | San Mateo Creek, from estuaries to northern border of Camp Pendleton; also main-stem San Mateo Creek and Los Alamos Canyon on USFS | Camp Pendleton, USFS | Military land: 2010 – 54 percent occupancy includes Cristianitos and Talega Creeks (Brehme *et al.* 2011). USFS land: 1991 – 20+ tadpoles. Los Alamos Canyon only: 1999 – 2 adults: 0 detections in 2005 and 2010. (CNF 2005; WRCRCA 2006; WRCRCA 2011; CNDDB 2012, Occ. Num. 58). | Extant |
| | 11. **San Onofre Creek Basin,** San Diego County | San Onofre Creek, from mouth to confluence of North and South Forks San Onofre Canyon | Camp Pendleton | 2010 – 40 percent occupied (Brehme *et al.* 2011). | Extant |

| | | | | | |
|---|---|---|---|---|---|
| | 12. **Lower Santa Margarita River Basin**, San Diego County | Santa Margarita River;<br>DeLuz Creek<br>Roblar Creek | Private; Camp Pendleton; Fallbrook Naval Weapons Station. | Military land: 2010 – 94 percent occupancy (Brehme *et al.* 2011). | Extant |
| | | Sandia Creek | Private | No data available. | Unknown |
| | 13. **Upper Santa Margarita River Basin**, Riverside County | Arroyo Seco Creek | Private (WRC MSHCP[1]), USFS | 1993 – 9 adults, 50+ tadpoles; 2000 – 2 adults, 2 tadpole clusters; 2010 – 46 to 59 individuals (USGS 2000; MSHCP BMP GIS data 2011; CNDDB 2012, Occ. Num. 56). | Extant |
| | | Temecula Creek | Private (WRC MSHCP[1]), USFS[2] | 1992 – 2 adult males; 2001 – 6 adults; 2003 – 8 adults; 2004 – 1 adult (CNDDB 2012, Occ. Num. 72) | Unknown because no surveys conducted recently. |
| | | Wilson Creek | Private (WRC MSHCP[1]) | 1998 – Observed larvae, unknown number; 2010 – Not detected (Haase, *in litt*. 2009; WRCRCA 2011). | Unknown because no comprehensive surveys conducted recently. |
| | 14. **Murrieta Creek Basin**, Riverside County | Cole Creek | California Department of Fish and Wildlife | 2001– 1 adult; 2005 – >100 tadpoles. Not detected since 2005 (WRCRCA 2006; WRCRCA 2011). | Unknown because no comprehensive surveys conducted recently. |
| | 15. **Lower and Middle San Luis Rey River Basin**, San Diego County | San Luis Rey River | Private, Tribal | 1928 – 23 adults; 1996 – 1 juvenile; 1998 – 16 adults; 2000 – 31 adults, 12 juveniles; 2004 – 1 adult, 500+ tadpoles; 2011 – 2 individuals (CNDDB 2012, Occ. Nums. 39, 41, 42, 74, 86; USFWS GIS data 2012). | Extant |
| | | Keys Creek | Private | 1998 – 7 adults; 1999 – 5 adults, 6 juveniles; 2001 – minimum 3 adults (Varanus 1999a; CNDDB 2012, Occ. Num. 78; USFWS GIS data 2012). | Unknown because no surveys conducted recently. |
| | | Pala Creek | Private, Tribal | 1959 – 6 adults; 1998 – 3 indiv. (CNDDB 2012, Occ. Num. 57; USFWS GIS data 2012). | Unknown because no surveys conducted recently. |
| | 16. **Upper San Luis Rey River Basin**, San Diego County | West Fork San Luis Rey River | Vista Irrigation District, USFS | 1991 – 1 juvenile; 1992 – 2 adults, 20+ juveniles; 2010 – adults, unknown number (Chambers Group 2011; CNDDB 2012, Occ. Num. 45). | Extant |
| | | San Luis Rey | Vista | 1989 – 2 adults; 1991 – 1 adult; | Extant |

| | | | | | |
|---|---|---|---|---|---|
| | | River, Cañada Aguanga | Irrigation District, USFS | 2003 – 1 adult; 2006 – 9 adults; 2010 – adults, unknown number (Tierra Data Inc. 2007; Clark *et al*. 2011; CNDDB 2012, Occ. Nums. 31, 76). | |
| | | Agua Caliente Creek | Private, USFS, Vista Irrigation District | Private: 1999 – 4 males, 1 female; 2005 – 2 males (Varanus 1999b; CNDDB 2012, Occ. Num. 90). Private and USFS: 1992 – 69 adults, population estimate 120; 1999 – 16 individuals plus tadpoles (CNF 2005; CNDDB 2012, Occ. Num. 27). | Unknown because no surveys conducted recently. |
| | 17. **Lower Santa Ysabel Creek Basin**, San Diego County | San Dieguito River/Santa Ysabel Creek | Private (SD MSCP[1]), Local, water districts, USFS | 2005 – 396 individuals; 2012 – evidence of breeding observed (Brown, pers. comm. 2012; USFWS GIS data 2012). | Extant |
| | | Guejito Creek | Private | 2005 to 2008 – 11 areas observed (CNDDB 2012, Occ. Nums. 109–112). | Extant |
| | | Boden Canyon | Local, State | 2003 – 6 adults, 1 juvenile; 2004 – 2 adults; 2005 to 2012– not detected, but surveys not comprehensive (USGS GIS data 2011; Hovey, pers. comm. 2013). | Presumed extant because surveys not comprehensive, arroyo toads detected downstream at the confluence with Santa Ysabel Creek, and patches of good habitat. |
| | | Temescal Creek | City of San Diego (SD MSCP[1]), USFS | 1993 – 124 adults, population estimate 200; 2012 – larvae, unknown number (Brown, pers. comm. 2012; CNDDB 2012, Occ. Num. 59). | Extant |
| | | Santa Maria Creek | Private, Local, Ramona Water District | 2001 – 4 to 9 adult males; 2005 – 10 individuals; 2008 – 9 adults (Merkel & Associates 2008; CNDDB 2012, Occ. Num. 1; USFWS GIS data 2012). | Extant |
| | 18. **Upper Santa Ysabel Creek Basin,** San Diego County | Santa Ysabel Creek and Witch Creek | Private, Local, Tribal | 1991 – 2 egg masses; 2005 – 2 adults; 2008 – 1 juvenile, 1 tadpole (CNDDB 2012, Occ. Nums. 62, 123; USGS GIS data 2011). | Extant |
| | 19**. Upper San Diego River Basin**, San Diego County | San Vicente Creek | Private (SD MSCP[1]), Water Districts, State | 1992 – 13 adults, 7 juveniles; 1997 – 8 individuals; 2008 – 18 individuals (CNDDB 2012, Occ. Nums. 68; USFWS GIS data 2012). | Extant |

| | | | | | |
|---|---|---|---|---|---|
| | | San Diego River | Water Districts, USFS, Tribal | 1993 – 2 adults, population estimate 25; 2002 – 2 adults, 3 juveniles; 2008 – 1 juvenile, 6 larvae, 10 tadpoles on June 19 (USGS GIS data 2011; CNDDB 2012, Occ. Nums. 66). | Extant |
| | 20. **Lower Sweetwater River Basin**, San Diego County | Sweetwater River | Private (SD MSCP[1]), Water Districts, State , Tribal | 2000 – 9 adult males; 2001 – 1 juvenile; 2005 – 1 adult male calling; 2008 – 1 adult female, 1 adult of unknown sex; 2010 – 1 adult male (CNDDB 2012, Occ. Nums. 67, 85; Famolaro, pers. comm. 2013). | Extant |
| | 21. **Upper Sweetwater River Basin**, San Diego County | Viejas Creek | Private (SD MSCP[1]) | No data available. | Unknown because no surveys conducted recently. |
| | | Sweetwater River | Private (SD MSCP[1]), water district, California State Parks, USFS[2] | 1999 – 27 individuals; 2001 – 2 individuals; 2002 – 3 adults; 2004 – 4 adults, 2,000 larvae; 2008 – 8 individuals (CNDDB 2012, Occ. Nums. 70, 98, 99, 100, 122; USFWS GIS data 2012). | Extant |
| | | Peterson Creek | Private, Water District | 1998 – 5 adults, several larvae; 1999 – 2 adult males calling, 1 adult, 1 subadult (CNDDB 2012, Occ. Num. 43). | Unknown because no surveys conducted recently. |
| | 22**. Lower Cottonwood Creek Basin,** San Diego County and Baja California, México | Tijuana River/Rio Tijuana | United States: Local. Mexico: No data available. | 2001–2006 – none detected in Mexican waters of Tijuana River (Rio Tijuana) (Lovich 2009, p. 84). All historic and voucher specimens occur in the United States north of the international border (Lovich 2009, p. 84–86). | Extirpated by development, channelization, and changes in hydrology. |
| | | Cottonwood Creek | Private (SD MSCP[1]), Water Districts | 1998 – 6 calling males; 2002 – 14 adults; 2003 – 5 adults, 2 subadults, and 1 tadpole; 2008 – 3 larvae, 1 tadpole on May 21 (Madden-Smith *et al.* 2005; USGS GIS data 2011; CNDDB 2012, Occ. Num. 40). | Extant |
| | | Potrero Creek | Private | 1993 –12 adults, population estimate 80; 2010 – 8 adults, 111 juveniles, 300 tadpoles (ICF International 2010; CNDDB 2012, Occ. Num. 65). | Extant |
| | | Campo Creek | United States: Private, BLM. Mexico: No data | 2008 – 4 adult males vocalizing in the United States (LEI 2008). | Extant |

| | | | | | |
|---|---|---|---|---|---|
| | | | available. | | |
| | 23. **Upper Cottonwood Creek Basin,** San Diego County | Pine Valley Creek and Horsethief Canyon | USFS | 1992 – 7 adults; 2000 – 1 individual; 2001 – 1 individual; 2010 – adults, juveniles, larvae, unknown number (Brown, pers. comm. 2012; CNDDB 2012, Occ. Num. 63; USFWS GIS data 2012). | Extant |
| | | Pine Valley Creek, Noble Creek, Scove Canyon | Private, USFS | 1991 – 5 adults, 5 tadpoles; 1992 – 67 adults, population estimate ~200; 1998 – 28 individuals; 1999 – 48 individuals; 2001 – 1 adult; 2005 – 8 adults, 8 juveniles, larvae observed; 2009 – 1 individual (Haase 2005; CNDDB 2012, Occ. Nums. 21, 22, 30; USFWS GIS data 2012). | Extant |
| | | Morena Creek | Private, water districts, USFS | 1993 – 1 adult; 1999 – 1 individual (CNDDB 2012, Occ. Num. 69; USFWS GIS data 2012). | Unknown because no surveys conducted recently. |
| | | Cottonwood Creek and Kitchen Creek | Private, water districts, USFS | 1990 – 1 adult; 1991 – 3 adults, 300+ tadpoles, population estimated population size of 50+; 1992 – 16 adult males, population estimated population size 100; 1999 – 11 adults; 2005 – at least 5 individuals; 2011 – 1 individual (CNDDB 2012, Occ. Nums. 20, 44; USFWS GIS data 2012). | Extant |
| | | La Posta Creek | Private, water districts, USFS | 2005 – at least 1 individual (USFWS GIS data 2012). | Unknown because no surveys conducted recently. |
| | 24. **Antelope-Fremont River Basin**, Los Angeles County | Little Rock Creek, restricted to a 3-mile stretch above Little Rock Reservoir | USFS | 1996 – 16 adults, 1 juvenile; 2001 – 5 males, 1 female, 3 juveniles observed (CNDDB 2010, Occ. Num. 35); 2011 – 2 adults | Extant |
| | 25. **Mojave River Basin,** San Bernardino County | West Fork Mojave River | Private; Army Corps of Engineers | 2006 – calling adult males heard, 1 tadpole observed (CNDDB 2010, Occ. Num. 94); Upland habitat utilization and radio telemetry tracking studies have been conducted on these arroyo toads from 1999 through 2006 by Cadre Environmental (Ramirez 2002; 2003; 2007). Adults present in 2007 (Snyder-Velto 2013b, pers. obs) | Presumed Extant |
| | | Grass Valley | Private | 2001 – 1 dead adult on Hwy 173; | Presumed Extant |

| | | | | | |
|---|---|---|---|---|---|
| | | Creek, 2 miles of occupied stream channel (Glenn Lukos Assoc. 1999) | | 2005 – 30+ adults heard calling, 2 egg masses observed (CNDDB 2010, Occ. Num. 92); Upland habitat utilization and radio telemetry tracking studies have been conducted on these arroyo toads from 1999 through 2006 by Cadre Environmental (Ramirez 2002; 2003; 2007). Adults present in 2007 (Snyder-Velto 2013b, pers. obs) | |
| | | Upper and Lower Little Horsethief Creek, 3.5 miles of occupied stream channel (Glenn Lukos Assoc. 1999) | Private, USFS | 2004 – 30 adult toads (Hitchcock *et al.* 2004). Adults present in 2007 (Snyder-Velto 2013b, pers. obs) | Presumed Extant |
| | | Deep Creek | Private, USFS | 2001 – 1 adult observed in Deep Creek on edge of beaver (*Castor canadensis*) pond; 2001 – 4 adults observed; 2008 – 1 adult observed in Lower Deep Creek just south of the eastern flood control dam (CNDDB 2010, Occ. Num. 28, 96). | Extant |
| | | Mojave River | Victor Valley Water District; U.S. Army Corps of Engineers | Larvae first observed in vicinity of Victorville (Stebbins 1954 *in* Brown 1978, p. 19). No arroyo toads observed in 1978 study (Brown 1978, p. 19). | Unknown; assumed to be extirpated. No detections in >30 years and no surveys conducted recently. |
| **Baja California, Mexico** | 26. **Rio Las Palmas** | | No data available | 2001 to 2006 – species observed; 2013 – tadpoles, unknown number (Lovich 2009, p. 85; Peralta and Valdez, pers. comm. 2013). | Extant |
| | 27. **Rio Guadalupe** | | No data available | 2001 to 2006 – species observed; 2010 – species observed; 2013 – species observed (Lovich 2009, p. 85; Peralta and Valdez, pers. comm. 2013). | Extant |

| | | | | |
|---|---|---|---|---|
| | 28. **Arroyo San Carlos** | No data available | 2001 to 2006 – species observed (Lovich 2009, p. 85). | Unknown because no surveys conducted recently. |
| | 29. **Rio El Zorillo** | No data available | 2001 to 2006 – species observed (Lovich 2009, p. 85). | Unknown because no surveys conducted recently. |
| | 30. **Rio Santo Tomas** | No data available | 2001 to 2006 – species observed; 2013 – none detected (Lovich 2009, p. 85; Peralta and Valdez, pers. comm. 2013). | Unknown because no comprehensive surveys conducted recently. |
| | 31. **Rio San Vicente** | No data available | 2001 to 2006 – species observed; 2013 – males calling and tadpoles, unknown number (Lovich 2009, p. 85; Peralta and Valdez, pers. comm. 2013). | Extant |
| | 32. **Rio San Rafael** | No data available | 2001 to 2006 – species observed; 2012 – species observed; 2013 – tadpole (Lovich 2009, p. 85; Peralta and Valdez, pers. comm. 2013; Hollingsworth, pers. comm. 2013). | Extant |
| | 33. **Rio San Telmo** | No data available | 2001 to 2006 – species observed; 2013 – species observed (Lovich 2009, p. 85; Peralta and Valdez, pers. comm. 2013). | Extant |
| | 34. **Rio Santo Domingo** | No data available | 2001 to 2006 – species observed; 2013 – species observed (Lovich 2009, p. 85; Peralta and Valdez, pers. comm. 2013). | Extant |
| | 35. **Rio Santa Maria** | No data available | 2001 to 2006 – species observed (Lovich 2009, p. 85). | Unknown because no surveys conducted recently. |

Notes:

[1] Private land at site location within or partially within a habitat conservation plan: Orange County Central-Coastal Subregional Natural Community Conservation Plan/Habitat Conservation Plan (OC Central-Coastal NCCP); Orange County Southern Subregion Habitat Conservation Plan (OC So. Subregion HCP); City of San Diego Subarea Plan or County of San Diego Subarea Plan under the San Diego Multiple Species Conservation Program (San Diego MSCP); and Western Riverside County Multiple Species Habitat Conservation Plan (WRC MSHCP).

[2] USFS lands encompass upland or dispersal habitat only at these occurrences.

## THREATS

At the time of listing in 1994 (59 FR 64859), threats to the arroyo toad were listed as habitat destruction and alteration due to short- and long-term changes in river hydrology, including construction of dams and water diversions, alteration of riparian wetland habitats by agriculture and urbanization, construction of roads, site-specific damage by off-highway vehicle use and other recreational activities, overgrazing, and mining activities. Other threats to the arroyo toad identified were introduced nonnative predators such as bullfrogs and predatory fish, drought, periodic fires, unseasonal water releases from dams, and light and noise pollution from adjacent developments and campgrounds.

Historically, arroyo toad populations were reduced in size or extirpated because they occurred in areas used for dams and reservoirs, roads, agricultural and urban development, campgrounds and off-highway vehicle parks; extensive habitat loss occurred from about 1920 to 1980 (Service 1999, p. 3). Today, threats to the arroyo toad remain similar to when the species was listed, but some threats have been reduced (conservation efforts are ongoing in most occurrences to reduce impacts from 9 of the 12 current threats that affect the arroyo toad):

1. New dam construction, which caused the major decline in arroyo toads that occurred prior to listing, is not likely to occur in the future, but it is still considered a potential threat. New water diversions are a potential threat. However, the continued operation of existing dams and water diversions still impact arroyo toads through continued flow alteration and habitat modification. Some progress has been made at several large dams to maintain a more natural hydrologic regime.
2. California Department of Fish and Wildlife (CDFW) (formerly California Department of Fish and Game (CDFG)) revised their permitting regulations for suction dredge mining (Title 14, Natural Resources, §228 and §228.5) in 2012. Most of the streams and rivers occupied by arroyo toads are now classified as Class A and therefore, arroyo toads are not impacted by suction dredge mining because it no longer occurs in those streams. However, this threat could potentially still impact arroyo toads in streams that are not classified as Class A.
3. Collecting for recreational or scientific purposes (listing factor B) was considered a threat to the arroyo toad at the time of listing; since listing, however, we are not aware of any information that would indicate recreational collecting is a threat, and the scientific community is now well aware of the endangered status of the species and the prohibitions of section 9 of the Act. Therefore, collecting is no longer a threat to the species.
4. Inadequacy of existing regulatory mechanisms (listing factor D) was not considered to be a threat to the arroyo toad in the final listing rule. There are no specific regulations designed to protect arroyo toads or manage specific threats to arroyo toads. However, many conservation efforts have been taken to assist in recovery and these efforts are discussed below under the other listing factors (A, C, and E), and there is no information to suggest that inadequacy of existing regulatory mechanisms has become a threat since the time of listing.

*Classification of Threats*

To assess and rank threat impacts to arroyo toads, we used a simplified threat assessment process based on the Threats Classification methodology from NatureServe's Conservation Status Assessments (Master *et al.* 2009, p. 1–64). The primary purpose of NatureServe's Conservation Status Assessments is to evaluate potential extinction risk of elements of biodiversity, including regional extinction or extirpation risk (Master *et al.* 2009, p. 2). For this report, our purpose was much simpler; we wanted to derive the level of impact for each identified threat to determine how these threats affect arroyo toads.

In NatureServe's Threats Classification process and in our simplified threat assessment process, the threat impact indicates the degree to which a species or ecosystem is observed, inferred, or suspected to be directly or indirectly impacted in the area of interest (Master *et al.* 2009, p. 25). Threats are characterized in terms of scope, severity, and timing and the threat "impact" is calculated from the scope and severity (Master *et al.* 2009, p. 26). Although timing (immediacy) is recorded for threats, it is not used in the calculation of threat impact because past threats are included in the timing category, but calculating threat impact considers only present and future threats. In NatureServe's Conservation Status Assessments, effects of past threats (if not continuing) are addressed indirectly under the Long-term Trend and/or Short-term Trend factors (Master *et al.* 2009, pp. 25–26).

For our threat assessments, we used the best available scientific and commercial information to derive reasonable values for the scope and severity of each threat to arroyo toads. We took care to identify the most likely plausible range of values, excluding extreme or unlikely values. In this way, our values for the scope and severity of an impact were estimated for each occurrence in its entirety and not for a particular percentage of the occurrence that may be affected. Combining our scope and severity values, we determined the magnitude, or degree of impact, that arroyo toads are experiencing in the present time or are likely to experience in the future from each threat (Table 2). We also assessed timing values for each threat but did not include timing to derive the threat impact. Finally, we summarized our findings (Table 4) and ranked threats by their impact values to assess the relative risk facing the species from each threat (Table 5).

*Threat Assessment Definitions and Values*

SCOPE: The scope of a threat is the proportion of arroyo toad occurrences that can reasonably be expected to be affected by the threat, given continuation of current circumstances and trends. If a species is evenly distributed, then the proportion of the population or area affected is equivalent to the proportion of the range extent affected by the threat; however, if the population or area is patchily distributed, as it is for arroyo toads, then the proportion differs from that of range extent. Current circumstances and trends include both existing and new threats (Master *et al.* 2009, p. 26). Scope categories are:

**Pervasive –** threat affects all or most (71 to 100%) of the total occurrences;

**Large –** threat affects much (31 to 70%) of the total occurrences;

**Restricted –** threat affects some (11 to 30%) of the total occurrences;

**Small –** threat affects a small (1 to 10%) proportion of the total occurrences;

**Negligible** –threat is likely to be discountable in affecting habitat or species occurrences.

SEVERITY: Severity is measured as the degree of reduction (declines) in arroyo toad populations or the degree of degradation or decline in integrity of arroyo toad habitat. The severity of each threat can be determined by assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from the threat, given continuation of current circumstances and trends (Master *et al.* 2009, p. 26). Severity categories are:

**Extreme** – within the scope, threat is likely to destroy habitat or eliminate 71% to 100% of species occurrences;

**Serious** – within the scope, threat is likely to seriously degrade habitat or reduce 31% to 70% of species occurrences;

**Moderate** – within the scope, threat is likely to moderately degrade habitat or reduce 11% to 30% of species occurrences;

**Slight** – within the scope, threat is likely to only slightly degrade habitat or reduce 1% to 10% of species occurrences;

**Negligible** – within the scope, threat is likely to be discountable in degrading habitat or reducing species occurrences;

**Neutral or potential benefit** – within the scope, threat may have some localized negative effects, but overall is thought to either not affect or be a benefit to arroyo toads.

IMPACT: Threat impact reflects a reduction in arroyo toad populations or loss/degradation of habitat. This value reflects the degree to which arroyo toad occurrences or locations are observed, inferred, or suspected to be directly or indirectly impacted by the threat. The impact of a threat is based on the interaction between assigned scope and severity values. Impact categories are (Master *et al.* 2009, p. 27):

**Very High**

**High**

**Medium**

**Low**

TIMING: Although timing (immediacy) is recorded for threats, it is not used in the calculation of threat impact. Timing categories are (Master *et al.* 2009, p. 28):

**High (Ongoing)** – Continuing;

**Moderate (Near-term future)** – Only in the future (could happen in the short-term (<3 generations)), or now suspended (could come back in the short-term);

**Low (Long-term future)** – Only in the future (could happen in the long-term) or now suspended (could come back in the long-term);

**Insignificant/Past/Historical** – Only in the past and unlikely to return, or no direct effect.

***Table 2.*** *The Relationship of Threat Impact and Population Reduction or Ecosystem Decline or Degradation (modified from Master et al. 2009, p. 27).*

| | | SCOPE | | | | |
|---|---|---|---|---|---|---|
| | | **Pervasive** | **Large** | **Restricted** | **Small** | **Negligible** |
| **SEVERITY** | **Extreme** | Very High | High | Medium | Low | Not a threat |
| | **Serious** | High | High | Medium | Low | Not a threat |
| | **Moderate** | Medium | Medium | Low | Low | Not a threat |
| | **Slight** | Low | Low | Low | Low | Not a threat |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **Negligible** | Not a threat | Not a threat | Not a threat | Not a threat | Not a threat |
| | **Neutral** | Not a threat | Not a threat | Not a threat | Not a threat | Not a threat |

## THREAT ASSESSMENT

At the time of listing, habitat loss was the most severe threat facing the arroyo toad. Today it is still a serious threat, but introduced predators have become a critical problem as well. In the following discussions of current and future threats to the arroyo toad, we consider how habitat destruction and alteration together with other factors have caused habitat loss, high mortality, and low reproduction in the species, resulting in isolated occurrences of arroyo toads that are surviving in fragmented habitats. When assessing the scope and severity of a threat, we considered five specific categories of impacts from activities associated with the threat, as follows:

(1) Actions that alter water chemistry or temperature, caused by activities that include, but are not limited to: Release of chemicals, biological pollutants, or heated effluents into the surface water or into connected groundwater at a point source or by dispersed release (non-point source). These activities can alter water conditions beyond the tolerances of the arroyo toad and result in direct or cumulative adverse effects to these individuals and their life cycles.

(2) Actions that increase sediment deposition within the stream channel or disturb upland foraging and dispersal habitat, caused by activities that include, but are not limited to: Excessive sedimentation from livestock overgrazing, road construction, commercial or urban development, channel alteration, off-highway vehicle use or recreational activity, and other watershed and floodplain disturbances. These activities could eliminate or reduce the habitat necessary for the growth and reproduction of the arroyo toad by increasing the sediment deposition to levels that would adversely affect the arroyo toad’s ability to complete its life cycles.

(3) Actions that alter channel morphology or geometry, caused by activities that include, but are not limited to: Construction and operation of flood control and water diversion structures, such as dams and reservoirs that regulate stream flows and trap sediments, direct groundwater extraction, channelization, impoundment, road and bridge construction, development, mining, dredging, and destruction of riparian vegetation. These activities may lead to changes to the hydraulic functioning of the stream by altering the timing, duration, quantity and levels of water flows and may result in degradation or elimination of the arroyo toad and its habitat. These actions can also lead to increased sedimentation and degradation in water quality to levels that are beyond the tolerances of the arroyo toad and provide habitat for nonnative species that prey on arroyo toads.

(4) Actions that eliminate upland foraging, aestivating, or dispersal habitat for the arroyo toad, caused by activities that include, but are not limited to: Road construction, commercial or urban development, off-highway vehicle use or recreational activity, and other watershed

and floodplain disturbances. These actions could affect the species' habitat through erosion; siltation; soil compaction; water quality degradation from urban runoff containing contaminants, fertilizers, and pesticides; and the spread of introduced nonnative plants.

(5) Actions that lead to introducing, spreading, or augmenting nonnative aquatic species in stream segments used by arroyo toad, caused by possible activities that include, but are not limited to: Fish stocking for sport, nonnative aquatic plants or predator species for aesthetics, or other related actions. These activities could affect the growth and reproduction of the arroyo toad by subjecting eggs, larvae, tadpoles, and adult arroyo toads to increased predation pressure or limit the amount of habitat available for the species through competition, which would adversely affect the arroyo toad's ability to complete its life cycle.

We focus on these and other impacts that are attributable to the Act's listing factors A, C, and E. Threats and impacts attributable to listing factors B and D, as explained above, do not affect the arroyo toad at this time (nor are likely to in the future) and will not be discussed further in this report.

*Factor A: The Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range*

## 1. URBAN DEVELOPMENT

### Threat Status at the Time of Listing

At the time of listing, habitat loss from development projects in riparian wetlands caused permanent losses of riparian habitats. Urban development was the most conspicuous factor in the decline of the arroyo toad at the time of listing because the loss of arroyo toad breeding habitat was permanent. The trend toward increasing urbanization in California continues to the present day; by the time the arroyo toad was listed in 1994, development and urban sprawl had already occurred throughout southern California, with nearly 40 percent of the riparian areas along the coast from Ventura County to the Mexican border in urban and suburban use (CDFG 2005).

### Occurrences and Locations Currently Affected:

Currently, 23 out of 35 river basins, (66 percent of occurrences) at the following site locations are impacted by urban development. For the other 12 river basins, the best available information does not indicate that arroyo toads are being impacted by urban development.

Northern Recovery Unit:

- Occurrence 3: Santa Ynez River Basin – Upper Santa Ynez River
- Occurrence 4: Santa Clara River Basin – Sespe Creek, Piru Creek, Castaic Creek
- Occurrence 5: Los Angeles River Basin – Upper Big Tujunga Creek

Southern Recovery Unit:

- Occurrence 6: Lower Santa Ana River Basin – Silverado Creek
- Occurrence 9: San Juan Creek Basin – San Juan Creek, Trabuco Creek
- Occurrence 10: San Mateo Creek Basin – Talega Creek, Cristianitos Creek, San Mateo Creek
- Occurrence 12: Lower Santa Margarita River Basin – Santa Margarita River
- Occurrence 13: Upper Santa Margarita River Basin – Arroyo Seco Creek, Wilson Creek

Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River
Occurrence 16: Upper San Luis Rey River Basin – Agua Caliente Creek
Occurrence 17: Lower Santa Ysabel Creek Basin – San Dieguito River/Santa Ysabel Creek, Guejito Creek, Santa Maria Creek
Occurrence 18: Upper Santa Ysabel Creek Basin – Santa Ysabel Creek and Witch Creek
Occurrence 19: Upper San Diego River Basin – San Vicente Creek
Occurrence 20: Lower Sweetwater River Basin – Sweetwater River
Occurrence 21: Upper Sweetwater River Basin – Sweetwater River, Viejas Creek, Peterson Creek
Occurrence 22: Lower Cottonwood Creek Basin – Cottonwood Creek, Potrero Creek, Campo Creek
Occurrence 23: Upper Cottonwood Creek Basin – Pine Valley Creek, Noble Creek, Scove Canyon, Cottonwood Creek, La Posta Creek

Desert Recovery Unit:
Occurrence 25: Mojave River Basin – West Fork Mojave River, Little Horsethief Creek

Baja California, México:
Occurrence 26: Lower Rio Las Palmas
Occurrence 27: Rio Guadalupe
Occurrence 28: Arroyo San Carlos
Occurrence 34: Rio Santo Domingo
Occurrence 35: Rio Santa Maria

**Description of Impacts Resulting from Threat to Arroyo Toads and Habitat**

Habitat loss and degradation are extensive in rivers of southern California as a result of agricultural and urban development (Griffin *et al.* 1999, p. 5). Urban development features that result in substantial arroyo toad habitat loss and fragmentation include groundwater extraction; residential housing and commercial business development; construction of roads, bridges, culverts, wastewater treatment facilities, and flood control structures; and runoff. In the following paragraphs, we have separated out the different impacts caused by urban development and how the arroyo toad habitat may be affected by each type of impact.

*Groundwater Extraction*

Groundwater is extracted for many public uses, such as for delivery to homes, businesses, and industries, as well as for community uses such as firefighting, water services at public buildings, filling community swimming pools; industries and mining facilities also use groundwater. Groundwater extraction reduces the amount of surface flow available for creeks and rivers. This is detrimental to arroyo toads because they require breeding pools that persist for at least 2 months in the summer for larval development and tadpole metamorphosis. Groundwater pumping can also lower groundwater levels below the depth that streamside or wetland vegetation needs to survive. The overall effect is a loss of riparian vegetation and habitat (USGS 2012). Production from groundwater supplies in San Diego County is anticipated to increase 75 percent by 2015 (CEC 2009, p. 19). Currently, the City of San Diego is considering groundwater extraction in San Pasqual Valley (lower Santa Ysabel Creek) (Brown, USGS, pers. comm. 2012).

*Residential and Commercial Development*

Stream terraces that are converted to road corridors and residential and commercial uses eliminate foraging and burrowing habitat for arroyo toads, and are a barrier to dispersal. Construction activities can kill, injure, or limit foraging and breeding by excluding arroyo toads from portions of their habitat that are present within a development project area. Construction of bridges, bank stabilization, and maintenance of these features and of other flood, drainage, and water quality protection features, result in permanent loss of arroyo toad habitat. Flood control structures or other facilities change the flow regime of rivers and creeks, which reduce flow volume and velocity and eliminate the scouring flows that are required to maintain arroyo toad habitats.

*Runoff*

Runoff from urban areas such as roads, residential housing, and golf courses often contains chemicals that are toxic to wildlife (for example, car fluids, pesticides, and herbicides). Arroyo toads are exposed to hazardous materials by absorbing them through their skin from the water or contaminated vegetation, or by ingesting them from contaminated vegetation, prey species, or water. Although a rare occurrence, runoff from areas where concrete is being used to mix with the soil cement, such as for bridge and road construction, can cause increases in water pH. Substantial increases in water pH would kill all life stages of the arroyo toad for some distance downstream of the release. Sweet (1993, p. 12) reported that this occurred in the early 1990s on the Los Padres National Forest, when a release of such water with increased pH resulted in the mortality of a downstream population of arroyo toads. Generally, however, increases in surface runoff affect arroyo toads by disrupting breeding if flow rates are too high, and increased water flows also cause sedimentation which buries eggs or displaces adults and juveniles. Increased and perennial urban runoff allows nonnative aquatic predators of arroyo toads to persist in the river basins (Riley *et al.* 2005, p. 1905).

Arroyo toads have not been detected since 1997 downstream of Sloan Canyon in lower Sweetwater River where construction of a golf course and housing development, in addition to mining, has occurred since listing (Madden-Smith *et al.* 2005, p. 22). Brehme *et al.* 2011 (p. 2) expect the effects of urbanization, occurring largely outside of Marine Corps Base Camp Pendleton, to be the primary threat to arroyo toad occurrences on the military base as increased impervious surface area alters water runoff patterns and modifies natural water regimes. Increased impermeable surface area in the Lower Santa Margarita River Basin is predicted to increase peak and total water discharge by 50 percent resulting in larger and more frequent floods and wetter lowland conditions (Brehme *et al.* 2011, p. 5). Downstream of southern Orange County—where development is occurring at a rapid rate and is expected to increase—a lengthened hydroperiod (period of time during which the wetland holds water) and increased abundance of aquatic emergent vegetation has already been observed on the base in Cristianitos Creek (Brehme *et al.* 2011, p. 37).

## Actions Taken to Reduce Threat Impacts

*Northern Recovery Unit*

In the northern portion of the arroyo toads' range, particularly in the Santa Clara River Basin, urban development in the vicinity of the City of Santa Clarita, the proposed East Area 1 project in Santa Paula (EDC 2012), as well as current and future development plans for Newhall Ranch may reduce or eliminate much of the suitable arroyo toad habitat in this area. To reduce the impacts associated with urban development to arroyo toads and other listed species within the riparian corridor of the Santa Clara River, Newhall Ranch has developed a Natural Resource Management Plan (NRMP) that provides management measures designed to protect, restore, monitor, manage, and enhance habitat for multiple species, including the arroyo toad, that occur in the Santa Clara River Basin occurrence (one occurrence) along the Santa Clara River, Castaic Creek, and San Francisquito Creek. Of particular importance to the conservation of the arroyo toad and its habitat are the substantial conservation easements that are included in the NRMP, which when completed, will protect almost all of the arroyo toad's breeding habitat and riparian river corridor within the Newhall Ranch development. At the present time, approximately 1,011 ac (409 ha) of Newhall Ranch lands have been conveyed to the CDFW and additional easements are awaiting approval.

*Southern Recovery Unit – Habitat Conservation Plans* (*HCPs*)
In the southern portion of the range, pressure from urbanization continues to increase as well. Since listing, several habitat conservation plans (HCPs) have been developed to address impacts to the arroyo toad from new development and associated infrastructure including: (1) the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP); (2) the Orange County Central-Coastal Subregional Natural Community Conservation Plan/Habitat Conservation Plan (Orange County Central-Coastal NCCP); (3) the Orange County Southern Subregion HCP; (4) the City of San Diego Subarea Plan under the San Diego Multiple Species Conservation Program (MSCP); and (5) the County of San Diego Subarea Plan under the MSCP. Reserves will be established over time that are anticipated to provide protection of seven arroyo toad occurrences within, or partly within, these HCPs by reducing the threat of direct removal of habitat along with implementing long-term management and monitoring actions that would address indirect impacts.

Some areas have already been dedicated to reserves (portions of seven occurrences), including: (1) some lands within the Western Riverside County MSHCP reserve (portions of two occurrences: San Jacinto River and Upper Santa Margarita River basins); (2) all lands within the Orange County Central-Coastal NCCP reserve (portions of one occurrence: Lower Santa Ana River Basin); (3) some lands within the Orange County Southern Subregion HCP (portions of one occurrence: San Juan Creek Basin); and (4) some City of San Diego and County of San Diego lands within the MSCP (portions of three occurrences: Lower Santa Ysabel Creek, Upper San Diego River, and Lower Cottonwood Creek basins). Some management is occurring on these lands, such as ranger patrolling and road closures on City of San Diego lands. Within the Orange County Central-Coastal NCCP reserves, monitoring and management related to the arroyo toad have included reserve-wide herpetofauna surveys conducted from 1997 through 2001 and ongoing control of invasive nonnative vegetation in the upland environment. Development of adaptive management plans for the arroyo toad within these dedicated reserves is being planned for the future, but is not yet in place.

*Southern Recovery Unit – Other land acquisition*
Acquisition of arroyo toad habitat for conservation purposes since listing by Federal, State, and local governments as well as private conservation organizations has occurred through other mechanisms such as grants and section 7 consultations. Significant acquisitions include (portions of five occurrences): (1) some upland habitat acquired by the California Department of Transportation (portions of one occurrence: Lower and Middle San Luis Rey River Basin); (2)

County of San Diego land encompassing stretches of upper Santa Ysabel Creek and Santa Maria River (portions of two occurrences: Lower Santa Ysabel Creek and Upper Santa Ysabel Creek basins); (3) City of San Diego land encompassing Temescal Creek and a stretch of lower Santa Ysabel Creek (portion of one occurrence: Lower Santa Ysabel Creek Basin); (4) California Department of Fish and Wildlife land encompassing a stretch of San Vicente Creek (portions of one occurrence: Upper San Diego River Basin); and (5) private conservation organization land encompassing a stretch of Potrero Creek (portion of one occurrence: Lower Cottonwood Creek Basin).

*Southern Recovery Unit – Summary*
Some progress has been made since listing in the Southern Recovery Unit toward reducing the threat of urban development to arroyo toads and habitat at nine occurrences. The arroyo toad is not threatened by direct removal of habitat from urban development in dedicated reserves, and this threat is likely reduced by varying degrees in other areas within HCPs that are identified for future placement into reserves. Potential threats from indirect effects of urbanization still exist, as arroyo toad occurrences within these area-HCPs are not yet comprehensively managed for the species.

**Threat Assessment**

Threat Scope = Large. 23 out of 35 river basins (60 percent) are currently affected by urban development in both the U.S. and México.

Threat Severity = Serious. A summary of the effects of urban development to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; exposure to pesticides/herbicides, alteration of water quality or chemistry; and introduction of nonnative predators and invasive species. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from urban development, given continuation of current circumstances and trends, we find that within the scope, urban development is likely to seriously degrade habitat or reduce between 31 percent and 70 percent of species occurrences.

Threat Timing = High (Ongoing).

Threat Impact = High.

**What the Threat at Current Scope and Severity Means for the Species**

Given that urban development currently affects 23 out of 35 river basins where the arroyo toad is known to occur, and that where urban development occurs, it has a serious effect on arroyo toads and their habitats, and that this threat is reduced at 10 occurrences, we categorize this threat as having a high level of impact to the species as a whole. While decline in populations of arroyo toads has already occurred (Jennings and Hayes 1994, p. 57), increases in human population and urban development pressures will, through time, continue to cause the loss of arroyo toad populations and reduce opportunities for conservation and enhancement of existing populations, as well as reduce the potential for reintroduction of the species, and likely further reduce the genetic variation found in this species (Lovich 2009, p. 91). While impacts from development have been reduced at 10 occurrences through current conservation measures, this threat will likely continue to have a high level of impact to the arroyo toad.

## 2. AGRICULTURE

### Threat Status at the Time of Listing

At the time of listing, habitat loss from agricultural development projects in riparian wetlands also caused permanent losses of riparian habitats.

### Occurrences and Locations Currently Affected:

Currently, 15 out of 35 river basins (43 percent of occurrences) at the following site locations are impacted by agriculture. For the other 20 river basins, the best available information does not indicate that arroyo toads are being impacted by agriculture.

Southern Recovery Unit:

- Occurrence 8: San Jacinto River Basin – Bautista Creek, San Jacinto River
- Occurrence 9: San Juan Creek Basin – San Juan Creek, Trabuco Creek
- Occurrence 12: Lower Santa Margarita River Basin – De Luz Creek, Santa Margarita River
- Occurrence 13: Upper Santa Margarita River Basin – Arroyo Seco Creek, Temecula Creek, Wilson Creek
- Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River
- Occurrence 16: Upper San Luis Rey River Basin – Agua Caliente Creek
- Occurrence 17: Lower Santa Ysabel Creek Basin – Santa Ysabel Creek, Santa Maria Creek
- Occurrence 21: Upper Sweetwater River Basin – Sweetwater River
- Occurrence 22: Lower Cottonwood Creek Basin – Cottonwood Creek, Potrero Creek, Campo Creek
- Occurrence 23: Upper Cottonwood Creek Basin – Cottonwood Creek, La Posta Creek

Baja California, México:

- Occurrence 27: Rio Guadalupe (groundwater pumping)
- Occurrence 30: Rio Santo Tomas
- Occurrence 32: Rio San Rafael
- Occurrence 34: Rio Santo Domingo (groundwater pumping)
- Occurrence 35: Rio Santa Maria (groundwater pumping)

### Description of Impacts Resulting from Threat to Arroyo Toads and Habitat

Agricultural development features that result in substantial arroyo toad habitat loss and fragmentation include conversion of stream terraces and upland habitat to farmland, groundwater extraction, and runoff.

*Land Conversion*

Agricultural development converts stream terraces and upland habitats to farm land and road corridors, eliminates foraging and burrowing habitat for arroyo toads, and is a barrier to dispersal. The streams themselves are diverted for agricultural use as well, resulting in permanent loss of breeding habitat for arroyo toads.

According to Griffin and Case (2001, p. 641), "…agricultural fields may be ecological traps that appear to provide adequate habitat for arroyo toads at some times, but are dangerous for arroyo toads at other times." Arroyo toads are often attracted to agricultural fields for cover, food, and moisture, and can be killed by trampling, chemicals, and machinery (Griffin and Case 2001, pp. 641–642). In the Griffin and Case study (2001, p. 641), more than half of the male arroyo toads observed after July 29 were active in burrows or made new burrows in agricultural lands adjacent to breeding habitat. Mechanized tilling, pesticide application, and trampling were frequently observed in these agricultural fields within the study site. Thus, agriculture-free buffer zones next to known arroyo toad breeding sites were recommended to reduce mortality (Griffin and Case 2001, p. 641).

*Groundwater Extraction*
In addition to outright destruction of stream terraces and adjacent uplands, water is pumped out of the ground or diverted to support farmland irrigation. Just as in urban development, groundwater pumping has reduced flows in many creeks and rivers on the coastal plain, which only adds to the negative impacts of upstream dams and reservoirs as discussed below.

*Runoff*
Another concern related to agricultural development is agricultural runoff, which often contains contaminants such as herbicides, pesticides, and fertilizers that may kill toads, affect development of larvae, or affect their food supplies or habitat. For example, granular fertilizers, particularly ammonium nitrate, are highly caustic and have caused mass injuries and mortality to frogs and newts in Europe (Schneeweiss and Schneeweiss 1997 *in* Service 1999, p. 41). As described above under Urban Development, mortality of arroyo toads from water with increases in pH has been documented, although the extent to which agricultural runoff could affect pH levels in arroyo toad habitat is unknown. It is interesting to note, however, Sweet observed that arroyo toads almost never breed in pools that are isolated from the flowing channel; side channels and washouts may be used as long as there is some flow through them, but they are abandoned as soon as this flow ceases (Lanoo 2005, p. 2). Thus, the potential effects of chemical-contaminated runoff to arroyo toads may be lessened to some extent by their specialized breeding habitat needs.

Increased flows in streams due to runoff from agricultural fields can have effects similar to those of persistent releases from dams (see below). Also, changes in the invertebrate communities may lead to decreased survival of arroyo toad tadpoles due to competition or predation, and may reduce the food supply of post-metamorphic toads (Service 1999, p. 41).

### Actions Taken to Reduce Threat Impacts

Some progress has been made since listing toward reducing the threat of agriculture to arroyo toads and habitat at two occurrences. An agricultural lease was discontinued on Marine Corps Base Camp Pendleton adjacent to lower San Mateo Creek, where impacts to arroyo toads were documented in the Griffin and Case (2001) study. Also, within City of San Diego lands encompassing lower Santa Ysabel Creek, some agricultural leases have been moved away from riparian areas (McGinnis, City of San Diego, pers. comm. 2012).

### Threat Assessment

Threat Scope = Large. 15 out of 35 river basins (43 percent of occurrences) are currently affected by agriculture.

Threat Severity = Moderate. A summary of the effects of agriculture to arroyo toads and habitat include permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; exposure to pesticides/herbicides; alteration of water quality or chemistry; and introduction of nonnative predators and invasive species. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from agriculture, given continuation of current circumstances and trends, we find that within the scope, agriculture is likely to seriously degrade habitat or reduce between 11 percent and 30 percent of species occurrences.

Threat Timing = High (Ongoing).

Threat Impact = Medium.

**What the Threat at Current Scope and Severity Means for the Species**

Given that agricultural development currently affects 15 out of 35 river basins where the arroyo toad is known to occur, and that where agricultural development occurs it has a moderate effect on arroyo toads and their habitats, and because this threat is reduced at two occurrences, we categorize this threat as having a medium level of impact to the species as a whole. Because arroyo toads use both aquatic and terrestrial environments, they are doubly impacted by agricultural activities that subject their habitats to increased fragmentation and decreased quality from groundwater pumping, water diversions, and contaminated runoff. Arroyo toads are attracted to open areas of farm fields to find foraging and burrowing sites and thus are vulnerable to being run over by farm equipment or trampled by field workers. Where chemicals are used as a part of agricultural intensification, arroyo toads are exposed to residues that can collect in soils where they burrow or in pools where they breed, though the potential effects of chemical-contaminated runoff to arroyo toads may be lessened to some extent by their specialized breeding habitat needs. Overall, agricultural development is a current threat with a medium level of impact to the arroyo toad.

## 3. OPERATION OF DAMS AND WATER DIVERSIONS

**Threat Status at the Time of Listing**

At the time of listing, short- and long-term changes in river hydrology, including construction of dams and water diversions, were responsible for the loss of 40 percent of the estimated original range of the species, and nearly half of historical extirpations prior to listing are attributed to impacts from original dam construction and operation (Sweet 1992, pp. 4–5; Ramirez 2003, p. 7). These changes are a result of dam construction and operation because the original construction of a dam: (1) effectively fragments a watershed by slowing rivers and blocking the natural flow of water and sediments; (2) inundates large areas of arroyo toad habitat; and (3) blocks in-stream movement of arroyo toads, which effectively isolates populations upstream and downstream of dams and may preclude recolonization of areas formerly occupied by the arroyo toad (Campbell *et al.* 1996, p. 18).

**Occurrences and Locations Currently Affected**

Currently, 19 out of 35 river basins (54 percent of occurrences) at the following site locations are impacted by the operation of dams and reservoirs. For the remaining 16 river basins, the best available information does not indicate that arroyo toads are being impacted by dam and water diversion operations.

Northern Recovery Unit

- Occurrence 1: Salinas River Basin – Salinas River (Santa Margarita Dam), also dams on Nacimiento River and San Antonio River
- Occurrence 3: Santa Ynez River Basin – Santa Ynez River (Gibraltar Reservoir and Juncal Dam)
- Occurrence 4: Santa Clara River Basin – Piru Creek (Santa Felicia Dam and Pyramid Dam), Castaic Creek (Castaic Dam)
- Occurrence 5: Los Angeles River Basin – Big Tujunga Creek (Big Tujunga Dam)

Southern Recovery Unit

- Occurrence 6: Lower Santa Ana River Basin – Santiago Creek (Santiago Dam)
- Occurrence 12: Lower Santa Margarita River Basin – Water diversions (including Vail Dam) and water use from increasing urbanization in the upper watershed
- Occurrence 13: Upper Santa Margarita River Basin – Water diversions (including Vail Dam), water use
- Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River (Henshaw Dam)
- Occurrence 16: Upper San Luis Rey River Basin – San Luis Rey River (Henshaw Dam)
- Occurrence 17: Lower Santa Ysabel Creek Basin – San Dieguito River/Santa Ysabel Creek (Hodges Dam and Sutherland Dam)
- Occurrence 18: Upper Santa Ysabel Creek Basin – Santa Ysabel Creek (Sutherland Dam)
- Occurrence 19: Upper San Diego River Basin – San Diego River (El Capitan Dam and Cuyamaca Dam) and San Vicente Creek (San Vicente Dam and Sutherland Dam)
- Occurrence 20: Lower Sweetwater River Basin – Sweetwater River (Loveland Dam)
- Occurrence 21: Upper Sweetwater River Basin – Sweetwater River (Loveland Dam)
- Occurrence 22: Lower Cottonwood River Basin – Cottonwood Creek (Barrett Dam)
- Occurrence 23: Upper Cottonwood Creek Basin – Pine Valley Creek (Barrett Dam), Cottonwood Creek and Morena Creek (Morena Dam)

Desert Recovery Unit

- Occurrence 24: Antelope-Fremont Creek Basin – Little Rock Creek (Little Rock Reservoir)
- Occurrence 25: Mojave River Basin – Mojave River (Mojave Forks Dam and Cedar Springs Dam)

Baja California, México

- Occurrence 26: Rio Las Palmas (Rodriguez Dam located on Rio Tijuana)

**Description of Impacts Resulting from Threat to Arroyo Toads and Habitat**

Today, ongoing dam operations and water diversions continue to degrade and destroy arroyo toad breeding and upland habitats and limit dispersal by flow alteration. Water diversions that alter normal flows have degraded habitats and adversely affected arroyo toads by leading to: (1) The early drying of breeding pools, causing breeding failures or loss of the larval population; (2) restriction of the period essential for rapid growth when newly metamorphosed toads can forage on damp gravel bars; and (3) loss of damp subsurface soil, which may result in high adult mortality during late summer and early fall (Sweet 1992). Because river flow forms physical habitats, such as riffles, pools, and bars in rivers and floodplains, the primary impacts to habitat from dams and water diversions are caused by flow alteration, which can lead to severely modified channel and floodplain habitats. Arroyo toads, as well as other aquatic species, have evolved life history strategies, such as their timing of reproduction, in direct response to natural flow regimes.

*Flow Alteration – Reduced Sediment Transport*

Dams disconnect rivers from the surrounding floodplains and retain sediments and nutrients that would have nourished downstream ecosystems. Impacts of flow alteration on arroyo toad habitat include changes in the timing, amount, and duration of channel flows; loss of coarse sediments below the dam; and an increase in vegetation density due to the decrease or elimination of scouring flows (Madden-Smith *et al.* 2003, p. 3). For example, fine sediments necessary for replacement of breeding habitat are trapped behind the dam of Silverwood Lake and the reduction of natural flooding along with sustained summer flows from upstream water releases favor nonnative species.

*Flow Alteration – Sudden Water Releases*

Artificial flow regulation disrupts the natural processes that produce the terrace and pool habitats required by arroyo toad. Sudden excessive releases of water from dams during the breeding season can destroy sand bars and reconfigure or destroy suitable breeding pools, thus disrupting clutch and larval development (Ramirez 2003, p. 7). Excessive water releases also wash away arroyo toad eggs and tadpoles, promote the growth of nonnative species, and reduce the availability of open sand bar habitat. For example, water releases of several million gallons per day from Barrett Dam on Cottonwood Creek, during the period when larval arroyo toads were metamorphosing, negatively affected the population in San Diego County (Campbell *et al.* 1996, p. 15).

*Flow Alteration – Habitat Modification*

Flow alteration also causes habitat modification above and below dams, which favors nonnative plants and predators that thrive in the reservoirs and disperse downstream and upstream. Persistent releases from dams throughout the normal dry season also cause changes in vegetation by encouraging the growth of riparian species including some native species such as willow, sycamore, and cattails (*Typha* spp.), and some introduced species such as (tamarisk (*Tamarix* spp.) and giant reed (*Arundo donax*). Increased vegetation alters the open streambed and shallow pool habitat preferred by arroyo toads.

> Example: The flow release schedule from Pyramid Dam called for enhanced summer flows to maintain a trout fishery downstream of Pyramid Dam. This steady release of water created entrenched channels with increased vegetation encroachment on arroyo toad breeding habitat in Piru Creek, habitat more suited to aquatic nonnative predators than to arroyo toads. An example of how over time suitable habitat for arroyo toads becomes degraded from the lack of scouring flows is provided by Dr. Sweet in a description of arroyo toad habitat on Piru Creek below Pyramid Dam (Sweet, pers. comm. 2012):
>
> "Willows, mulefat, cottonwoods and alders have seeded in along the stream banks. After 6-8 years [since the last big scouring event], these trees are now several feet tall and form a nearly continuous riparian border 10 meters or more in width in many places. Moderate

> streamflows have been generally ineffective in clearing away these stands, and instead downcut the streambed between the zones that are heavily armored by roots. In many places, cattails have invaded and created continuous strips bordering the runs—they are especially insidious since their root mats entrap the finest sediment, and over time create a bed of dense clay that may be several feet wide and over 3 feet deep. This is extremely resistant to lateral erosion, and typically creates near-vertical banks 3 feet or more high."

*Flow Alteration – Premature Streambed Drying*

Water diversions can dry a streambed prior to the completion of metamorphosis from tadpole to toad. Water is diverted from some reservoirs such that releases rarely occur downstream, if at all. This is occurring at Barrett and Henshaw Dams where water is released along short segments of the streams below (Cottonwood Creek and the San Luis Rey River, respectively), then is diverted by pipeline to other reservoirs. No releases occur from Lake Sutherland into Santa Ysabel Creek as the water is piped directly from the reservoir to another watershed. Additionally, water does not spill over Sutherland Dam during high rainfall years.

*Flow Alteration – Introduced Species*

Suitable habitat for arroyo toads has often been flooded out by reservoir water, and downstream breeding and non-breeding habitat has been severely altered by persistent and reduced flows at some times and sudden excessive flows at others. Reservoirs turn running water habitats into lake-like systems, resulting in the proliferation of nonnative species that are adapted to still waters and are able to move downstream or upstream of the reservoir (BIP 2012). Reservoirs harbor nonnative aquatic predators and water releases maintain invasions of aquatic predators into arroyo toad habitat downstream. Persistent water releases throughout the year changes the ephemeral water supply to a permanent water supply that also maintains these nonnative predators (Campbell *et al.* 1996, p. 16; Madden-Smith *et al.* 2003, p. 3). Additionally, nonnative aquatic predators can move upstream of reservoirs if conditions are favorable.

High numbers of nonnative aquatic predators were detected just upstream of Irvine Lake (reservoir in the Lower Santa Ana River Basin) (Glenn Lukos Associates 2005, pp. 2–5). A Cooperative Water Resource Management Agreement was established between Marine Corps Base Camp Pendleton and Rancho California Water District in 2002 to mitigate impacts of increased groundwater pumping in the upper watershed of the Santa Margarita River. This agreement guarantees releases into the lower Santa Margarita River during summer months. Constant discharge of water into this system downstream allow nonnative aquatic predators to persist and may reduce suitable breeding pools in years of normal to high rainfall (Brehme *et al.* 2011, pp. 5, 37). Therefore, Brehme *et al.* (2011, pp. 2, 37–38) recommend modifying these releases to simulate a more natural hydrology pattern (i.e., no releases in summer months).

### Actions Taken to Reduce Threat Impacts

*Northern Recovery Unit*

The ongoing impact of dam operations to arroyo toads and habitat has been reduced to some extent by minimizing impacts of unseasonal water releases at one arroyo toad occurrence on Piru Creek (Santa Clara River Basin). Prior to 1992, the California Department of Water Resources (DWR), which operates Pyramid Dam on Piru Creek in the Los Padres and Angeles National Forests, frequently discharged excess flows from the reservoir resulting in the depressed population of arroyo toads on lower Piru Creek (Sweet 1992). Recent coordination among the DWR, Forest Service, and Fish and Wildlife Service have resulted in releases from the dam that more closely mimic natural flows, benefitting the arroyo toad (Service 2009). After several years of implementing the simulated natural flow regime, a 3-year monitoring plan was initiated by DWR to monitor arroyo toads in middle Piru Creek and Aqua Blanca downstream of Pyramid Dam (ESA 2012, p. 1–41+). Field surveys from 2010, 2011, and 2012 documented the status of arroyo toad breeding, threats and management concerns in middle Piru Creek. Following the 2012 surveys, reduced breeding populations were observed in middle Piru Creek and Agua Blanca Creek (ESA 2012, p. 35). The reduced arroyo toad breeding success in Piru Creek in 2012 was attributed to low rainfall and associated low stream flow and not to Pyramid Dam operations affecting stream flow. The study suggests arroyo toads may have delayed breeding in Piru Creek while waiting for winter/spring flows that never materialized (ESA 2012, p. 36).

*Southern Recovery Unit*

The ongoing impact of dam operations to arroyo toads and habitat has been reduced to some extent by minimizing impacts of unseasonal water releases at three arroyo toad occurrences (Lower Sweetwater River Basin, Lower Cottonwood Creek Basin, and a portion of Upper San Diego River Basin). In 2006, the Sweetwater Authority (Authority) implemented a Standard Operating Procedure of Loveland Reservoir to Sweetwater Reservoir water transfers in the lower Sweetwater River based in part on recommendations provided to the Authority in a study by USGS. If possible, no water is released during the arroyo toad breeding season except in the event of an emergency. If a release cannot take place outside the breeding season, arroyo toad breeding surveys are conducted within 72 hours prior to the release to determine if breeding has commenced. If breeding has commenced, then the release is postponed until toads are no longer breeding. Alternatively, releases occur, but flows are initiated during daytime hours and would not exceed current native flows. Follow-up surveys would be conducted upon completion of transfer; however, surveys can only be conducted in areas that are accessible to the Authority (Sweetwater Authority 2006, pp. 4–5). The area where the species occurs has been accessible in recent years, but future access is not guaranteed. Although these procedures are voluntary and may need further review, they improve on the prior conditions (water transfers occurring during the spring), which lessens the impacts to arroyo toads in the lower Sweetwater River.

The City of San Diego (City) has a voluntary internal policy guiding water transfers at two of the City's reservoir systems: (1) Morena Reservoir to Barrett Reservoir to Otay Reservoir; and (2) Sutherland Reservoir to San Vicente Reservoir. This policy minimizes impacts of water transfers to the Lower Cottonwood Creek Basin occurrence below Barrett Dam and the Upper San Diego River Basin occurrence that is above San Vicente Reservoir (it does not affect water transfers within the Upper San Diego River Basin occurrence below Cuyamaca Dam). Water transfers generally occur during winter months between October and March in order to take advantage of existing flows and minimize water lost to the river system, and avoid the breeding season of arroyo toad. City staff coordinates with the Service and contract with an arroyo toad specialist to monitor before, during, and after a water transfer event. All arroyo toad habitat is surveyed within 72 hours of a water transfer event. Negative survey results allow for the water transfer to begin immediately, with gradual increase of flow rates. Positive survey results require alternative release strategies or actions such as lowered flow release, postponement of water transfers, or releasing water at a flow rate that does not exceed flows at which the species was observed in the stream. Upon conclusion of water transfer activities, water releases are gradually ramped down at the same rate they were increased until all flows have ceased. Finally, an assessment report is prepared that quantifies and qualifies results with recommendations. If an emergency release is required based on an imminent threat to public health or safety, the release will occur as needed, City staff will notify the Service and other resource agencies, and a biologist will monitor the release at known arroyo toad locations (McGinnis, City of San Diego, pers. comm. 2012).

**Threat Assessment**

Threat Scope = Large. 19 out of 35 river basins (54 percent of occurrences) are currently affected by the operation of dams and water diversions in both the U.S. and México. In several instances, multiple dams have been constructed along the same river or stream.

Threat Severity = Serious. A summary of the effects to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; alteration of water quality or chemistry; and introduction of nonnative predators and invasive species. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from the operation of dams and water diversions, given continuation of current circumstances and trends, we estimate that within the scope, existing dams and water diversion operations are likely to seriously degrade habitat or reduce between 31 percent and 70 percent of species occurrences.

Timing Impact = High (Ongoing).

Threat Impact= High.

**What the Threat at Current Scope and Severity Means for the Species**

Given that dams and water diversions currently affect 19 out of 35 river basins where the arroyo toad is known to occur, and that where dams and water diversions occur, they have a serious effect on arroyo toads and their habitats, and because this threat is reduced at four occurrences, we categorize this threat as having a high level of impact to the species as a whole. Dam construction results in the immediate destruction of habitat above the dam through inundation, destroying both arroyo toad breeding and upland habitats. Downstream habitat is eliminated by regulated stream flows that destroy sand bars used during the breeding season; reconfigure, and in some cases eliminate, suitable breeding pools; and disrupt clutch and larval development (Ramirez 2005, p. 2). The initial downstream effects of a dam will modify and degrade breeding habitat for the arroyo toad, but in the long-term will eventually eliminate it (Madden-Smith *et al.* 2005, p. 23). Some progress has been made since listing towards reducing the threat of operation of dams and water diversions to arroyo toads and habitat at four river basin occurrences. Impacts from unseasonal water releases has been minimized at three of these occurrences at the Santa Clara River Basin, Lower Sweetwater River Basin, and Lower Cottonwood Creek Basin, and has been partially minimized at the Upper San Diego River Basin occurrence. Although the threat is reduced in these areas, other impacts from dams and water diversions, such as reduction of sediments and nutrients, increased desiccation, vegetation density, and aquatic predators still exist. Overall, dams and water diversions are a current threat with a high level of impact to the arroyo toad.

## 4. MINING AND PROSPECTING

**Threat Status at the Time of Listing**

At the time of listing, habitat loss through recreational suction dredge mining for gold was considered an additional threat to the species. In 1991, during the Memorial Day weekend, four small dredges operating on Piru Creek in the Los Padres National Forest produced sedimentation visible more than 0.8 mi (1 km) downstream and adversely affected 40,000 to 60,000 arroyo toad larvae. Subsequent surveys revealed nearly total loss of the species in this stream section; fewer than 100 larvae survived and only four juvenile toads were located (Sweet 1992, pp. 180–187).

**Occurrences and Locations Currently Affected:**

Currently, 8 out of 35 river basins (23 percent of occurrences) at the following site locations are impacted or may be impacted by mining. For the other 27 river basins, the best available information does not indicate that arroyo toads are being impacted by mining and prospecting.

Northern Recovery Unit:

- Occurrence 2: Santa Maria River Basin – Sisquoc River (sand and gravel mining)
- Occurrence 4: Santa Clara River Basin – Santa Clara River and tributaries (sand and gravel mining)

Southern Recovery Unit:

- Occurrence 13: Upper Santa Margarita River Basin – Temecula Creek (sand and gravel mining)
- Occurrence 20: Lower Sweetwater River Basin – Sweetwater River (mining has stopped but impacts continue)
- Occurrence 22: Lower Cottonwood Creek Basin – Potrero Creek, Campo Creek (potential for suction dredge mining)

Desert Recovery Unit:

- Occurrence 25: Mojave River Basin – Little Horsethief Creek (prospecting for gold)

Baja California, México

- Occurrence 26: Rio Las Palmas (sand and gravel mining)
- Occurrence 27: Rio Guadalupe (sand and gravel mining)

**Description of Impacts Resulting from Threat to Arroyo Toads and Habitat**

Although not widespread, impacts from mining activities have localized impacts on arroyo toads.

*Suction Dredge Mining – Habitat Alteration and Mortality of Individuals*

Suction dredge mining causes substantial alteration of arroyo toad habitat by degrading water quality, altering stream morphology, increasing siltation downstream, and creating deep pools that hold water year-round for introduced predators of arroyo toad eggs and larvae (Campbell *et al.* 1996, p. 16). Suction dredges pull material up from the stream bottom and after separating the minerals out, redeposit the stream material back onto the bottom of the stream. The increase in suspended sediments in the stream can suffocate arroyo toad eggs and small larvae. Arroyo toad eggs, tadpoles, and newly metamorphosed juveniles can also be entrained on the suction pump and killed.

*Sand and Gravel Mining – Habitat Alteration and Increased Sedimentation*

In addition to removing habitat, the increase in sediment or other contaminant runoff entering the stream from sand and gravel mining operations can increase water temperature and turbidity and result in degrading or even destroying arroyo toad breeding habitat (CDFG 2005). For example, habitat degradation has occurred at Sloan Canyon on the lower Sweetwater River as a result of the sand and gravel mining operations of the previous landowner, Vulcan Minerals Inc., and the subsequent formation of the sand/gravel pond known as Lake Emma. The Lower Sweetwater River Basin occurrence is now restricted to habitat upstream of Lake Emma. Reduction in water flow due to the presence of a dam at Lake Emma appears to be a primary barrier to the successful reestablishment of arroyo toads downstream (Madden-Smith *et al.* 2005, p. 22). Additionally, coarse sediment loss from breeding habitat upstream in Sloan Canyon continues as the sediments are washed down into Lake Emma (and sediments are not replaced above Sloan Canyon because of Loveland Reservoir upstream) (Madden-Smith *et al.* 2003, p. 15).

Sand and gravel extraction as well as reclamation occurs in the Santa Maria River Basin on the Sisquoc River, beginning approximately 4.5 mi (7.2 km) downstream of the confluence with the Cuyama River and ending approximately 7.4 mi (12 km) upstream of this confluence (Service 2008). Sand and gravel mining also occurs in the Santa Clara River Basin.

In Baja California, the sand mining industry is impacting the Rio Guadalupe, Rio Las Palmas, Rio Ensenada, and other smaller coastal arroyos by providing the necessary raw materials for California's construction industry (Lovich 2009, p. 90). Sand and rock are extracted in such large volumes that the hydrology in coastal canyons is affected, and associated riparian habitats are eliminated. The public has demonstrated opposition to this scale of sand mining, but the Mexican government supports the industry (Lovich 2009, p. 90).

In the Mojave River Basin, gold prospecting activities in general, including digging pits in the stream bed and banks, has been observed on Little Horsethief Creek on the San Bernardino National Forest (Loe *in litt.* 1997).

**Actions Taken to Reduce Threat Impacts**
At present, the impact of suction dredge mining to arroyo toads and habitat has been eliminated in Class A streams by a recent change in CDFW regulations. Most of the streams and rivers occupied by arroyo toads in the United States are now classified as Class A (24 occurrences) and therefore suction dredge mining no longer occurs in those streams. However, this threat could potentially impact arroyo toads in streams that are not classified as Class A (Lower Cottonwood Creek Basin).

**Threat Assessment**
Threat Scope = Small. 8 out of 35 river basins (23 percent of occurrences) are currently affected or may be affected by mining both in the U.S. and México.
Threat Severity = Moderate. A summary of the effects to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; alteration of water quality or chemistry; and introduction of nonnative predators and invasive species. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from sand and gravel mining and

suction dredge mining, given continuation of current circumstances and trends, we find within the scope, this threat is likely to moderately degrade habitat or reduce 11 percent to 30 percent of species occurrences.

Timing Impact = High (Ongoing).

Threat Impact = Low.

**What the Threat at Current Scope and Severity Means for the Species**

Given that mining and prospecting currently affects 8 out of 35 river basins where the arroyo toad is known to occur, and that where mining and prospecting occurs, it has a moderate effect on arroyo toads and their habitats, and the threat has been reduced at 24 occurrences, we categorize this threat as having a low level of impact to the species as a whole. The data indicate that suction dredge mining threatens the survival of arroyo toads not just during the breeding season, but at any time of year and should be permanently prohibited on all arroyo toad occupied streams. CDFW has prohibited suction dredge mining in Class A streams, which accounts for all but one of the occurrences in the United States (24 occurrences). However, sand and gravel mining remains a threat at five occurrences and gold prospecting is a threat at one occurrence. Overall, mining and prospecting is a current threat with a low level of impact to the arroyo toad.

## 5. LIVESTOCK GRAZING

**Threat Status at the Time of Listing**

At the time of listing, overgrazing brought a potential source of mortality to arroyo toads if horses or cattle were allowed to graze in riparian areas. The effects of livestock grazing on arroyo toads included directly crushing individuals and burrows; trampling stream banks resulting in soil compaction, loss or reduction in vegetative bank cover, stream bank collapse, and increased in-stream water temperatures from loss of shade; and excess sedimentation entering stream segments at crossings or other stream areas used by livestock for watering or grazing on riparian vegetation.

**Occurrences and Locations Currently Affected:**

Currently, 10 out of 35 river basins (28 percent of occurrences) at the following site locations are impacted by livestock grazing. For the other 25 river basins, the best available information does not indicate that arroyo toads are being impacted by livestock grazing.

Northern Recovery Unit:

- Occurrence 2: Santa Maria River Basin – Sisquoc River
- Occurrence 4: Santa Clara River Basin – Piru Creek

Southern Recovery Unit:

- Occurrence 10: San Mateo Creek Basin – Talega Creek, Cristianitos Creek, Gabino Creek
- Occurrence 16: Upper San Luis Rey River Basin – Agua Caliente Creek, San Luis Rey River
- Occurrence 17: Lower Santa Ysabel Creek Basin – Santa Ysabel Creek, Santa Maria Creek, Guejito Creek
- Occurrence 18: Upper Santa Ysabel Creek Basin – Santa Ysabel Creek
- Occurrence 21: Upper Sweetwater River Basin – Sweetwater River
- Occurrence 22: Lower Cottonwood Creek Basin – Cottonwood Creek, Potrero Creek
- Occurrence 23: Upper Cottonwood Creek Basin – Cottonwood Creek, La Posta Creek

Desert Recovery Unit:
Occurrence 25: Mojave River Basin – West Fork Mojave River, Little Horsethief Creek

**Description of Impacts Resulting from Threat to Arroyo Toads and Habitat**

*Streambank Degradation and Erosion*
Pastured cattle (and other livestock) are recognized as a critical factor in stream bank degradation and erosion (Moore et al. 2000, p. 1). When cattle graze in stream corridors, their hooves exert several times greater pressure on the soil than the per square inch weight of a bulldozer (Moore 2000, p. 1). Cattle grazing causes soil compaction, loss or reduction in vegetative bank cover, stream bank collapse, and increased in-stream water temperatures from loss of shade. Cattle consume or trample vegetation, eliminating the stream's natural protective blanket of vegetation and exposing the soil, increasing its vulnerability to erosion. Cattle also defecate close to or in the stream, causing bacterial pollution of the water.

*Sedimentation*
Sedimentation occurs in stream segments at crossings or other stream areas used by livestock for watering or grazing on riparian vegetation. Increased sedimentation could smother egg masses and large amounts of silt could retard the growth of tadpoles by covering food sources.

*Habitat Alteration*
In the Santa Clara River Basin occurrence on Los Padres National Forest land, concentrated use by cattle grazing in and near arroyo toad occupied habitat on Piru Creek has, over time, reduced or eliminated the under- and mid-story components of the gallery forest. This gallery forest, consisting of a stand of mature cottonwoods and willows on the upper terrace along the east side of Piru Creek, had been used by arroyo toads for foraging and burrowing. In addition, cattle have impacted the Piru Creek riparian corridor to such an extent that there is a lack of breeding pool habitat, sloughed and trampled stream-banks, and a stressed riparian plant community where sedges and young willows are becoming scarce and tamarisk are increasing (USFS 2007, p. 8). Arroyo toad individuals are also impacted by cattle that stray out of the crossing and trample nearby arroyo toad egg masses and other life stages while being herded across Piru Creek into the allotment (USFS 2007, p. 8).

There are recent reports of cattle impacting streams occupied by arroyo toad in San Diego County. Cattle were observed in upper Santa Ysabel Creek by USGS personnel conducting surveys for arroyo toad larvae on County of San Diego property. The cattle trespassed from neighboring private property (Brown, USGS, pers. comm. 2012). Additionally, cattle were observed trespassing across the international border from Mexico onto City of San Diego property and in lower Cottonwood Creek (Brown, USGS, pers. comm. 2012).

**Actions Taken to Reduce Threat Impacts**
Although livestock grazing continues to impact 10 occurrences of arroyo toads, progress has been made toward reducing or eliminating the impact and in raising public awareness of the problem. The Forest Service has developed grazing allotment management guidelines to reduce the effects of livestock grazing on threatened and endangered species and habitat. The Service has consulted with the Forest Service on various grazing allotment permit renewal projects that

resulted in biological opinions (1-6-99-F-21 (Service 2000a), 1-8-03-F-53 (Service 2004a), 1-6-01-F-1694 (Service 2001a), and FWS-SB-1464.2 (Service 2001b)).

*Northern Recovery Unit*
Los Padres National Forest has kept the Sisquoc Grazing Allotment in the Santa Maria River Basin vacant for approximately 10 years due to concerns about impacts to arroyo toads and other sensitive riparian species (Cooper *in litt*. 2009). The Service completed section 7 consultation with the USFS in 2009 on the Piru and Canton Canyon allotments that contained provisions to minimize impacts to arroyo toad habitat (81440-2009-I-0217).

*Southern Recovery Unit*
On the Cleveland National Forest, grazing has a minimal impact because the Forest Service excluded most of the habitat occupied by arroyo toads from grazing allotments during the 1990s. The Cleveland National Forest has also formally excluded grazing from some arroyo toad habitat within current allotments, including 12,112 ac (4,901 ha) centered around riparian areas (Service 2005b). Areas with arroyo toad habitat within Santa Ysabel, Pine Valley, and Morena Creeks (Lower Santa Ysabel Creek Basin and Upper Cottonwood Creek Basin) were excluded from grazing (Service 2001a). The Pine Valley Allotment, which was the only streamside grazing allotment still active at the time of the 5-year review in 2007, is now vacant.

**Threat Assessment**
Threat Scope = Restricted. 10 out of 35 river basins (28 percent of occurrences) are currently affected by livestock grazing.
Threat Severity = Moderate. A summary of the effects of livestock grazing to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; alteration of processes that create and maintain suitable breeding habitat; alteration of water quality or chemistry; and introduction of invasive nonnative plants. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from livestock grazing, given continuation of current circumstances and trends, we find within the scope, this threat is likely to moderately degrade habitat or reduce 11 percent to 30 percent of species occurrences.
Timing Impact = High (Ongoing).
Threat Impact = Low.

**What the Threat at Current Scope and Severity Means for the Species**
Given that livestock grazing currently affects 10 out of 35 river basins where the arroyo toad is known to occur, and that where livestock grazing occurs, it has a moderate effect on arroyo toads and their habitats, and because this threat is reduced at four occurrences, we categorize this threat as having a low level of impact to the species as a whole. Due to their fragile nature, even occasional use of riparian corridors by cattle can cause harm to the riparian and aquatic habitats. Concentrated grazing by cattle will, over time, reduce or eliminate the under- and mid-story components of vegetation. Livestock overgrazing is seen in the lack of breeding pool habitat, sloughed and trampled stream-banks, and a stressed riparian plant community where desirable species such as sedges and young willows are becoming scarce and undesirable species such as tamarisk are increasing. Livestock grazing on Federal lands has been reduced to some extent due

to section 7 consultation and the addition of minimization measures to grazing allotment permits issued by Los Padres and Cleveland National Forests. Overall, livestock grazing is a current threat with a low level of impact to the arroyo toad.

## 6. ROADS AND ROAD MAINTENANCE

### Threat Status at the Time of Listing

At the time of listing, the use of heavy equipment in yearly reconstruction of roads and stream crossings in the national forests had a significant and repeated impact to arroyo toads and their habitat. As described in the listing rule (59 FR 64589), the Ogilvy Ranch Road, a private inholding in the Los Padres National Forest, made 18 crossings of Mono Creek, many directly through or near arroyo toad breeding pools. In the summer of 1992, the Los Padres National Forest declined to open the Ogilvy Ranch Road in order to protect populations of arroyo toads and other candidate amphibians and reptiles. However, Ogilvy Ranch opened the road with a bulldozer in the fall. As juvenile arroyo toads were likely burrowed in the soft sand adjacent to the creek, grading the road up the creek destroyed habitat and probably killed individual toads (Sweet, pers. comm. 2007b). Maintenance of the road to Ogilvy Ranch still likely contributes to a depressed population of arroyo toads in Mono Creek.

### Occurrences and Locations Currently Affected:

Currently, 20 out of 35 river basins (57 percent of occurrences) at the following site locations are impacted by roads and road maintenance. For the remaining 15 river basins, the best available information does not indicate that arroyo toads are being impacted by roads and road maintenance.

Northern Recovery Unit:

- Occurrence 1: San Antonio River (public and military vehicles)
- Occurrence 3: Santa Ynez River Basin – Santa Ynez River, Indian Creek, Mono Creek
- Occurrence 4: Santa Clara River Basin – Santa Clara River Basin – Sespe Creek, Piru Creek, Forest Service (FS) Road 4N37 (Indian Canyon Road), Soledad Canyon; FS Road 5N62, Soledad Canyon; Soledad Canyon Road; 6N32.2, Castaic Road; 6N13, Castaic Power Plant Road; FS Road 6N32.1 (Warm Springs/Fish Canyon Road), Castaic. Stream crossings Castaic Creek and Fish Creek (feeds into Castaic).
- Occurrence 5: Los Angeles River Basin – 3N19.2 (Upper Big Tujunga Canyon Highway), Upper Big Tujunga; FS Road 3N27 (Fall Creek Road), Middle Big Tujunga; FS Road 4N18.2 (Lynx Gulch Road), Upper Big Tujunga; FS Road 3N24 (Colby Ranch Road), Upper Big Tujunga; FS Road 3N20 (Upper Big T Powerline Road), Upper Big Tujunga; Stream Crossings: Upper Big Tujunga Creek, Alder Creek, Lynx Gulch, and Santiago Creek.

Southern Recovery Unit:

- Occurrence 6: Lower Santa Ana River Basin – Santiago Canyon Road, Santiago Creek; Silverado Canyon Road, Silverado Creek.
- Occurrence 8: San Jacinto River Basin – Bautista Canyon Road, Bautista Creek; Highway 74, San Jacinto River.

Occurrence 9: San Juan Creek Basin – Highway 74 (Ortega Highway), San Juan Creek; Trabuco Canyon Road, Trabuco Creek.

Occurrence 10: San Mateo Creek Basin – Avenue Pico/TRW Bridge, Cristianitos Creek; Cristianitos Road: Cristianitos and San Mateo creeks; unpaved private road, Gabino Creek; Talega Road, Talega Creek; San Mateo Road, San Mateo Creek; Proposed Foothill-South Toll Highway: Talega, Cristianitos, Gabino, and San Mateo creeks.

Occurrence 11: San Onofre Creek Basin – Basilone Road, San Juan Road, and unpaved roads: San Onofre Creek.

Occurrence 12: Lower Santa Margarita River Basin – Vandegrift Boulevard, Stagecoach Road, and unpaved roads: Santa Margarita River; De Luz Road: Santa Margarita River, De Luz Creek; Roblar Truck Trail, De Luz Creek; Sandia Creek Drive: Santa Margarita River, Sandia Creek.

Occurrence 13: Upper Santa Margarita River Basin – Crosley Truck Trail, Arroyo Seco Creek; private unpaved roads, Wilson Creek.

Occurrence 15: Lower & Middle San Luis Rey River Basin – Highway 76 and private unpaved roads, San Luis Rey River; Pala Temecula Road, Pala Creek. Stream crossings, San Luis Rey River: Pauma Ridge Road, Cole Grade Road, Valley Center Road, private unpaved roads.

Occurrence 16: Upper San Luis Rey River Basin – Highway 79: Agua Caliente Creek, San Luis Rey River, Cañada Aguanga; Linton Road, San Luis Rey River; private unpaved roads: Cañada Aguanga, San Luis Rey River, West Fork San Luis Rey River.

Occurrence 17: Lower Santa Ysabel Creek Basin – Highway 78 (San Pasqual Valley Road), Santa Ysabel Creek; Orosco Road, Boden Canyon; Pamo Road, Temescal Creek; Rangeland and Highland Valley roads, Santa Maria Creek; private unpaved roads: Santa Ysabel Creek, Guejito Creek, Santa Maria Creek. Stream Crossings: Ysabel Creek Road, Orosco Road, Pamo Road cross Santa Ysabel Creek; Guejito Road, Guejito Creek.

Occurrence 19: Upper San Diego River Basin – Kimball Valley and Chuck Wagon roads, San Vicente Creek.

Occurrence 20: Lower Sweetwater River Basin – Sloan Canyon Road, Sweetwater River.

Occurrence 21: Upper Sweetwater River Basin – Interstate 8, Highway 79, Riverside Drive, Viejas Boulevard, Oak Grove Drive, River Drive, Upper Green Valley Fire Road, private unpaved roads (all Sweetwater River).

Occurrence 22: Lower Cottonwood Creek Basin – Highway 94 (Campo Road), Barrett Lake Road, private unpaved roads (all Cottonwood Creek); Harris Ranch Road, Potrero Creek; Highway 94 and unpaved roads, Campo Creek. Stream Crossings: Barrett Dam road and private unpaved roads cross Cottonwood Creek; private unpaved roads, Potrero Creek; unpaved roads, Campo Creek.

Occurrence 23: Upper Cottonwood Creek Basin – Pine Creek Road, Old Highway 80, Interstate 8 (all Pine Valley Creek); Rua Alta Vista, Scove Canyon; Morena Stokes Valley Road, Morena Creek; Buckman Springs Road, Cottonwood and La Posta Creeks; Old Highway 80, Interstate 8, Kitchen Creek. Stream Crossings: Pine Creek Road, Fire Dept Road, Pine Creek Crossing (all Pine Valley Creek); Morena Stokes Valley Road, Morena Creek.

Desert Recovery Unit:

Occurrence 24: Antelope-Fremont Creek Basin – FS Road 5N04.2 (Cheseboro Road), Little Rock Reservoir; FS Road 5N04.3 (Little Rock Canyon Road), Little Rock Canyon; Little Rock Creek stream crossing.

**Description of Impacts Resulting from Threat Maintenance to Arroyo Toads and Habitat**

*Roads and Road Maintenance – Injury or Mortality to Arroyo Toads*

Most road maintenance activities, such as vegetation cutting and ditch and culvert cleaning, occur on the surface of the road or within 10 feet of the road surface. Toads are crushed by equipment on the roads or when vehicles use the low water crossings during normal daytime project activities. Toads are harmed or disturbed when rocks and debris are removed from the road surface or ditches near habitat. Toad mortality on sandy, unpaved roads occurs because (1) increased food sources (ants, other insects) lure toads onto roads at night, and (2) arroyo toads like to burrow into sandy roadbeds during the day (Sandburg, U.S. Forest Service, pers. comm., 1997).

*Low Water Crossing Use and Maintenance – Injury or Mortality to Arroyo Toads*

Unimproved stream crossings can develop characteristics of suitable toad habitat that attracts arroyo toads—shallow, sand or gravel-based pools with low current velocity and minimal shoreline woody vegetation (USFS 2012a, p. 45). Adults burrow during the day but come out at night to forage, so are more likely be killed by nighttime traffic or during wet weather. Use of low water crossings and roads adjacent to suitable habitat can result in mortality to arroyo toads, particularly juveniles that would be crushed by summer traffic. Hardened crossings lack the substrate that toads prefer until silt and gravel collects and builds up over time, but adults will forage on any stream crossing or hardened crossing at night (USFS 2012a, p. 45).

Low water crossing maintenance, such as removal or shaping of channel sediments, debris, and vegetation above and below crossings, can alter habitat suitability for arroyo toads by increasing the flow over the crossing. Toads can be harmed during any stream crossing maintenance activity where there is suitable habitat, even during the dry season because toads could be burrowed in the soil or under rocks. Eggs or larvae could also be crushed or disturbed when vehicles use low water crossings (Service 2000, p. 13).

*Erosion*

Soil disturbance has been directly implicated in both lethal and sublethal effects on amphibians (Maxell and Hokit 1999, p. 2-11). If not contained, road construction may cause increased sedimentation in adjoining aquatic habitats. Traffic on native surface and dirt roads causes soil erosion that can run off into streams, particularly during wet weather. Pollutants from exhaust and tire wear can build up along roadsides and enter riparian areas. Vehicles using low water crossings over streams cause increased siltation, which can cover and suffocate egg masses and larvae (Service 2000, p. 14).

**Actions Taken to Reduce Threat Impacts**

*Northern Recovery Unit*

To reduce this threat on Federal lands, Los Padres National Forest reinitiated section 7 consultation (8-8-12-F-43) with the Service for ongoing activities related to their transportation system and road use (Service 2013). The consultation covered roads and low water stream crossings in the Santa Clara River Basin and Santa Ynez River Basin. Los Padres National Forest must repair and maintain approximately 1,025 mi (1,649 km) of roads and 137 low water stream crossings on forest lands and must implement best management practices and conservation measures to protect the arroyo toad before conducting any road or water crossing maintenance including, but not limited to, pre-construction surveys for arroyo toads and relocating individuals to suitable habitat nearby, permanently removing bullfrogs and other nonnative species, avoiding maintenance work during the breeding season, and developing a water control plan. In addition, Los Padres National Forest has rerouted trails and closed roads in arroyo toad habitat. Administrative access by USFS personnel is also restricted during the breeding season unless a biologist surveys the road crossings first.

*Southern Recovery Unit*
The other National Forests in southern California, the Angeles, Cleveland, and San Bernardino, have completed similar section 7 consultations to reduce or avoid effects from ongoing road use and maintenance to arroyo toads and habitat. On the Cleveland National Forest, roads are still identified as one of the top three threats to arroyo toad, along with drought and aquatic predators (Winter, pers. comm. 2012).

**Threat Assessment**
Threat Scope = Large. 20 out of 35 river basins (57 percent of occurrences) are currently affected by roads and road maintenance.
Threat Severity = Moderate. A summary of the effects to arroyo toads and habitat include permanent loss of breeding habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; and introduction of nonnative species. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from roads and road maintenance activities, given continuation of current circumstances and trends, and with the knowledge that this threat has been reduced at 3 occurrences, we find within the scope, this threat is likely to moderately degrade habitat or reduce 11 to 30 percent of species occurrences.
Timing Impact = High (Ongoing).
Threat Impact = Medium.

**What the Threat at Current Scope and Severity Means for the Species**

Given that roads and road maintenance currently affects 20 out of 35 river basins where the arroyo toad is known to occur, and where roads and road maintenance occurs, it has a moderate effect on arroyo toads and their habitats, and because this threat is reduced at three occurrences, we categorize this threat as having a medium level of impact to the species as a whole. Overall, roads and road maintenance is a current threat with a medium level of impact to the arroyo toad.

## 7. RECREATION

**Threat Status at the Time of Listing**

At the time of listing, recreational activities in riparian wetlands had substantial negative effects on arroyo toad habitat and individuals. Streamside campgrounds in southern California National Forests were frequently located adjacent to arroyo toad habitat (Sweet 1992). With nearly 20 million people living within driving distance of the National Forests and other public lands in southern California, recreational access and its subsequent effects are an ongoing concern (CDFG 2005). Numerous studies have documented the effects of recreation on vegetation and soils and report results of human trampling caused by hiking, camping, fishing, and nature study. Significantly fewer studies report the consequences of horse and bicycle riding or that of off-road vehicles and snowmobiles (Cole and Landres 1995).

**Occurrences and Locations Currently Affected:**

Currently, 22 out of 35 river basins (63 percent of occurrences) at the following site locations are impacted by recreational facilities and activities. For the remaining 13 river basins, the best available information does not indicate that arroyo toads are being impacted by recreation.

Northern Recovery Unit:

- Occurrence 2: Santa Maria River Basin – Sisquoc River
- Occurrence 3: Santa Ynez River Basin – Upper Santa Ynez River (campgrounds, fishing, water play), Indian Creek, Mono Creek (hiking, water play)
- Occurrence 4: Santa Clara River Basin – Santa Clara River Basin – Sespe Creek (fishing, campgrounds), Piru Creek (fishing), Castaic Creek (fishing)
- Occurrence 5: Los Angeles River Basin – Big Tujunga Creek (recreational residences)

Southern Recovery Unit:

- Occurrence 6: Lower Santa Ana River Basin – Silverado Creek
- Occurrence 7: Upper Santa Ana River Basin – Cajon Wash (swimming and OHV)
- Occurrence 8: San Jacinto River Basin – San Jacinto River (trails), Bautista Creek (OHV)
- Occurrence 9: San Juan Creek Basin – San Juan Creek (campground)
- Occurrence 10: San Mateo Creek Basin – Talega Creek, Cristianitos Creek, Gabino Creek, San Mateo Creek (all: OHV)
- Occurrence 11: San Onofre Creek Basin – San Onofre Creek (OHV)
- Occurrence 12: Lower Santa Margarita River Basin – Santa Margarita River (OHV), De Luz Creek
- Occurrence 13: Upper Santa Margarita River Basin – Arroyo Seco Creek (trail), Temecula Creek, Wilson Creek (OHV)
- Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River
- Occurrence 16: Upper San Luis Rey River Basin – San Luis Rey River (campground), Agua Caliente Creek (OHV, Pacific Crest Trail)
- Occurrence 17: Lower Santa Ysabel Creek Basin – Santa Ysabel Creek (OHV)
- Occurrence 19: Upper San Diego River Basin – San Diego River (swimming)
- Occurrence 20: Lower Sweetwater River Basin – Sweetwater River
- Occurrence 21: Upper Sweetwater River Basin – Sweetwater River (horseback riding, swimming), Viejas Creek (OHV, trails)
- Occurrence 22: Lower Cottonwood Creek Basin – Cottonwood and Campo creeks (international border patrolling, OHV, trails)

Occurrence 23: Upper Cottonwood Creek Basin – Recreation: Pine Valley Creek (swimming), Horsethief Creek, Cottonwood Creek (campground), Kitchen Creek (campground). OHV and trails: Pine Valley Creek, Scove Canyon, Morena Creek, Kitchen Creek, Cottonwood Creek (Pacific Crest trail), La Posta Creek

Desert Recovery Unit:

Occurrence 24: Antelope-Fremont Creek Basin – Little Rock Creek (fishing)

Occurrence 25: Mojave River Basin – West Fork Mojave River (OHV), Deep Creek (swimming, wading)

**Description of Impacts Resulting from Threat to Arroyo Toads and Habitat**

The Forest Service's Recreation Program provides an opportunity for local rural communities and millions of Americans to enjoy engaging in physical activities in National Forests (USFS 2013b, p. 2). The National Forest Trails System is designed to provide public access for recreation. Non-motorized trails are designed to provide diverse opportunities for access to remote natural areas as well as day use "loop" trails. The Hiking Trails Program provides opportunities not only for hiking, but for cross-country skiing, biking, and horse riding. The trails also offer access to campsites, hunting and fishing areas, and provide opportunities for viewing wildlife, scenery, and historic places (USFS 2013b, p. 2). Outfitters are permitted to use the trail system for commercial ventures including leading equestrian groups into the backcountry. Equestrian campsites provide pipe corrals, parking for trailers, water troughs, and hitching rails. Bike riding is prohibited in Wilderness areas and some front country trails (USFS 2013b, p. 2).

*Recreational activities*

Recreational activities include camping, fishing, hiking, mountain biking, horseback riding, swimming, wading, and water play. On the Los Padres National Forest, toads may burrow into the soft sand along the edges of a hiking trail and be killed by trail users or maintenance crews during the day, although the trail tread is usually compacted soils and not likely to be burrowed into (USFS 2013b, p. 13). Eggs or tadpoles could also be stepped on by trail users and work crews at stream crossings. Pack horses may be allowed to graze or water at stream crossings and impact streamside vegetation or trample various life stages of the arroyo toad (USFS 2013b, p. 14). In fact, each arroyo toad population on the Los Padres National Forest is located in an area where, in almost all cases, hiking trails follow the floodplain and cross the stream channels in multiple locations within a short distance.

Recreational development occurs along Pine Valley Creek in San Diego County. Recreation at Cedar Creek falls on the Cleveland National Forest, a popular destination for swimming, impacts water quality in the Upper San Diego River Basin. No amphibian larvae have been detected within 250 meters of the falls where treefrogs and newt larvae were previously detected (Brown, USGS, pers. comm. 2012). Decreased detection of arroyo toads and high impacts to the stream from water play was observed downstream of Green Valley falls (upper Sweetwater River) after Cuyamaca Rancho State Park opened access to the area, although use of the area has dropped significantly since State Parks began charging a small fee (Brown, USGS, pers. comm. 2012). There is a Recreation Residence Tract on Big Tujunga Creek in Angeles National Forest.

*Campgrounds*

Campgrounds focus large numbers of people and intensive use on limited habitats. Disturbances created by recreation favor the germination, establishment, and growth of nonnative plant species, substantially altering food availability within a habitat. Streamside campgrounds and recreational activities reduce riparian vegetation and increase soil erosion and sedimentation that can cover and kill algae, bacteria, and fungi on the surface of rocks, which are what arroyo toad tadpoles feed on. Excess sedimentation from people swimming and wading in the creek increases the turbidity of water and can bury eggs or suffocate larvae.

Streamside campgrounds in the three southern California National Forests (Los Padres, Angeles, and Cleveland) have frequently been located in or near (165 to 300 ft (50 to 92 m)) arroyo toad habitat (i.e., on the stream terrace; Sweet 1992, p. 158–160). In the Los Padres National Forest, each of the three campgrounds on Piru and Sespe Creeks were developed on stream terraces used by arroyo toads within 100–300 ft (30–90 m) of their breeding pools. On the upper Santa Ynez River, three of four campgrounds are located in arroyo toad habitat. The placement of campgrounds is similar in the Cleveland National Forest in San Diego County; upper San Juan Creek, upper San Luis Rey River, and Cottonwood Creek all have campgrounds situated adjacent to arroyo toad breeding habitats.

*Off-Highway Vehicles*

Sweet (1992, pp. 162–163) observed off-highway vehicles (OHVs) in arroyo toad breeding sites on the Los Padres National Forest that resulted in the deaths of arroyo toad egg clutches, larvae, and juveniles. Adult toad mortality on sandy, unpaved roads occurs because increased food sources (ants, other insects) lure toads onto roads at night and because arroyo toads like to burrow into sandy roadbeds during the day (Sandburg, USFS, pers. comm., 1997).

The impacts of motorized vehicles on amphibian populations do not end at the roadside. In addition to direct mortality resulting from collisions, OHVs may disrupt habitat to the point that it becomes unusable by herpetofauna (Maxell and Hokit 1999, p. 2-10). Recreational OHV use of trails opens relatively undisturbed areas to increased use. OHVs spread seeds of nonnative plants and disturb soils, contributing to excess erosion and sedimentation of aquatic habitats.

Noise from on- and off-road vehicles is also likely to have negative indirect impacts on amphibians. Although we did not find studies that targeted arroyo toads specifically, Nash *et al.* (1970 *in* Maxell and Hokit 1999, p. 2.10) exposed leopard frogs to loud noises (120 decibels) and found that the frogs remained immobilized for much longer periods of time than a similarly handled control group. Thus, an immobility reaction resulting from noise-induced fear could increase mortality of amphibians that inhabit areas used by OHVs or individuals that are crossing roads by inhibiting their ability to find shelter or move across a roadway (Maxell and Hokit 1999, p. 2.2–2.10).

*Sedimentation and runoff*

Indirect effects of recreational activities include a small potential for sedimentation from hiking trails into breeding pools. Sedimentation is likely to occur from surface runoff over the disturbed soil of the trail prism as well as areas along the shoulder where vegetation has been removed.

Sedimentation could affect eggs by coating them, and the food resources of tadpoles could be affected. However, March signals the end of the rainy season in California, so the potential for rainstorms that would move this sediment diminishes greatly by the onset of the arroyo toad breeding season in late March.

*Spread of Disease*
A potential threat to arroyo toads that is incompletely understood is the potential for maintenance equipment or hikers to spread the amphibian disease, chytridiomycosis. Studies have found that transmission by fishing, hiking, and equestrian uses does not occur; rather, mechanized equipment may be more likely since mud infected with the fungus could be transported among sites in tire treads (USFS 2012a, p. 15).

**Actions Taken to Reduce Threat Impacts**
To reduce the threat of recreational activities on Federal lands, the Forest Service has implemented campground closures and conservation measures to promote recovery of the arroyo toad at six occurrences.

*Northern Recovery Unit*
Seasonal closures of campgrounds and roads in arroyo toad habitats by Los Padres National Forest in the Santa Ynez River Basin have resulted in increased breeding success in the Santa Ynez River (Service 1999, p. 55). Los Padres National Forest permanently closed the following campgrounds to all uses, year-round, in the Santa Clara River Basin to protect arroyo toads and habitat:  Hardluck Campground on the middle Piru Creek, Blue Point Campground on the lower Piru Creek; Beaver Campground and Lion Campground on Sespe Creek (Cooper *in litt*. 2009). In addition, on the Los Padres National Forest, Snowy Trail on the Mount Pinos Ranger District was re-routed out of the riparian habitat to protect arroyo toad habitat in Piru Creek in the Santa Clara River Basin. The Agua Blanca Trailhead and Trail were re-routed away from Sespe Creek, also in the Santa Clara River Basin. Hiking trail crossings in the Sisquoc River in the Santa Maria River Basin were surveyed for potential impacts to arroyo toads in some areas (no impacts detected), and interpretive signs were placed in four campgrounds along the Sisquoc River. In addition to closing Blue Point and Hardluck Campground access roads, Camuesa Road was closed to public access to protect arroyo toad habitat near Mono and Indian Creeks in the Santa Clara River Basin.

*Southern Recovery Unit*
The Cleveland National Forest has been proactive in reducing or eliminating some of these threats on their lands, primarily effects to toads from recreation, grazing, and nonnative plants. All of the arroyo toad occurrences on the Cleveland National Forest are small and are along low-order streams. Because road use and recreation is increasing, the Cleveland National Forest has installed stream crossings in some areas to prevent direct and indirect impacts of OHVs to the arroyo toad (Service 2005b). To help control recreational activities, the Forest has installed road signs, erected barriers, and implemented seasonal road closures as well. For example, 2 mi (3.21 km) of unauthorized roads that were affecting arroyo toad habitat in Noble Creek were permanently closed and the Lower San Juan Picnic Area in was permanently closed to protect arroyo toad habitat along San Juan Creek in the San Juan Creek Basin. To minimize impacts from the recreational residences in the San Juan Creek (San Juan Creek Basin) and Pine Valley

Creek (Upper Cottonwood Creek Basin), Cleveland National Forest replaced septic systems, instituted public education programs, and removed nonnative vegetation (Service 2003a). It also acquired an additional 232 ac (94 ha) of arroyo toad habitat at Hook Ranch on Cottonwood Creek in the Upper Cottonwood Creek Basin (Service 2005b) so that it is protected and will not be available for grazing or off-highway vehicle (OHV) use. However, recreational use (mostly campgrounds and swimming) is still impacting six occurrences on the Forest (Lower Santa Ana River Basin, San Juan Creek Basin, Upper Santa Margarita River Basin, Upper San Luis Rey River Basin, Upper San Diego River Basin, and Upper Cottonwood Creek Basin) (Winter, pers. comm. 2012).

*Desert Recovery Unit*
Beginning in 1996, the Angeles National Forest permanently closed the Antelope-Fremont Creek Basin at Little Rock Creek to all uses, year-round, to protect arroyo toads and habitat (Service 1999, pp. 55–56). The threat of recreation has been reduced at one occurrence in the Desert Recovery Unit.

**Threat Assessment**

Threat Scope = Large. 22 out of 35 river basins (63 percent of occurrences) are currently affected by recreational activities.

Threat Severity = Moderate. A summary of the effects to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; exposure to pesticides/herbicides, alteration of water quality or chemistry; and introduction of nonnative predators and invasive species. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from recreational activities, given continuation of current circumstances and trends, we find that within the scope, this threat is likely to moderately degrade habitat or reduce 11 percent to 30 percent of species occurrences.

Timing Impact = High (Ongoing).

Threat Impact = Medium.

**What the Threat at Current Scope and Severity Means for the Species**

Given that recreational activities currently affect 22 out of 35 river basins where the arroyo toad is known to occur, and that where recreational activities occur, they have a moderate effect on arroyo toads and their habitats, and because the threat of recreation has been reduced at 6 occurrences, we categorize this threat as having a medium level of impact to the species as a whole. Many of the recreational activities described above, and recreational impacts in general, may result in the loss and fragmentation of arroyo toad habitat. Roads, trails, OHV use, recreational facilities, and water impoundments can replace natural habitat, and this destruction can displace arroyo toad populations (Maxell and Hokit 1999, p. 2.15). The National Forest has been proactive in reducing or eliminating some of these threats on their lands. To help control recreational activities, the Forests have closed campgrounds seasonally or permanently, installed road and interpretive signs, erected barriers, re-routed trails and trailheads, and implemented seasonal road closures in 6 occurrences on Federal lands, although impacts have not been reduced, at most of the recreational sites on national forests. Overall, recreational activities are a current threat with a medium level of impact to the arroyo toad.

## 8. INVASIVE NONNATIVE PLANTS

### Threat Status at the Time of Listing

At the time of listing, invasive nonnative plants were not identified as a threat to arroyo toads. Since then, invasive nonnative plants have had a negative effect on arroyo toads and their habitat in 16 of 35 river basins. Nonnative plant species, particularly tamarisk (*Tamarix* spp.) and giant reed (*Arundo donax*), alter the natural hydrology of stream drainages by eliminating sandbars, breeding pools, and upland habitats.

### Occurrences and Locations Currently Affected:

Currently, 16 out of 35 river basins (46 percent of occurrences) at the following site locations are impacted by invasive nonnative plants. For the remaining 19 river basins, the best available information does not indicate that arroyo toads are being impacted by invasive nonnative plants.

Northern Recovery Unit:

- Occurrence 2: Santa Maria River Basin – Sisquoc River
- Occurrence 3: Santa Ynez River Basin – Lower Santa Ynez River, Indian Creek, lower Mono Creek
- Occurrence 4: Santa Clara River Basin – Sespe Creek, Santa Clara River
- Occurrence 5: Los Angeles River Basin – Big Tujunga Creek

Southern Recovery Unit:

- Occurrence 9: San Juan Creek Basin – San Juan Creek, Trabuco Creek
- Occurrence 10: San Mateo Creek Basin – Talega Creek, Cristianitos Creek, Gabino Creek, San Mateo Creek (watercress)
- Occurrence 11: San Onofre Creek Basin – San Onofre Creek (watercress)
- Occurrence 12: Lower Santa Margarita River Basin – Santa Margarita River, De Luz Creek (giant reed, tamarisk, watercress)
- Occurrence 13: Upper Santa Margarita River Basin – Arroyo Seco Creek
- Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River
- Occurrence 17: Lower Santa Ysabel Creek Basin – Santa Ysabel Creek, Santa Maria Creek, Guejito Creek
- Occurrence 19: Upper San Diego River Basin – San Vicente Creek
- Occurrence 20: Lower Sweetwater River Basin – Sweetwater River
- Occurrence 21: Upper Sweetwater River Basin – Sweetwater River (watercress)
- Occurrence 22: Lower Cottonwood Creek Basin – Cottonwood Creek, Potrero Creek
- Occurrence 23: Upper Cottonwood Creek Basin – Pine Valley Creek, Cottonwood Creek, La Posta Creek

### Description of Impacts Resulting from Threat to Arroyo Toads and Habitat

Invasive nonnative plants may be spread by off-road vehicles, recreation, livestock, and camping activities. In addition, the introduction of nonnative species may enhance the probability of successful introduction of other nonnative species. For example, there is some evidence that the survival of bullfrogs is enhanced by the presence of nonnative aquatic vegetation, which provides habitat more suitable to bullfrogs (Maxell and Hokit 1999, p. 2-8). Management of nonnative plants and insect pests with chemical herbicides and pesticides can have impacts on amphibian communities. In particular, several features of arroyo toad biology may enhance their susceptibility to chemical contamination because their life history involves both aquatic larvae and terrestrial adults, allowing exposure to toxicants in both habitats.

The most problematic nonnative plant species in aquatic systems in southern California is giant reed, which is widespread along the Ventura, Santa Clara, Santa Ana, Santa Margarita, San Luis Rey, and San Diego Rivers (CDFG 2005). Giant reed invades stream banks and lakeshores, where it can completely displace native vegetation, reduce wildlife habitat, increase fire risk, and alter flow regimes that can cause flooding (Ventura County 2006, pp. 21–23). Giant reed is a tall, grass-like plant with jointed stems resembling corn stalks that grow up to 20 ft (6.1 m) in height. Coffman *et al.* (2010, pp. 2723–2734) examined the regrowth rates of giant reed and nearby native woody vegetation following a 741-acre (300 ha) fire in the Santa Clara River watershed in 2005. Giant reed grew three to four times faster following the fire, and within 11 years, its density was 20 times greater than native species. This suggests that rapid regrowth of the highly flammable biomass creates an invasive plant-fire cycle that ultimately leads to a decline in native species in the ecosystem (Coffman *et al.* 2010, pp. 2730–2731).

Another problematic nonnative species, tamarisk (*Tamarix ramosissima*), is less widespread than giant reed but also invades riparian habitats in the above-listed rivers and is distributed in coastal and desert drainages (Coffman *et al*. 2010, p. 2724). Tamarisk can replace or displace native woody species such as cottonwood and willow that occupy similar habitats, especially when timing and amount of peak water discharge, salinity, temperature, and substrate texture have been altered by human activities (Carpenter 2004, pp. 1–30). It is an aggressive, woody invasive plant that can tolerate a variety of environmental conditions and has become established over as much as a million acres of floodplains, riparian areas, wetlands, and lake margins in the western United States (Carpenter 2004, pp. 1–30). Tamarisk also consumes large quantities of water, possibly more than woody native plant species occupying the same habitat (Carpenter 2004, p. 3). Highly resistant to removal by flooding, tamarisk has the potential to form dense corridors along most large streams. Where this has been allowed to occur, tamarisk have replaced native vegetation, invaded sand bars, and led to channelization by constricting flood flows.

Sometimes, one nonnative plant species competitively overruns an entire ecosystem (Pimental *et al.* 2005, p. 275). The extend of yellow star thistle (*Centaurea solstitalis*) infestation in California is estimated to be between 10 and 15 million acres (UC Davis 2007, p. 1); however, DeLong (2002, p. 2) contends that yellow star thistle heavily infests 22 percent of the state, or an area equal to 20 million acres. Regardless, the plant is now common in open areas on roadsides, rangelands, wildlands, hay fields, pastures, and waste areas (UC Davis 2007, p. 1). It is a fast-growing invasive plant with multiple rigid stems that can reach over 6 ft (2 m) in height and greater than 6 feet (2 m) in diameter. Its taproot can reach over 3 ft (1 m) deep into the soil, allowing it to thrive during dry, hot summers. Arroyo toad suitable habitat is destroyed when yellow star thistle becomes well-established on stream terraces because arroyo toads are unable to dig their burrows for shelter or estivation through yellow star thistle-infested soil (Sweet 2007a, p. 1).

Sedimentation from fire in the upper Sweetwater River initially created more breeding habitat, and an increase in breeding was detected. As watercress (*Nasturtium officinale*) subsequently invaded—covering the water surface—recruitment plummeted. It is possible that, while reducing available breeding area, the watercress reduced detectability of arroyo toads. However, in sandy open areas, larvae of other toad species were detected while arroyo toads were not. USGS intends to test this data set soon (Brown, USGS, pers. comm. 2012).

**Actions Taken to Reduce Threat Impacts**

*Northern Recovery Unit*

Nonnative aquatic and riparian plants are a serious problem on the Los Padres National Forest. Introduced plants are affecting the larger drainages, chief among them white sweet-clover (*Melilotis albus*), which now covers many sandbars on Sespe Creek formerly suitable for use by juvenile arroyo toads (Sweet 1992, p. 157). Tamarisk is taking over streamside flats on the Santa Ynez River and along lower Piru Creek, and is present and increasing elsewhere on the Los Padres National Forest (Sweet 1992, p. 157). To reduce the impacts of the invasive nonnative plants threat on Federal lands, the Los Padres National Forest has made a concerted effort to remove giant reed and tamarisk from arroyo toad habitat. Forest Service staff and volunteers conduct annual tamarisk removal along portions of Piru Creek, Sisquoc River, Santa Ynez River, and Sespe Creek to protect and restore arroyo toad habitat.

*Southern Recovery Unit*

In 1995, the Service issued a non-jeopardy biological opinion for arroyo toad (1-6-95-F-02), which addressed impacts from training activities, infrastructure maintenance, several construction projects, and a Riparian and Estuarine Programmatic Conservation Plan on the Marine Corps Base Camp Pendleton (Base). To minimize the impact of incidental take of arroyo toad, the Marine Corps must take measures to assess threats to the survival and recovery of arroyo toad on Base. To assure implementation of these measures, the Marine Corps, with assistance from the Service, shall assess the severity of threats to arroyo toad posed by green sunfish, bullfrog, and other likely predators or competitors. If mutually deemed a threat of sufficient magnitude that may preclude attainment of recovery objectives on Base for arroyo toad, the Base shall implement specific control programs for invasive nonnative plants and predatory animals (Service 1995, pp. 1, 26, 32, 35).

The Marine Corps has implemented nonnative plant control programs on Base. Researchers from USGS that have been monitoring arroyo toad occurrences on Base since 2003 recommend continued eradication efforts of nonnative plants, particularly those that alter the natural hydrology of watersheds occupied by arroyo toad (Brehme *et al.* 2011, p. 38). In recent years, tamarisk has been recorded in all watersheds on Base (San Mateo Creek Basin, San Onofre Creek Basin, and Lower Santa Margarita River Basin), but large stands persisted only along the lower Santa Margarita River.

Prevalence of giant reed has been reduced from removal efforts by the Marine Corps, along with scouring that occurred from flooding events. Dense stands of giant reed were still common along sections of the lower Santa Margarita River as of 2010. Watercress has become well established in the Santa Margarita River and De Luz Creek (Lower Santa Margarita River Basin). Scattered patches of watercress have been observed in the upper portions of San Mateo and San Onofre Creeks (Brehme *et al.* 2011, p. 32).

**Threat Assessment**

Threat Scope = Large. 16 out of 35 river basins (46 percent of occurrences) are being affected by invasive nonnative plants.

Threat Severity = Moderate. A summary of the effects to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; displacement of individuals; reduced foraging and breeding success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; and exposure to pesticides/herbicides. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from invasive nonnative plants, given continuation of current circumstances and trends, we find that within the scope, this threat is likely to moderately degrade habitat or reduce 11 percent to 30 percent of species occurrences.

Timing Impact = High (Ongoing).

Threat Impact = Medium.

**What the Threat at Current Scope and Severity Means for the Species**

Given that invasive nonnative plants currently affect 16 out of 35 river basins where the arroyo toad is known to occur, and that where invasive nonnative plants occur, invasive plants have a moderate effect on arroyo toad habitats, and because this threat is reduced at six occurrences, we categorize this threat as having a medium level of impact to the species as a whole. Invasive nonnative plants such as tamarisk and giant reed alter the natural hydrology of watersheds occupied by arroyo toad. Large riparian corridors have historically acted as natural firebreaks in southern California because of their low-lying topography and relative absence of flammable fuels. However, the highly flammable tamarisk and giant reed have altered this situation and pose a serious problem for management because they vigorously resprout after burning. Management of invasive plants and weeds with chemical herbicides and pesticides can have impacts to arroyo toads. Solutions seem to be limited to proactive control efforts and minimizing the amount of habitat disturbances that permit some species to become established. Overall, invasive nonnative plants are a current threat with a medium level of impact to the arroyo toad.

*Factor C: Disease and Predation*

## 9. DISEASE

**Threat Status at the Time of Listing**

Disease was not considered a threat to the arroyo toad at the time of listing. However, during the last several decades, significant declines in populations of amphibians have been observed worldwide (Beebee and Griffiths 2005, p. 273). Since the arroyo toad was listed, chytridiomycosis, an infectious amphibian disease caused by the fungus (*Batrachochytrium* *dendrobatidis* (Bd)), has been clearly linked to these amphibian declines and extinctions worldwide. Bullfrogs may also carry the pathogen without showing clinical signs of the disease (Beebee and Griffiths 2005, p. 273).

**Occurrences and Locations Currently Affected:**

Bd has been implicated in mass amphibian die-offs and species extinctions in pristine areas of Central America and Australia, and is considered a probable cause of precipitous boreal toad (*Anaxyrus boreas boreas,* a subspecies of the western toad (*Anaxyrus boreas*)) declines in Colorado (Hahr 2006).

The literature generally indicates chytridiomycosis was first identified in 1998 by an international team of scientists from Australia, the United States, and Great Britain (Hahr 2006). However, in 1991, Nichols (2003) examined three dead formalin-fixed arroyo toads that had died of an amphibian skin disease characterized by thickening of the epidermis. These arroyo toads had been part of a captive colony consisting of approximately 120 animals kept at the University of California, Santa Barbara. A disease outbreak had already caused the death of 60 percent of the toads in this colony and the three specimens were sent to Nichols to determine the cause (Sweet 1992, p. 128–131). Nichols, along with Dr. Joyce Longcore at the University of Maine, spent the next 5 years characterizing the fungal organism that caused the skin disease and the factors that influenced the development of chytridiomycosis in amphibians (Nichols 2003). It is clear from Nichols' research that arroyo toads can be infected by this pathogen and killed by this disease and, therefore, it must be considered a potential threat.

Currently, we do not have adequate data or reports to indicate which occurrences may be impacted by this potential threat.

### Description of Impacts Resulting from Threat to Arroyo Toads and Habitat

Bd is a water-borne fungus that can be spread through direct contact between aquatic animals or by spores that can move short distances through the water. The fungus only attacks the parts of an amphibian's skin that have keratin (thickened skin), such as the mouthparts of tadpoles and the toes of adults. The fungus can decimate amphibian populations, causing fungal dermatitis which usually results in death in 1 to 2 weeks, but not before infected animals may have spread the fungal spores to other individuals, ponds, and streams. Once a pond has become infected with Bd, the fungus stays in the water for an undetermined amount of time.

### Actions Taken to Reduce Threat Impacts

Arroyo toads are now routinely swabbed for the presence of Bd to get a better understanding of the pathogen's distribution and potential impact on the species.

To prevent the spread of Bd, the Service recommends that strict disease prevention protocols as described in the Declining Amphibian Population Task Force's Code of Practice (Appendix D) should be followed in the field. For example, all footwear and equipment should be disinfected before and between visits to aquatic habitat. These same precautions should be taken by anyone visiting amphibian breeding ponds in the wild, and the handling of toads should be avoided whenever possible.

A recent study has developed methods to assess Bd distribution and abundance in water and sediment. The field sampling demonstrated that water can be sampled, with or without concurrent amphibian sampling. The technique will allow researchers to study the implications of Bd's presence in water bodies, to monitor water bodies before reintroduction efforts, and to investigate the spread of Bd across the landscape (Kirshtein *et al.* 2007, p. 15).

### Threat Assessment

Based on the best available information, no instances of disease are known among wild arroyo toad populations, but a chytrid fungal epidemic killed all juvenile arroyo toads being reared in a laboratory in 1991 (Sweet 1992, p. 128–131; Lanoo 2005, p. 1). Symptoms appeared too soon after collection for a laboratory-acquired origin, but no unexplained mortality was observed in the wild source populations during the remainder of the season.

## 10. INTRODUCED PREDATOR SPECIES

### Threat Status at the Time of Listing

At the time of listing, nonnative predators had caused substantial reductions in the sizes of extant populations of arroyo toads, and nonnative predators have caused arroyo toads to disappear from large portions of historically occupied habitat (Jennings and Hayes 1994, p. 57).

### Occurrences and Locations Currently Affected:

Currently, 28 out of 35 river basins, (80 percent of occurrences) at the following site locations are impacted by introduced predator species. For the remaining 7 river basins, the best available information does not indicate that arroyo toads are being impacted by introduced predator species.

Northern Recovery Unit

- Occurrence 1: Salinas River Basin – San Antonio River (bullfrogs)
- Occurrence 2: Santa Maria River Basin – Sisquoc River
- Occurrence 3: Santa Ynez River Basin – Lower Santa Ynez River, Indian Creek,
- Occurrence 4: Santa Clara River Basin – Sespe Creek, Piru Creek (bullfrogs), Santa Clara River
- Occurrence 5: Los Angeles River Basin – Big Tujunga Creek (bullfrogs)

Southern Recovery Unit

- Occurrence 9: San Juan Creek Basin – San Juan Creek, Trabuco Creek (all: nonnative aquatic predators, bullfrogs)
- Occurrence 10: San Mateo Creek Basin – Talega Creek, Cristianitos Creek, Gabino Creek, San Mateo Creek (all: nonnative aquatic predators)
- Occurrence 12: Lower Santa Margarita River Basin – Santa Margarita River, De Luz Creek, Roblar Creek (all: nonnative aquatic predators)
- Occurrence 13: Upper Santa Margarita River Basin – Arroyo Seco Creek (nonnative aquatic predators)
- Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River (nonnative aquatic predators)

Occurrence 16: Upper San Luis Rey River Basin – San Luis Rey River, West Fork San Luis Rey River, Agua Caliente (all: nonnative aquatic predators, wild pigs)
Occurrence 17: Lower Santa Ysabel Creek Basin – Santa Ysabel Creek, Santa Maria Creek, Guejito Creek (all: nonnative aquatic predators)
Occurrence 18: Upper Santa Ysabel Creek Basin – Santa Ysabel Creek (nonnative aquatic predators, bullfrogs, wild pigs)
Occurrence 19: Upper San Diego River Basin – San Diego River (nonnative aquatic predators, wild pigs), San Vicente Creek (nonnative aquatic predators, bullfrogs, crayfish, wild pigs)
Occurrence 21: Upper Sweetwater River Basin – Sweetwater River (wild pigs, nonnative aquatic predators)
Occurrence 22: Lower Cottonwood Creek Basin – Potrero Creek (nonnative aquatic predators)
Occurrence 23: Upper Cottonwood Creek Basin – Pine Valley Creek (nonnative aquatic predators, wild pigs), Morena Creek (nonnative aquatic predators, wild pigs), La Posta Creek (nonnative aquatic predators)

Desert Recovery Unit
Occurrence 25: Mojave River Basin – West Fork Mojave River (beaver, bullfrogs), Horsethief Creek (bullfrogs)

Baja California, Mexico
Occurrence 26: Rio Las Palmas
Occurrence 27: Rio Guadalupe
Occurrence 28: Arroyo San Carlos
Occurrence 29: Rio El Zorillo
Occurrence 30: Rio Santo Tomas
Occurrence 31: Rio San Vicente
Occurrence 32: Rio San Rafael
Occurrence 33: Rio San Telmo
Occurrence 34: Rio Santo Domingo
Occurrence 35: Rio Santa Maria

**Description of Impacts Resulting from Threat to Arroyo Toads and Habitat**

Introduced predator species that compete for resources and that prey on arroyo toads impact arroyo toads and their habitats in 28 of 35 river basins. The introduction of aquatic species not native to southern California watercourses has been facilitated by the construction of the California Aqueduct and other sources of inter-basin water transport (Service 1999, p. 48). Predatory species, many of which have used the aqueduct to colonize the Santa Clara River, San Jacinto River, and Mojave River basins, include green sunfish, largemouth bass (*Micropterous salmoides*), black bullhead (*Ictalurus nebulosus*), prickly sculpin (*Cottus asper*), stocked rainbow trout (*Oncorhynchus mykiss*), oriental gobies (*Tridentiger* spp.), red shiners (*Notropis lutrensis*), bullfrogs, African clawed frogs, and crayfish (Sweet 1992, p. 118–122; Service 1999, p. 48). All of these species prey on arroyo toad tadpoles.

*Bullfrogs and African clawed frogs*

Bullfrogs and African clawed frogs feed on arroyo toads at all life stages (Ramirez 2007, p. 102). The presence of deep and persistent pools during summer and fall provide refuge and breeding habitat for these nonnative predators. Artificially sustained flow regimes and activities that create ponds (including the introduction of beaver into central and southern coastal montane regions) make habitat more suitable for bullfrogs and African clawed frogs than for arroyo toads (Sweet 1992, p. 156).

Where the two species co-occur, bullfrogs are major predators on arroyo toads (Sweet 1992, p. 128). Bullfrogs are well-adapted to deep-water conditions in ponded areas above dams, and dam releases can introduce them to downstream habitats (CDFG 2005, p. 178). In these modified systems with deep pools that persist year-round, both bullfrogs and arroyo toads must rely on the same habitat for breeding, even though their biological needs differ. This situation allows bullfrogs more opportunity to prey on essentially all of the life stages of arroyo toads. Sweet (1992, p. 132) found that bullfrogs target calling male arroyo toads were associated with resulting sex ratio biases in arroyo toads of 1:14 (one male to 14 females) in Sespe Creek. Of 40 bullfrogs captured along the Santa Margarita River in 2008, arroyo toad remains were found in the stomach contents of over half of them (Brehme *et al.* 2011, p. 44). USGS further estimated 125 arroyo toads were being consumed by bullfrogs per kilometer per month along the lower Santa Margarita River (Backin and Brehme, USGS, pers. comm. 2012).

In fact, the presence of bullfrogs in a stream is an indicator of how the natural hydrology of that stream drainage has been altered. Whereas arroyo toad breeding habitat requirements are highly specialized because they require shallow, slow-moving streams and riparian habitats that are disturbed on a regular basis, bullfrogs are more of habitat generalists and can tolerate elevated water temperatures and even use standing pools resulting from urban runoff to complete their 2-year life cycle (CDFG 2005, p. 178). However, in stream habitats with pools that predominately persist only through the summer and then dry up by the fall, arroyo toads would be at an advantage in comparison to bullfrogs.

*Other aquatic predators*
Arroyo toad tadpoles are also subject to predation by introduced fish species, especially green sunfish (*Lepomis cyanellus*), prickly sculpin (*Cottus asper*), mosquitofish (*Gambusia affinis*) and crayfish (*Procambarus clarkii*). Over the past 20 years, at least 60 species of fishes have been introduced to the western United States, 59% of which are predatory.

*Recent examples of impacts from aquatic predators*
Occupancy models for wet arroyo toad habitat on Marine Corps Base Camp Pendleton indicate that nonnative aquatic predators had the largest negative impact on arroyo toad occupancy and detectability (Brehme *et al.* 2006, p. 43). This negative association weakened to a level of insignificance in 2009—which corresponded with elevated aquatic predator removal efforts—but returned again in 2010 along with a greater number of sites where nonnative predator fish and crayfish were detected (Brehme *et al.* 2011, pp. 29, 31, 35–36). Once established, nonnative predators appear resilient and persist in the system except when drying acts to create a period of habitat unsuitability (Miller *et al.* 2012, pp. 2, 7). Thus, Brehme *et al.* (2011, p. 2) recommend modifying water releases along the lower Santa Margarita River to simulate a more natural hydrology pattern (i.e., no releases in summer months), along with continued, elevated control of nonnative aquatic species.

Surveys along San Mateo Creek on the Cleveland National Forest confirmed a very high abundance and widespread distribution of nonnative aquatic species, with approximately 77 percent of the "major" pools and 45 percent of the "minor" pools occupied by at least one nonnative species (ECORP 2004, pp. 18, 25).

*Wild pigs*
Wild pigs (*Sus scrofa*) have been identified as a new threat to arroyo toads (76 FR 7247) at 5 of 35 river basin occurrences. Wild pigs were introduced during the approximately 2004–2006 period near the San Diego River and spread over much of central San Diego County. Subsequently, pigs have been introduced in two other areas of the County. Arroyo toads are expected to be adversely affected in the San Diego River watershed as a result of wild pig introductions (SDNHM 2010, pp. 3, 23, 29, 32, 34–35). The mild climate of San Diego County should support rapid population growth and expansion (with a potential range expansion north into Riverside County and south into Mexico) making eradication of wild pigs unlikely and control difficult (CBI 2009, pp. 14, 20–21; SDNHM 2010, p. 42; Winchell, USFWS, pers. comm. 2012).

In a recent study by Jolley *et al.* (2010, p. 519), wild pigs were found to negatively affect almost all aspects of ecosystem structure and function. Their rooting disturbs soil layers and natural decomposition cycles. Typically traveling in groups, areas where pigs have rooted appear as if rototilled, leaving large areas of bare earth that can be easily colonized by invasive nonnative weeds.

Wild pigs do not have functional sweat glands and must therefore cool themselves in water and mud. For this reason, their distribution is often focused around water, particularly in hot climates or seasons. At these locations, wallowing, trampling, and churning of water and mud can harm water quality and quantity, cause streambed erosion, reduce riparian habitat quality, and impact water systems (CBI 2009, p. 4).

Wild pigs are opportunistic omnivores that will eat anything from grain to carrion (Barrett and Birmingham 1994, p. D-66; Wilcox and Van Vuren 2009, p. 114). Numerous studies have documented wild pigs preying on reptiles and amphibians. Results from wild pig stomach samples collected at a military installation in southeastern United States found that eastern spadefoot toads (*Scaphiopus holbrookii*) were consumed in the greatest quantity among herpetofauna, thought to be caused by this amphibian's life-history characteristic of concentrating at high densities in breeding pools (Jolley *et al.* 2010, pp. 520–522).

### Actions Taken to Reduce Threat Impacts

*Northern Recovery Unit*
Some progress has been made since listing toward reducing the threat of introduced predators to arroyo toads and habitat at two arroyo toad occurrences (Santa Ynez River Basin and the Santa Clara River Basin). Efforts are being made to remove or reduce nonnative plant and animal populations in several areas, including the Santa Ynez River Basin on the Los Padres National Forest and San Francisquito Creek on the Angeles National Forest. Forest Service personnel have also worked with animal control agencies to reduce the releases of raccoons and opossums in arroyo toad habitats.

*Southern Recovery Unit*

Some progress has been made since listing toward reducing the threat of introduced predators to arroyo toads and habitat at three arroyo toad occurrences (San Mateo Creek Basin, Lower Santa Margarita River Basin, and San Juan Creek Basin). As mentioned above under Invasive Nonnative Plants, the Marine Corps must take measures to assess threats to the survival and recovery of arroyo toad on Marine Corps Base Camp Pendleton (Base) pursuant to a biological opinion issued in 1995 (1-6-95-F-02). To assure implementation of these measures, the Marine Corps, with assistance of the Service, shall assess the severity of threats to arroyo toad posed by green sunfish, bullfrog, and other likely predators. If mutually deemed a threat of sufficient magnitude that may preclude attainment of recovery objectives on Base for arroyo toad, the Base shall implement specific control programs for predatory animals (Service 1995, pp. 1, 26, 32, 35). Nonnative aquatic predator removal on Base has been ongoing for several years and has shown a benefit to arroyo toads in the lower San Mateo Creek, San Onofre Creek, and in particular, the lower Santa Margarita River on the Base. Brehme *et al.* (2011, pp. 2–3) strongly recommend continued control of nonnative aquatic species, especially bullfrogs and crayfish, for continued persistence of arroyo toad in the lower Santa Margarita River.

In the San Juan Creek Basin, a 6-year aquatic predator control program was conducted along a portion of San Juan Creek in Orange County as mitigation for two California Department of Transportation (CalTrans) projects on adjacent State Route 74. The program was effective in reducing bullfrog adults and larvae from the headwaters of the creek and has slowed local proliferation of this species. Continuation of removal efforts is recommended within the creek and at downstream breeding populations that provide sources of dispersal into the study area (LSA and BonTerra 2012, pp. 12–13). However, the program ended in 2012, and work has ceased. As another CalTrans project is anticipated along State Route 74, the work could be continued through this new project, but may not be initiated for another year or more.

In 2012, the Cleveland National Forest prepared an environmental assessment of a proposed feral pig damage control project on the Forest, Bureau of Land Management lands, and on the Capitan Grande Indian Reservation (USDA 2012, p. 49). At this time, we do not know if this program will be implemented, but we support control of this threat. Eradication of wild pigs is unlikely and control is difficult in San Diego County, as private land is interspersed with public land. The control program would be restricted to public lands and private lands where access is granted, as the State has no jurisdiction to control wild pigs on private land. Thus, private lands could harbor the pigs. If there was access and funding, this species could be controlled, however, securing reliable funding is usually a challenge in these matters (Winchell, USFWS, pers. comm. 2012).

**Threat Assessment**

Threat Scope = Pervasive. 28 out of 35 river basins (80 percent of occurrences) are currently affected by introduced predator species.

Threat Severity = Extreme. A summary of the effects to arroyo toads and habitat include reduced breeding success; mortality, injury, or displacement of individuals; potential extirpation of entire populations. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from introduced predator species, given continuation of current circumstances and trends, we find that within the scope, this threat is likely to seriously degrade habitat or reduce 71 percent to100 percent of species occurrences.

Timing Impact = High (Ongoing).
Threat Impact = Very High.

### What the Threat at Current Scope and Severity Means for the Species

Given that introduced predators currently affect 28 out of 35 river basins where the arroyo toad is known to occur, and that where introduced predators occur, they have an extreme effect on arroyo toads and their habitats, and because this threat is reduced at five occurrences, we categorize this threat as having a very high level of impact to the species as a whole. Introduced fishes and bullfrogs prey on arroyo toad larvae, juveniles, and adults. These predator species pose a continuing threat to almost all arroyo toad populations and have essentially become residents of the ecosystem. In reality, bullfrogs, green sunfish, and other exotic predatory fishes are not well-adapted to be permanent residents of the portions of streams occupied by arroyo toads; they die off during droughts, or are washed out by even moderate flooding (Sweet 1992, p. 156). However, they thrive in reservoirs and need only part of one season to reinvade upstream; additionally, the deep pools formed below dams provide them refugia and allow rapid recolonization of downstream areas (Sweet 1992, p. 156). Overall, introduced predators are a current threat with a very high level of impact to the arroyo toad.

*Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence*

### 11. DROUGHT

### Threat Status at the Time of Listing

At the time of listing, drought and the resultant deterioration of riparian habitats was considered to be the most significant natural factor adversely affecting the arroyo toad. Although drought is a recurring phenomenon in southern California, there is no doubt that this natural event combined with the many manmade factors negatively affects arroyo toad survival. Drought continues to have negative effects on arroyo toads.

### Occurrences and Locations Currently Affected:

Currently, there are 21 out of 35 river basins (60 percent of occurrences) at the following site locations that are impacted by drought. For the remaining 14 river basins, the best available information does not indicate that arroyo toads are being impacted by drought.

Northern Recovery Unit:

- Occurrence 2: Santa Maria River Basin – Sisquoc River
- Occurrence 3: Santa Ynez River Basin – Mono Creek, Indian Creek
- Occurrence 4: Santa Clara River Basin – Sespe Creek, Santa Clara River
- Occurrence 5: Los Angeles River Basin – Big Tujunga Creek

Southern Recovery Unit:

- Occurrence 6: Lower Santa Ana River Basin – Silverado Creek, Santiago Creek
- Occurrence 7: Upper Santa Ana River Basin – Cajon Wash
- Occurrence 8: San Jacinto River Basin – San Jacinto River, Bautista Creek
- Occurrence 9: San Juan Creek Basin – San Juan Creek, Trabuco Creek
- Occurrence 10: San Mateo Creek Basin – San Mateo Creek
- Occurrence 11: San Onofre Creek Basin – San Onofre Creek

Occurrence 12: Lower Santa Margarita River Basin – Arroyo Seco Creek, Temecula Creek, Wilson Creek
Occurrence 14: Murrieta Creek – Cole Creek
Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River, Keys Creek, Pala Creek
Occurrence 16: Upper San Luis Rey River Basin – San Luis Rey River, West Fork San Luis Rey River, Cañada Aguanga, Agua Caliente Creek
Occurrence 17: Lower Santa Ysabel Creek Basin – Santa Ysabel Creek, Boden Canyon
Occurrence 18: Upper Santa Ysabel Creek Basin – Santa Ysabel Creek and Witch Creek
Occurrence 19: Upper San Diego River Basin – San Diego River
Occurrence 21: Upper Sweetwater River Basin – Sweetwater River
Occurrence 22: Lower Cottonwood Creek Basin – Cottonwood Creek
Occurrence 23: Upper Cottonwood Creek Basin – Pine Valley Creek, Horsethief Creek, Morena Creek, Cottonwood Creek, Kitchen Creek, La Posta Creek

Desert Recovery Unit:
Occurrence 25: Mojave River Basin – West Fork Mojave River, Little Horsethief Creek

**Description of Impacts Resulting from Threat of Drought to Arroyo Toads and Habitat**
Statewide water run-off data indicate California has experienced two multi-year droughts of large-scale extent since listing: from 2000 to 2002, and from 2007 to 2009 (CDWR 2012, p. 4). Increasing temperatures and more frequent and severe droughts will likely worsen existing competition for water resources and threaten native forests and ecosystems (EPA 2012b, p. 1). Future warming is also projected to produce more severe droughts in the southwestern region of the United States (Nevada, Arizona, Utah, central and southern California), with further reductions in water supplies (EPA 2012b, p. 1). Depending on the severity and duration of drought, drought is a threat that affects arroyo toads because it can result in serious impacts to the riparian habitats that the species depends on. Drought causes soil degradation and increased erosion that damages aquatic and riparian habitat; drought-stressed plants become diseased more easily; vegetation dries out and becomes highly flammable causing uncontrolled fires; and the lack of water and food stresses wildlife and plant species.

As drought conditions increase, plants reduce the number of stems they produce, while other parts of the plant shrivel and die back. This reduction in plant growth results in less available canopy cover and shade, which could increase predation rates on arroyo toads. Growth reduction produces fewer flowers for insects; fewer insects results in less available food for arroyo toads. At the time of listing and today, a major concern regarding the effect of drought on arroyo toads is that female toads may not be able to find sufficient insect prey to build up enough fat storage for egg production in time to find a mate, resulting in no reproduction for that year (Sweet 1992). In addition, if streams dry up too early in the breeding season, arroyo toad tadpoles may not have enough time to reach metamorphosis.

*Northern Recovery Unit*
Prolonged drought can result in the loss of suitable breeding pools, foraging habitat, and prey availability for arroyo toads (Sweet 1992, p. 190) and lead to a “bottleneck” in population size and age structure (Sweet 1992, p. 147). Sweet (1992, p. 147-148) provides an example of this

scenario that occurred during a severe 5-year drought in southern California: From 1987 to 1991, this drought progressively curtailed or eliminated stream flow in most areas inhabited by arroyo toads on the Los Padres National Forest (Sweet (1992, p. 147). This drought, combined with water diversions from streams, had created extremely stressful conditions for the toads in the Santa Ynez River Basin in the Santa Ynez River, and the Santa Clara River Basin in Sespe and Piru creeks. By the time the drought ended in 1992, there were no 1- or 2-year old subadults in the Sespe and Piru creek populations and none in the Santa Ynez population, which also contained no 3-year old toads. Based on his data on the size and ages of adults in his 1992 Santa Ynez River sample, Sweet theorized that few individuals on Sespe or Piru creeks ever reached ages greater than 5 years. Also, because there was virtually no recruitment of adults (few of those hatched in 1989 or 1990 had survived), he believed that these populations could potentially crash in 1992 or 1993 if the drought continued (Sweet 1992, p. 147).

Consequently, the ending of the drought in 1992 was an extremely critical year for the continued survival of arroyo toads in the Santa Ynez River and only slightly less so for toads in the Sespe and Piru creeks (Sweet 1992, p. 148). Fortunately, both 1992 and 1993 were characterized by ample rainfall that was distributed in 3-4 significant storms between December and early April (Sweet 1993, p. 3). As a result, all of the streams used by arroyo toad on the Los Padres National Forest maintained sufficient flow until August. Following the drought, Sweet (1993, pp. 11–24) again surveyed the Santa Ynez River Basin and Santa Clara River Basin occurrences. Both showed an increase in breeding success and an increase in adult population size. Overall, 263 clutches were found in 1992, compared to 166 clutches in a somewhat larger survey area in 1991 (Sweet 1993, p. 24).

*Southern Recovery Unit*
Arroyo toad occurrences in ephemeral streams on Marine Corps Base Camp Pendleton (San Mateo Creek, San Onofre Creek basins) and Remote Training Site Warner Springs (Upper San Luis Rey River Basin) are at increased risk of extirpation from a prolonged drought and may be more dependent upon dispersal from more stable sites for recolonization (Brehme *et al.* 2006, pp. 43–44; Clark *et al.* 2011, p. 18).

Water is released into the San Luis Rey River along a short segment from Lake Henshaw and then is piped over to another reservoir. Drought has been confirmed as a threat at this occurrence (Moreno, USFWS, pers. comm. 2012).

Water is released into Cottonwood Creek along a short segment from Barrett Dam, and then is piped over to another watershed. Only occasional dam topping occurs during storms. Drought has been confirmed as a threat at this occurrence (Brown, USGS, pers. comm. 2012).

### Actions Taken to Reduce Threat Impacts
We do not have any information on conservation measures that have been implemented to reduce this threat.

### Threat Assessment
Threat Scope = Large. 21 out of 35 river basins (60 percent of occurrences) are being affected by drought.

Threat Severity = Serious. A summary of the effects to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; alteration of processes that create and maintain suitable breeding habitat; alteration of water quality or chemistry; and introduction of nonnative predators and invasive species. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from drought, given continuation of current circumstances and trends, we find that within the scope, this threat is likely to seriously degrade habitat or reduce between 31 percent and 70 percent of species occurrences. Timing Impact = High (Ongoing).

Threat Impact = High.

### What the Threat at Current Scope and Severity Means for the Species

Given that drought currently affects 21 out of 35 river basins where the arroyo toad is known to occur, and that where drought occurs, they have a serious effect on arroyo toads and their habitats, and because this threat is reduced at none of the occurrences, we categorize this threat as having a high level of impact to the species as a whole. Most occurrences are small and are in ephemeral streams at high elevations. At lower elevations, impacts from drought on arroyo toad occurrences are exacerbated by alteration of hydrology from dams, water diversions, and groundwater extraction due to urbanization and agriculture. The arroyo toad's lifespan averages 5 to 6 years; if drought persists longer than 6 years, entire populations could be extirpated for lack of water (Sweet 1992, p. 147; Backlin and Brehme, USGS, pers. comm. 2012). Drought is certainly not unique in southern California and arroyo toad populations have withstood such episodes in the past, such that no occurrences have become extirpated since listing. Overall, drought is a current threat with a high level of impact to the arroyo toad.

## 12. PERIODIC FIRE AND FIRE SUPPRESSION

### Threat Status at the Time of Listing

At the time of listing and at present, periodic fires are considered a threat to the arroyo toads because fires can cause direct mortality of arroyo toads, destroy streamside vegetation, or eliminate vegetation that sustains the watershed. For example, the 1991 Lions Fire on upper Sespe Creek in the Los Padres National Forest directly destroyed riparian habitat along Sespe Creek, which contained the largest known extant population of arroyo toads. The fire also destroyed 15 known breeding pools and over 50 percent of the known adult population on the Sespe drainage. By 1993, surveys in the burned riparian area indicated that toads had recovered rapidly through an equivalent recruitment of newly matured toads throughout the length of Sespe Creek (Sweet 1993, p. 19); a robust population continues to persist in upper Sespe Creek.

### Occurrences and Locations Currently Affected:

Currently, 22 out of 35 river basins (63 percent of occurrences) in the following site locations are affected by periodic fire and fire suppression. For the remaining 13 river basins, the best available information does not indicate that arroyo toads are being impacted by fires and fire suppression.

Northern Recovery Unit:

Occurrence 2: Santa Maria River Basin – Sisquoc River
Occurrence 3: Santa Ynez River Basin – Mono Creek, Indian Creek, Santa Ynez River
Occurrence 4: Santa Clara River Basin – Sespe Creek, Piru Creek,, Santa Clara River
Occurrence 5: Los Angeles River Basin – Upper Big Tujunga, Mill, and Alder creeks

Southern Recovery Unit:
Occurrence 6: Lower Santa Ana River Basin – Silverado Creek, Santiago Creek
Occurrence 7: Upper Santa Ana River Basin – Cajon Wash
Occurrence 8: San Jacinto River Basin – San Jacinto River, Bautista Creek
Occurrence 9: San Juan Creek Basin – San Juan Creek, Trabuco Creek
Occurrence 10: San Mateo Creek Basin – Talega Creek, Cristianitos Creek, Gabino Creek, San Mateo Creek
Occurrence 11: San Onofre Creek Basin – San Onofre Creek
Occurrence 12: Lower Santa Margarita River Basin – Santa Margarita River, De Luz Creek, Roblar Creek
Occurrence 13: Upper Santa Margarita River Basin – Arroyo Seco Creek, Temecula Creek, Wilson Creek
Occurrence 14: Murrieta Creek Basin – Cole Creek
Occurrence 15: Lower & Middle San Luis Rey River Basin – San Luis Rey River, Pala Creek
Occurrence 16: Upper San Luis Rey River Basin – San Luis Rey River, West Fork San Luis Rey River, Cañada Aguanga, Agua Caliente Creek
Occurrence 17: Lower Santa Ysabel Creek Basin – Santa Ysabel Creek, Guejito Creek, Boden Canyon, Temescal Creek
Occurrence 18: Upper Santa Ysabel Creek Basin – Santa Ysabel Creek and Witch Creek
Occurrence 19: Upper San Diego River Basin – San Diego River
Occurrence 20: Lower Sweetwater River Basin – Sweetwater River
Occurrence 21: Upper Sweetwater River Basin – Sweetwater River, Peterson Creek
Occurrence 22: Lower Cottonwood Creek Basin – Cottonwood Creek, Potrero Creek, Campo Creek
Occurrence 23: Upper Cottonwood Creek Basin – Pine Valley Creek, Horsethief Creek, Morena Creek, Cottonwood Creek, Kitchen Creek, La Posta Creek

**Description of Impacts Resulting from Threat to Arroyo Toads and Habitat**

In recent decades, large fires in the West have become more frequent, more widespread, and potentially more deadly to wildlife (Joint Fire Science Program (JFSP) 2007). There has been a shift to more severe fires on the Los Padres National Forest. Wildfire effects are often exacerbated by drought and insect attack. Pilliod *et al.* (2003, p. 176) state that the effects of fire may be greatest for amphibians that are habitat specialists, such as arroyo toads, compared to species that occupy different types of habitat and tolerate a wide range of environmental conditions.

Periodic fires impact arroyo toads by causing direct mortality, destroying streamside vegetation, and eliminating vegetation that sustains the watershed. Other effects from fires include increased water temperature (as a result of canopy loss), toxic effects of smoke and fire retardant to water chemistry, increased sedimentation in streams and ponds that negatively impact reproduction and recruitment, and the effects of fire and post-fire conditions on arroyo toad terrestrial movements (Pilliod *et al.* 2003, pp. 163–181). In addition, wildfires often generate a substantial increase in erosion following the loss of protective ground cover and root anchors (Service 2003, p. 8).

Both nonnative plants, giant reed and tamarisk, are well known to be highly flammable, yet both species recover rapidly from fire by regrowth from below-ground plant parts. By contrast, cottonwoods, willows, and other native woody plants are much less tolerant of direct exposure to fire. Recent studies suggest that these invasive plants are making riparian systems more fire-prone (Lambert *et al.* 2010).

Related to the threat of fire are fire suppression activities, such as fire line construction, hand line construction, bulldozing, water withdrawal using helicopters and pumps, backfiring, and fire camp and safety zone construction. Direct mortality to arroyo toads can result from construction of fuelbreaks and safety zones in stream terraces where arroyo toads are burrowed. Bulldozing operations can also severely degrade other essential upland habitats. For example, during the Day Fire in 2006, the stream terrace on Piru Creek at Hardluck Campground, where there is a substantial population of arroyo toads, was used as a staging area and helispot for fire crews. Piru Creek was crossed twice by bulldozer and several engines, and crew vehicles crossed Piru Creek during firing operations. Arroyo toads were observed jumping out of the way of the vehicles into the creek. Backfiring activities were conducted at night when arroyo toads are active and at risk of being run over because they are out of their burrows.

Another example of fire activities affecting arroyo toads, in response to the Zaca Fire that occurred on the Los Padres National Forest in 2007, is that a number of broad fuelbreaks and safety zones were bulldozed in several areas, including the lower portions of Mono and Indian Creeks (Sweet 2007a, pp. 1–9; 2007b, p. 1). Based on research along these creeks prior to the fire (Sweet 1992, pp. 1–198; 1993, pp. 1–73), juvenile and adult arroyo toads were known to make extensive use of the stream terraces where several of the fuelbreaks and safety zones were constructed. In August and September of 2007 when construction occurred, a large proportion of the population would have been within burrows on the terraces, and any toads that were in those burrows were very likely killed by bulldozing (Sweet 2007a, p. 1). In addition to causing direct mortality, Sweet (2007a, p. 1) reported that the bulldozing operations severely degraded essential upland habitat by removing shade and the opportunity for toads to select microclimates based on soil temperature, moisture content, and ground cover. The bulldozing also created substantial barriers to toad movement through the placement of large piles of woody debris between the creek bed and the terraces. This formed ideal conditions for the terraces to become invaded by nonnative weeds, in particular yellow star thistle, and thus created unsuitable habitat for arroyo toads because they are unable to dig burrows for shelter or estivation in the infested terraces (Sweet 2007a, p. 1).

**Actions Taken to Reduce Threat Impacts**
We do not have any information on conservation measures that have been implemented to reduce this threat.

**Threat Assessment**

Threat Scope = Large. 22 out of 35 river basins (63 percent of occurrences) are potentially affected by periodic fire and fire suppression activities.

Threat Severity = Moderate. A summary of the effects to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; alteration of water quality or chemistry; and introduction of invasive nonnative plants. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from period fire and fire suppression activities, given continuation of current circumstances and trends, we find that within the scope, this threat is likely to moderately degrade habitat or reduce 11 percent to 30 percent of species occurrences.

Timing Impact = High (Ongoing).

Threat Impact = Medium.

### What the Threat at Current Scope and Severity Means for the Species

Given that periodic fire and fire suppression activities could potentially affect 22 out of 35 river basins where the arroyo toad is known to occur, they have a moderate effect on arroyo toads and their habitats, and this threat is reduced at none of the occurrences, we categorize this threat as having a medium level of impact to the species as a whole. Overall, periodic fire and fire suppression activities are a current threat with a medium level of impact to the arroyo toad.

## 13. CLIMATE CHANGE

### Threat Status at the Time of Listing

Climate change is a new threat identified since listing.

### Occurrences and Locations Currently Affected:

Currently, 35 out of 35 river basins (100 percent of occurrences) are affected by climate change.

### Description of Impacts Resulting from Threat to Arroyo Toads and Habitat

Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). The term “climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007, p. 78). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007, p. 78).

*Projections*

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see IPCC 2007a, p. 30; and Solomon *et al.* 2007, pp. 35–54, 82–85). Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-20th century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in greenhouse gas (GHG) concentrations in the atmosphere as a result of human activities, particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007a, pp. 5-6 and figures SPM.3 and SPM.4; Solomon *et al.* 2007, pp. 21–35). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011, p. 4), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as various scenarios of potential levels and timing of GHG emissions, to evaluate the causes of changes already observed and to project future changes in temperature and other climate conditions (e.g., Meehl *et al.* 2007, entire; Ganguly *et al.* 2009, pp. 11555, 15558; Prinn *et al.* 2011, pp. 527, 529). All combinations of models and emissions scenarios yield very similar projections of increases in the most common measure of climate change, average global surface temperature (commonly known as global warming), until about 2030. Although projections of the magnitude and rate of warming differ after about 2030, the overall trajectory of all the projections is one of increased global warming through the end of this century, even for the projections based on scenarios that assume that GHG emissions will stabilize or decline. Thus, there is strong scientific support for projections that warming will continue through the 21st century, and that the magnitude and rate of change will be influenced substantially by the extent of GHG emissions (IPCC 2007a, pp. 44–45; Meehl *et al.* 2007, pp. 760–764 and 797–811; Ganguly *et al.* 2009, pp. 15555–15558; Prinn *et al.* 2011, pp. 527, 529). (See IPCC 2007b, p. 8, for a summary of other global projections of climate-related changes, such as frequency of heat waves and changes in precipitation. Also see IPCC 2011(entire) for a summary of observations and projections of extreme climate events.).

*Vulnerability of Species to Climate Change*

Various changes in climate may have direct or indirect effects on species. These effects may be positive, neutral, or negative, and they may change over time, depending on the species and other relevant considerations, such as interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007a, pp. 8–14, 18–19). Identifying likely effects often involves aspects of climate change vulnerability analysis. Vulnerability refers to the degree to which a species (or system) is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the type, magnitude, and rate of climate change and variation to which a species is exposed, its sensitivity, and its adaptive capacity (IPCC 2007a, p. 89; see also Glick *et al.* 2011, pp. 19–22). There is no single method for conducting such analyses that applies to all situations (Glick *et al.* 2011, p. 3). We use our expert judgment and appropriate analytical approaches to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

As is the case with all stressors that we assess, even if we conclude that a species is currently affected or is likely to be affected in a negative way by one or more climate-related impacts, it does not necessarily follow that the species meets the definition of an "endangered species" or a "threatened species" under the Act. If a species is listed as endangered or threatened, knowledge regarding the vulnerability of the species to, and known or anticipated impacts from, climate-associated changes in environmental conditions can be used to help devise appropriate strategies for its recovery.

Global climate projections are informative, and, in some cases, the only or the best scientific information available for us to use. However, projected changes in climate and related impacts can vary substantially across and within different regions of the world (e.g., IPCC 2007a, pp. 8–12). Therefore, we use "downscaled" projections when they are available and have been developed through appropriate scientific procedures, because such projections provide higher resolution information that is more relevant to spatial scales used for analyses of a given species (see Glick *et al.* 2011, pp. 58–61, for a discussion of downscaling). With regard to our analysis for the arroyo toad, downscaled projections are available. We reviewed predictions from Point Reyes Bird Observatory (PRBO) (2011, pp. 1–2), which summarized recent regional climate models and relevant information from the literature by ecologically-defined regions, or "ecoregions." Four occurrences in the northern portion of the arroyo toad's range are within the Central Western California Ecoregion, and 21 occurrences in the southern portion of the range in the United States are in the Southwestern California Ecoregion. We also reviewed predictions from other sources.

*Temperature Changes*

Mean annual temperatures are predicted to increase from 1.6 to 1.9°C (2.9 to 3.4°F) in the Central Western California Ecoregion and 1.7 to 2.2°C (3.1 to 4.0°F) in the Southwestern California Ecoregion by 2070 (PRBO 2011, pp. 35, 40). According to historic climate data, California has already experienced a warming trend over the past 50 years, with warming more pronounced in higher elevations (Climate Wizard 2013). High temperature events are expected to become more common in both ecoregions, and taxa with very narrow temperature tolerance levels may experience thermal stress to the point of direct mortality or diminished reproduction in the Southwestern California Ecoregion (PRBO 2011, pp. 38, 42).

*Precipitation Changes*

There is a general lack of consensus of the effects of future climate change on precipitation patterns in both ecoregions. Some models suggest almost no change, whereas others project decreases of up to 32 percent in the Central Western California Ecoregion and 37 percent in the Southwestern California Ecoregion by 2070 (PRBO 2011, pp. 35, 40). Qualitative indicators of changes in concentrated near-surface water vapor (atmospheric rivers) above the Pacific Ocean in current projections suggest flood risks in California from warm-wet storms, commonly known as "pineapple express" storms, may increase beyond those known historically, mostly in the form of occasional more-extreme-than-historical storm seasons (Dettinger 2011, p. 522).

*Snowpack Changes*

High elevation areas will be most severely impacted by temperature and moisture responses (Snyder *et al.* 2004, p. 600). Temperature and precipitation are key factors affecting snowpack, which is the amount of snow that accumulates on the ground (EPA 2012a). In a warming climate, more precipitation will be expected to fall as rain, not snow, in most areas – reducing the extent and depth of snowpack (EPA 2012a). Snyder *et al.* (2004, pp. 594, 600) has projected that annual snow accumulation will decrease significantly for all hydrologic regions in California, with 86 to 94 percent reduction in the arroyo toad's range (hydrologic regions 1, 2, and 4), although these percent values were not statistically significant for these specific regions. We also reviewed predictions from Cal-Adapt (*http://cal-adapt.org/*; CEC 2011), where projected changes in snow water equivalence (amount of water contained in snowpack) within arroyo toad's range are available for southern California (some areas within the San Gabriel, San Bernardino, San Jacinto, and Laguna mountains in Los Angeles, San Bernardino, Riverside, and San Diego Counties). April snow water equivalence averaged across these mountains under a low carbon emissions scenario (B1) indicate a 71 percent reduction in snow water, and a 91 percent reduction in snow water under a high emissions scenario (A2), between a baseline time period (1961-1990) and an end of century period (2070-2090) (CEC 2011; Love 2013, USFWS, pers. obs.).

Reduced snowpack will lead to reduced stream-flows, especially in the spring (EPA 2012b). Additionally, rising temperatures cause snow to begin melting earlier in the year, which alters the timing of stream-flow in rivers that have their sources in mountainous areas (EPA 2013). Thus, taxa that rely on runoff from snowmelt will find streams and rivers drying up much earlier than before, and temperatures of the water are likely to increase due to a reduction in snowmelt contribution (Snyder *et al.* 2004, p. 600). Further, data specific to the Southwestern California Ecoregion suggest reduced stream-flow from snow-fed rivers and streams may reduce riparian habitat and affect taxa associated within riparian areas (PRBO 2011, p. 42).

*Groundwater Changes*
Climate change could affect groundwater sustainability through: (1) decreasing groundwater recharge; (2) more severe and longer lasting droughts; (3) changes in evapotranspiration resulting from changes in vegetation; and (4) increasing demands for groundwater as a backup source of water supply. Surficial aquifers, which supply much of the flow to streams, lakes, wetlands, and springs, are likely to be the part of the groundwater system most sensitive to climate change (Alley *et al.* 1999, p. 21).

*Increased Competition for Water Resources*
Projected temperature increases, river-flow reductions, dwindling reservoirs, decreased groundwater recharge, and rapid population growth will increase the competition for water resources in the southwestern United States and Mexico (EPA 2012b). For example, the California Energy Commission (CEC) (2009, p. 22) predicts the combined effects of climate change, water use practices, and regional growth will expose San Diego County to greater risk of water shortfalls before 2050. Additionally, they anticipate that: (1) droughts will be 50 percent more common during the 2000–2049 period than during the 1950–1999 period, thus reducing soil moisture content; (2) production from groundwater supplies will increase 75 percent by 2015; (3) after 2015, local surface and groundwater supplies will have reached their foreseeable limit and the region will need to rely on less-traditional sources as well as imported water to meet new demands; and (4) the effects of climate change will significantly reduce the availability of imported water from northern California and the Colorado River by 2050 (CEC 2009, pp. 19–21).

*Changes in Vegetation Communities*

Substantial increases in grassland, and decreases in other vegetation communities, are predicted to occur within the arroyo toad's range by 2070. In the Central Western California Ecoregion, grassland is projected to increase by 85 to 130 percent, while chaparral/coastal scrub decreases by 19 to 43 percent, and blue oak woodland/foothill pine decreases by 44 to 55 percent. In the Southwestern California Ecoregion, grassland is projected to increase by 345 to 390 percent, while chaparral/coastal scrub decreases by 38 to 44 percent. These shifts in vegetation communities may be hastened by changes in fire severity and frequency (PRBO 2011, pp. 38, 42).

*Potential Effect on Arroyo Toads and Habitat*
Changes in climate that occur faster than the ability of endangered species to adapt could cause local extinctions (EPA 1989, p. 153). Although range shifts have been observed in some plant and animal taxa in response to climate change, the changes observed amongst amphibians have been more associated with changes in timing of breeding (phenology) (Corn 2005, p. 60). Amphibians are sensitive to certain environmental changes, such as slight shifts in temperature and water availability due to their permeable skin, biphasic lifecycles (aquatic and terrestrial), and unshelled eggs (Carey and Alexander 2003, pp. 113–114). Additionally, eggs and larvae may be particularly vulnerable to warming because they cannot move to cooler areas and instead must rely on parents to select sites with favorable microclimates (Perry *et al.* 2012, p. 831). Emergence from hibernation and breeding cues are initiated by changes in the environment. Reduced water levels from changes in mountain snowpack and higher temperatures could limit arroyo toad breeding and larval development during spring or summer months and may cause direct mortality from desiccation. Changes in vegetation communities may reduce riparian and upland habitat for foraging and aestivating, which could also reduce arroyo toad survival.

Physical barriers could hinder the ability of a species to migrate at a rate sufficient to adapt to changing climatic conditions (EPA 1989, p. 154). Reduction or loss of dispersal habitat from the effects of climate change could further hinder arroyo toad movement across areas already fragmented by existing physical barriers.

Changes in temperature may also affect virulence of pathogens (Carey 1993, p. 359), which could make amphibians such as the arroyo toad more susceptible to disease. Climate change could affect the distribution of pathogens and their vectors, exposing arroyo toads (potentially with weakened immune systems as a result of other environmental stressors) to new pathogens (Blaustein *et al.* 2001, p. 1808). Climate change may result in a range shift of Bd (Pounds *et al.* 2006, p.161; Bosch *et al.* 2007, p. 253), and could also lead to increased virulence of Bd (Fisher *et al.* 2009, p. 299).

**Actions Taken to Reduce Threat Impacts**

We do not have any information on conservation measures that have been implemented to reduce this threat.

**Threat Assessment**

Threat Scope = Pervasive. 35 out of 35 river basins (100 percent of occurrences) in both the U.S. and México.

Threat Severity = Serious. A summary of the effects of climate change to arroyo toads and habitat include permanent loss of breeding habitat; permanent loss of upland habitat; mortality, injury, or displacement of individuals; reduced foraging and breeding success; dispersal barriers; alteration of processes that create and maintain suitable breeding habitat; and alteration of water quality or chemistry. Assessing the level of impact to arroyo toad occurrences or locations that can reasonably be expected from climate change, given continuation of current circumstances and trends, we find that within the scope, this threat is likely to seriously degrade habitat or reduce between 31 percent and 70 percent of species occurrences.

Threat Timing = High (Ongoing).
Threat Impact = High.

**What the Threat at Current Scope and Severity Means for the Species**

Given that climate change currently affects 35 out of 35 river basins where the arroyo toad is known to occur, and that where climate change is occurring, it has a serious effect on arroyo toads and their habitats, and this threat is reduced at none of the occurrences, we categorize this threat as having a high level of impact to the species as a whole. The key risk factor for climate change impacts to arroyo toad is likely the interaction between: (1) reduced water levels limiting breeding and larval development or causing direct mortality; (2) reduction or loss of breeding and upland habitat; and (3) the relative inability of individuals to disperse longer distances in order to occupy more favorable habitat conditions (*i.e.*, move up and down stream corridors, or across river basins). This reduced adaptive capacity for arroyo toad is a function of its highly-specialized habitat requirements, the dynamic nature of its habitat, natural barriers such as steep topography at higher elevations, and extensive fragmentation (unnatural barriers) within and between river basins from reservoirs, urbanization, agriculture, roads, and the introduction of nonnative plants and predators. Overall, climate change is a current threat with a high level of impact to the arroyo toad.

## SUMMARY OF THREATS CLASSIFICATION

We evaluated 13 observed, inferred, or suspected current threats to arroyo toads' survival and recovery throughout its range, based on the best available scientific and commercial information. Threats were characterized in terms of scope, severity, and timing and the range-wide "impact" of each threat to arroyo toads was derived from the scope and severity of the threat. The results of our threat classification assessment are summarized in the two tables below.

***Table 4.*** *Summary of Threat Effects and Threat Classifications:*

| **1. Urban Development** |
| --- |
| **Threat Effects**<br>• Permanent loss of breeding habitat<br>• Permanent loss of upland habitat<br>• Mortality, injury, or displacement of individuals<br>• Reduced foraging and breeding success<br>• Dispersal barriers |

- Alteration of processes that create and maintain suitable breeding habitat
- Exposure of pesticides/herbicides, alteration of water quality or chemistry
- Introduction of nonnative predators, invasive species

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Serious** | **High** | **High** |

**2. Agriculture**

**Threat Effects**

- Permanent loss of upland habitat
- Mortality, injury, or displacement of individuals
- Reduced foraging success
- Exposure of pesticides/herbicides, alteration of water quality or chemistry
- Introduction of nonnative predators, invasive species

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Moderate** | **Medium** | **High** |

**3. Operation of Dams and Water Diversions**

**Threat Effects**

- Permanent loss of breeding habitat
- Permanent loss of upland habitat
- Mortality, injury, or displacement of individuals
- Dispersal barriers
- Alteration of processes that create and maintain suitable breeding habitat
- Introduction of nonnative predators, invasive species

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Serious** | **High** | **High** |

**4. Mining and Prospecting**

**Threat Effects**

- Permanent loss of breeding habitat
- Mortality, injury, or displacement of individuals
- Alteration of processes that create and maintain suitable breeding habitat
- Alteration of water quality or chemistry

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Small** | **Moderate** | **Low** | **High** |

**5. Livestock Grazing**

**Threat Effects**

- Mortality, injury, or displacement of individuals
- Alteration of water quality or chemistry from excess sedimentation
- Reduced breeding success
- Alteration of processes that create and maintain suitable breeding habitat
- Introduction of nonnative invasive species

| | | | | |
|---|---|---|---|---|
| | | | | |
| Threat Classification | Scope | Severity | Impact | Timing |
| | **Restricted** | **Moderate** | **Low** | **High** |

**6. Roads and Road Maintenance**

**Threat Effects**

- Mortality, injury, or displacement of individuals
- Reduced foraging and breeding success
- Dispersal barriers
- Alteration of processes that create and maintain suitable breeding habitat
- Introduction of nonnative predators, invasive species

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Moderate** | **Medium** | **High** |

**7. Recreation**

**Threat Effects**

- Permanent loss of breeding habitat
- Permanent loss of upland habitat
- Mortality, injury, or displacement of individuals
- Reduced foraging and breeding success
- Dispersal barriers
- Alteration of processes that create and maintain suitable breeding habitat
- Introduction of nonnative predators, invasive species

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Moderate** | **Medium** | **High** |

**8. Invasive Nonnative Plants**

**Threat Effects**

- Permanent loss of breeding habitat
- Permanent loss of upland habitat
- Reduced foraging and breeding success
- Dispersal barriers
- Alteration of processes that create and maintain suitable breeding habitat

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Moderate** | **Medium** | **High** |

**9. Disease**

**Threat Effects**

- Mortality of individuals
- Potential extirpation of entire populations
- Permanent contamination of water in breeding pools

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|

| | Unknown | Unknown | Unknown | Unknown |
|---|---|---|---|---|

**10. Introduced Predator Species**

**Threat Effects**
- Mortality, injury, or displacement of individuals
- Reduced breeding success
- Potential extirpation of entire populations

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Pervasive** | **Extreme** | **Very High** | **High** |

**11. Drought**

**Threat Effects**
- Permanent loss of breeding habitat
- Permanent loss of upland habitat
- Mortality, injury, or displacement of individuals
- Reduced foraging and breeding success
- Dispersal barriers
- Alteration of processes that create and maintain suitable breeding habitat
- Introduction of nonnative predators, invasive species

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Serious** | **High** | **High** |

**12. Periodic Fire and Fire Suppression**

**Threat Effects**
- Temporary loss of breeding habitat
- Temporary loss of upland habitat
- Mortality, injury, or displacement of individuals
- Reduced foraging and breeding success
- Exposure to fire retardants, alteration of water quality and chemistry
- Introduction of invasive nonnative plants

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Large** | **Moderate** | **Medium** | **High** |

**13. Climate Change**

**Threat Effects**
- Permanent loss of breeding habitat
- Permanent loss of upland habitat
- Reduced foraging and breeding success
- Alteration of processes that create and maintain suitable breeding habitat
- Introduction of nonnative predators, invasive species

| Threat Classification | Scope | Severity | Impact | Timing |
|---|---|---|---|---|
| | **Pervasive** | **Serious** | **High** | **High** |

***Table 5.*** *Threat Assessment Results*

| Threat | Low Impact | Medium Impact | High Impact | Very High |
|---|---|---|---|---|
| Mining and prospecting | X | | | |
| Livestock overgrazing | X | | | |
| Agriculture | | x | | |
| Roads and road maintenance | | x | | |
| Recreation | | x | | |
| Invasive plants | | x | | |
| Fire and fire suppression | | x | | |
| Urban development | | | x | |
| Operation of dams and water diversions | | | x | |
| Climate change | | | x | |
| Drought | | | x | |
| Introduced predator species | | | | x |

*Synergistic Effects of Threats*

Combinations of threats working in concert with one another have the ability to negatively impact species to a greater degree than individual threats operating alone. Multiple stressors can alter the effects of other stressors or act synergistically to affect individuals and populations (IPCC 2002, p. 22; Boone *et al*. 2003, pp. 138–143; Westerman *et al*. 2003, pp. 90–91; Opdam and Wascher 2004, pp. 285–297; Boone *et al.* 2007, pp. 293–297; Vredenburg and Wake 2007, p. 7; Lawler *et al*. 2010, p. 47; Miller *et al*. 2011, pp. 2360–2361).

The extreme habitat specialization of arroyo toads, coupled with the small sizes of many arroyo toad occurrences, make them particularly vulnerable to the negative effects of human-induced changes to their habitat (Jennings and Hayes 1994, p. 57). Additionally, small, isolated occurrences of arroyo toad—often the result of human-induced fragmentation of habitat—are at risk from natural disturbances such as drought, fire, and rare, large floods (Service 1999, p. 50). Examples of potential cumulative impacts of multiple threats include: (1) increased perennial water flows from urbanization, agriculture, and operations of dams and water diversions have allowed introduced predator species (nonnative aquatic predators) to persist in arroyo toad habitat; (2) dam operations, livestock grazing, recreation, fire, and fire suppression activities have facilitated the establishment of invasive nonnative plants; and (3) drought has exacerbated the negative effects of decreased water flows from dam operations and water diversions. In addition, climate change may exacerbate other threats to the arroyo toad by increasing the frequency or severity of droughts, increasing groundwater pumping and water diversion for urban and agriculture use, increasing runoff and erosion during extreme flood events, increasing the frequency or intensity of wildfire, and increasing the spread and virulence of pathogens.

Combinations of threats impede dispersal of arroyo toads, which could affect the long-term viability of individual occurrences. Should arroyo toad occurrences become extirpated, recolonization of these localities may not be possible when occurrences are isolated by physical barriers that may be too large or difficult to cross. Threats such as urbanization and agriculture (including road infrastructure) and dams and reservoirs create unnatural barriers that have already eliminated arroyo toad habitat used for dispersal within and between river basins. These threats continue to impact dispersal habitat through alteration of hydrological conditions and direct removal of habitat. Other threats can degrade habitat and present barriers to dispersal, such as habitat occupied by introduced predator species or habitat rendered unsuitable by invasive plants, recreation, drought, or climate change. This isolation further increases the risk of extirpation to the remaining occurrences. Isolated occurrences may continue to decrease in size over time and may begin to experience negative impacts associated with small population size, including increased inbreeding and loss of genetic variation if they diminish to below threshold levels. In addition, drought-caused population bottlenecks may be more severe when coupled with habitat loss and degradation in the range of the arroyo toad, and while being impacted by introduced predators, water releases, and other anthropogenic activities. As mentioned above, small, isolated occurrences of arroyo toad are at risk from natural disturbances such as drought, fire, and rare, large floods. If the effects of climate change become more severe as predicted, these disturbances could increase, along with the potential spread or change in virulence of Bd, and these effects could further reduce dispersal habitat for arroyo toads.

Recent research on the effects of multiple stressors such as climate change, habitat destruction, pesticides, and disease has shown compelling evidence of negative impacts to amphibians; however, due to variability among species, this discipline needs further research. Protecting or improving amphibians such as arroyo toads and their habitat so that they can adapt to expected changes in climate and multiple stressors may be the most important conservation action (Chambers *et al*. 2004b, pp. 266–268; Seavy *et al*. 2009, pp. 331–333).

Further discussion of threats specific to geographic portions of the range is below.

*Geographic Breakdown of Threats*

*Northern Recovery Unit*

Threats in the northern portion of the arroyo toad's range (five occurrences in Monterey, Santa Barbara, Ventura, and Los Angeles Counties) are likely to impact some of the river basins and are characterized as moderate to very-high in impact; impacts primarily involve roads and road maintenance, recreation, overgrazing, nonnative plants, introduced predator species, and fire and fire suppression on Forest Service lands. All five occurrences in the northern recovery unit are afforded protection that contributes to the conservation of the arroyo toad through existing land management plans or an Integrated Natural Resources Management Plan. Nearly all of these locations currently receiving protection and management are on Federal lands. Through section 7 of the Act, Federal agencies are required to use their authorities to carry out programs for the conservation of listed species and to consult with the Service when a Federal action may have an effect on listed species. Forest Service management efforts have been successful in reducing some impacts to arroyo toads, including bullfrog remediation or eradication, nonnative plant removal, habitat restoration and enhancement, cattle exclusion, road and off-highway vehicle trail closures or relocations, campground and recreation area closures and relocations, road crossing improvements and monitoring, upland habitat preservation, and project changes for avoidance of breeding habitat or season.

*Southern Recovery Unit*

In the central/southern portion of the species' range (18 occurrences in Orange, Riverside, San Bernardino, and San Diego Counties), threat impacts are moderate to very high, and will continue to increase as the demand for water and suitable development sites continues. Threats here primarily involve urban development, agriculture, roads, operation of dams and water diversions, recreation, nonnative plants, introduced predator species, fire and fire suppression, and drought. As the human population grows, the negative effects from increased water needs and recreational activities will put more pressure on the remaining habitats, even those sites receiving some protection. Most occurrences (12 of 18) are restricted to ephemeral or low-order streams, and of these, most (10 of 12) are unnaturally restricted to these areas because habitat downstream was destroyed by large reservoirs, urbanization, or agriculture, thereby reducing the ability to adapt to dynamic habitat conditions and increased threats, especially drought, climate change, roads, recreation, agriculture, and introduced predators. According to new information received since the 5-year review, wild pigs are now in five of these river basins. The area's mild climate likely will result in rapid population growth and expansion into other river basins nearby.

Occurrences and habitat at lower elevations within larger streams (6 of 18) are typically surrounded by urban and agricultural development or are immediately downstream of these areas. All but one occurrence are downstream of a major dam, and therefore, alteration of hydrology from cumulative effects of dams, water diversions, urbanization, and agriculture continues to degrade habitat in these areas. Road density is high, which increases the risk of impacts from recreation.

Large-scale habitat conservation planning efforts are being undertaken in the Southern Recovery Unit because most of the occurrences are on, or partly on, non-Federal lands, but some areas or activities (*e.g.*, dam operations) may not be addressed by these plans. The arroyo toad is a covered species under four HCPs within this recovery unit that help to reduce impacts from current threats at seven occurrences.

Portions of five occurrences are in reserves and some basic management is occurring within some of these areas, but these areas are not yet being comprehensively managed for the species. There are large areas of Federal lands, such as the Marine Corps Base Camp Pendleton, where arroyo toads are protected under the military's Integrated Natural Resources Management Plan (INRMP). Continued control of nonnative aquatic species, especially bullfrogs and crayfish, is strongly recommended for continued persistence of the largest arroyo toad occurrence.

Eleven of eighteen occurrences within the Southern recovery unit are on Forest Service lands or are partly on Forest Service lands. As in the northern portion of the species' range, Forest Service management efforts have been successful in reducing some impacts, including cattle exclusion, road and off-highway vehicle trail closures or relocations, road crossing improvements and monitoring, and project changes for avoidance of breeding habitat or season. However, occurrences on these lands are mostly small, in upper elevations along ephemeral streams and continue to be threatened by drought, climate change, roads, recreation, and introduced predators.

*Desert Recovery Unit*

In the desert portion of the species' range (two occurrences in Los Angeles and San Bernardino Counties), threats are moderate in impact, and result primarily from recreation, urban development, agriculture, overgrazing, and dam operations. Portions of both occurrences are afforded protection through land management plans.

## RECOVERY PLAN

Since the arroyo toad was listed in 1994, the Service developed a recovery plan (Service 1999, pp. 1–119) and twice revised the designated critical habitat, most recently on February 7, 2011 (76 FR 7246).

The intent of the recovery plan was to prescribe recovery criteria that would at least demonstrate population stability and good habitat management over a period of years, which would indicate a substantially improved situation for arroyo toads. We anticipated developing better information on the status and needs of arroyo toads, based on the surveys, research, and monitoring prescribed in the plan. Because the recovery plan incorporated an adaptive management approach to recovery, new information would be used to modify the recovery tasks and criteria, as appropriate (Service 1999, p. 108). The recovery plan for the arroyo toad has not been updated since it was completed in 1999.

The number of populations needed to reach recovery was determined based on an examination of the distribution of the arroyo toad and suitable habitat throughout the species' range. The approach taken in the recovery plan was to focus on protection of a sufficient number of arroyo toad populations and their habitat as identified in the recovery plan to allow the preservation of the genetic and phenotypic characteristics of the species throughout the range, and the maintenance of connectivity between subpopulations, where applicable. The latter would maintain properly functioning populations by ensuring there would be adequate gene flow between small subpopulations to prevent deleterious founder effects in newly established populations, that dispersing arroyo toads from expanding populations would be able to move into nearby suitable habitats, and that the natural recolonization of habitats from which arroyo toads have been extirpated by naturally occurring random events would take place within a reasonable time frame. The actual distribution of those protected populations or metapopulations and habitat would be determined based on hydrologic units and watershed management areas, connectivity between and among habitat patches, and existing reserves, as appropriate (Service 1999, p. 108).

### *Recovery Strategy and Objectives*

The goal of recovery efforts as described in the recovery plan was the reclassification of the arroyo toad from an endangered species to a threatened species and, ultimately, delisting the species. The strategy for reclassification in the recovery plan included the following actions:

1) Stabilize and maintain populations throughout the range of the arroyo toad in California by protecting sufficient breeding and non-breeding habitat;
2) Monitor the status of existing populations to ensure recovery actions are successful;
3) Identify and secure additional suitable arroyo toad habitat and populations;

4) Conduct research to obtain data to guide management efforts and determine the best methods for reducing threats; and
5) Develop and implement an outreach program.

The overall objectives of the recovery plan are to prevent further loss of individuals, populations, and habitat critical for the survival of the species; and to recover existing populations to normal reproductive capacity to ensure viability in the long term, prevent extinction, maintain genetic viability, and improve conservation status. The general aim in species' recovery is to establish sufficient self-sustaining healthy populations for the species to be no longer considered as a threatened species.

The recovery plan describes 22 river basins in the coastal and desert areas of nine Counties along the central and southern coast of California, and the recovery plan divides the range of the arroyo toad into three large recovery units – Northern, Southern, and Desert. These recovery units were established to reflect the ecological and geographic distribution of the species and its current and historic range (Service 1999, pp. 71–72).

*Recovery Criteria*

The downlisting recovery criteria address the recovery strategy of providing sufficient breeding and upland habitat to maintain self-sustaining populations of arroyo toads. In addition, "In-stream and riparian habitats that support breeding, as well as upland habitats that provide foraging and overwintering habitat, also must be managed to maintain and enhance populations throughout the range of the arroyo toad" (Service 1999, p. 68).

*Downlisting criteria* - These criteria provide for reclassification of the arroyo toad to threatened status when the following are met:

1. Management plans have been approved and implemented on federally managed lands to provide for securing the genetic and phenotypic variation of the arroyo toad in each recovery unit by conserving, maintaining, and restoring the riparian and upland habitats used by arroyo toads for breeding, foraging, and wintering habitat.

2. At least 20 self-sustaining metapopulations or populations at the locations below must be maintained. Self-sustaining metapopulations or populations are those documented as having successful recruitment (i.e., inclusion of newly matured individuals into the breeding population) equal to 20 percent or more of the average number of breeding adults in 7 of 10 years of average to above average rainfall amounts with normal rainfall patterns. Such recruitment would be documented by statistically valid trend data indicating stable or increasing populations. In addition, self-sustaining populations require no direct human assistance (such as captive breeding or rearing, or translocation of toads between sites). This does not include activities such as patrolling or closing roads, campgrounds or recreational areas, or maintaining stream crossings or fencing (Service 1999, p. 76).

    a. *Northern Recovery Unit – 7 populations or metapopulations*

Fort Hunter Liggett Army Reserve Training Center: 1 population – San Antonio River.

Los Padres National Forest: 4 populations – Sisquoc River; Upper Santa Ynez River Basin, including Indian and Mono Creeks; Sespe Creek; and upper and lower Piru Creek.

Angeles National Forest: 2 populations – Castaic Creek; Los Angeles River Basin, including Upper Big Tujunga, Mill, and Alder Creeks.

b. *Southern Recovery Unit – 10 populations or metapopulations*
Marine Corps Base Camp Pendleton: 2 metapopulations – San Mateo and San Onofre Creeks; Santa Margarita River.

Cleveland National Forest: 8 populations – San Juan Creek Basin; San Mateo Creek Basin; Upper Santa Margarita River Basin; San Luis Rey River Basin; San Dieguito River Basin (*i.e.*, Lower Santa Ysabel Creek Basin), San Diego River Basin; Sweetwater River Basin; Tijuana River-Cottonwood Creek Basin.

c. *Desert Recovery Unit – 3 populations or metapopulations*
Angeles National Forest: 1 population – Little Rock Creek.

San Bernardino National Forest: 1 metapopulation – Mojave River Basin, including West Fork of the Mojave River, Little Horsethief Canyon, and Deep Creek.

Bureau of Land Management: 1 population – Pinto Wash Basin, in the Jacumba (In-Ko-Pah Mountains) Wilderness Study Area.

Since the species was listed, we determined that the population in the Pinto Wash area was misidentified. Consequently, we believe the species has never occurred in the Pinto Wash wilderness area that is managed by the Bureau of Land Management and this location should be removed from the list of required self-sustaining populations.

*Delisting Criteria* –The criteria below provide for delisting of the arroyo toad. The recovery plan states that delisting criteria include first meeting all of the downlisting criteria.

1. In addition to areas protected under the downlisting criteria, the genetic and phenotypic variation of the arroyo toad throughout its range in California, is secured by maintaining 15 additional self-sustaining populations of arroyo toads in coastal plain, coastal slope, desert slope, and desert river basins, including known populations and metapopulations outside of Federal jurisdiction. Each of the three recovery units should look for opportunities to find previously unknown populations or to reestablish populations on rehabilitated habitat.

    a. *Northern Recovery Unit* – Upper Salinas River, tributaries to the Santa Maria and Sisquoc Rivers, and tributaries to the upper Santa Clara River such as San Francisquito and Bouquet Creeks. At least one additional population should be protected in this recovery unit.

    b. *Southern Recovery Unit* – At least eight protected populations on non-Federal lands in each of the following systems: Santa Margarita River; San Juan Creek, San Luis Rey River; San Dieguito River/Santa Ysabel Creek; San Diego River; Sweetwater River; Otay/Dulzura Creek; and Tijuana River-Cottonwood Creek Basins. Additional populations, particularly any found in the Santa Ana/San Jacinto River basin, should be protected as appropriate.

c. *Desert Recovery Unit* – Two known populations on private and other non-Federal lands in the Mojave River and Whitewater River Basins is essential for delisting the arroyo toad. Historically, populations were found in the San Felipe Creek and Vallecitos Creek basins in what is now Anza-Borrego State Park. These drainages, as well as Coyote Creek and other potential desert slope sites should be surveyed and protected as appropriate.

Since the species was listed, we determined that the populations in the Whitewater River, San Felipe Creek, and Vallecitos Creek basins were misidentified. Consequently, we believe the species has never occurred in these areas and these locations should be removed from the list of required self-sustaining populations.

*Achievement of Downlisting Criteria*
According to the recovery plan, the arroyo toad will be considered for reclassification from endangered to threatened status in each recovery unit when management plans have been approved and implemented on federally managed lands. For each recovery unit, the minimum number of self-sustaining metapopulations or populations in targeted river basins should be maintained (Service 1999, p. 75).

*Criterion 1 – Approved and Implemented Management Plans on Federal Lands*
The first component of the downlisting criteria in the recovery plan requires that management plans have been approved and implemented on federally managed lands to provide for conserving, maintaining, and restoring the riparian and upland habitats used by arroyo toads for breeding, foraging, and wintering habitat. The Forest Service has approved Land Management Plans (LMPs) for each of the four southern California National Forests (Angeles, Los Padres, San Bernardino, and Cleveland National Forests). The LMPs all contain avoidance and minimization measures to protect arroyo toad populations within each National Forest. Fort Hunter Liggett and Marine Corps Base Camp Pendleton each have a Service-approved INRMP that also contains measures to protect arroyo toads on their lands (U.S. Army Reserve Command 2004; MCB Camp Pendleton 2007). These management plans cover a wide range of activities and species, and though they do not focus exclusively on actions for arroyo toad, they have helped to reduce the impacts of current threats. For the arroyo toad, 17 occurrences are extant or presumed extant and are within or partially within Federal lands that have land management plans or military INRMPs.

For all occurrences on Federal lands, “monitor[ing] the status of existing populations to ensure recovery actions are successful” is a goal of the recovery plan.

*Northern Recovery Unit*
In the Northern Recovery Unit occurrences, we do have 3 years of monitoring results (2010–2012) according to the arroyo toad monitoring plan that was initiated by the DWR for arroyo toads in middle Piru Creek and Aqua Blanca downstream of Pyramid Dam (ESA 2012, p. 1–41+). Because the monitoring plan was required and approved by FERC to track the health and status of arroyo toad breeding populations in middle Piru Creek and ensure the simulated natural

water releases from Pyramid Dam are successfully contributing to recovery of the arroyo toad, we believe FERC should be considered one of the Federal agencies that is helping to meet this downlisting component for the Santa Clara River Basin occurrence.

*Criterion 2 – Self-sustaining Populations or Metapopulations Maintained*
The second component of the downlisting criteria in the recovery plan requires that measures in these Federal land management plans must maintain at least 20 self-sustaining metapopulations or subpopulations of arroyo toads at the specified locations (listed above). The recovery plan states that self-sustaining occurrences must be documented with monitoring data collected over 7–10 years of average to above average rainfall amounts with normal rainfall patterns (Service 1999, p. 76). It is biologically important to monitor data collected over 7–10 years of average to above average rainfall amounts with normal rainfall patterns. This makes sense from a biological viewpoint because of the high variability of arroyo toad population numbers from year to year. Currently, multiple-year studies on Federal lands that are gathering data for this criterion have been conducted on occurrences within Marine Corps Base Camp Pendleton and at the Upper San Diego River Basin occurrence within the Cleveland National Forest. Overall, occurrences of the arroyo toad are extant within the same river basins and range of the species since the time of listing. While we do not have monitoring data for 7-10 years at each arroyo toad location on Federal lands in the United States, 22 occurrences appear to be self-sustaining. When México is included, 28 river basins are extant or presumed to be extant.

*Northern Recovery Unit*
For occurrences located in the Northern Recovery Unit, the Angeles National Forest and Los Padres National Forest monitor arroyo toads by conducting annual surveys of occurrences on their lands. Because this monitoring is typically presence/absence surveys, the information does not indicate whether these occurrences meet the definition of self-sustaining populations according to the recovery plan; however, results do show that occurrences on Forest Service lands are persisting. The Angeles National Forest has worked well with the Service to report on their annual arroyo toad population monitoring program (2003–2012) in the Antelope-Fremont River Basin (Little Rock Creek, Santiago Creek), Los Angeles River Basin (Upper Big Tujunga Creek) and the Santa Clara River Basin (Castaic Creek) occurrences. For example, a result of presence/absence surveys in 2011 show successful breeding occurred at all of these occurrences, with some surveys recording up to 17 adult toads and several thousand tadpoles observed (USFS 2011, pp. 1–3). The Los Padres National Forest also monitors arroyo toad occurrences on their lands, but tracks breeding success by conducting annual arroyo toad clutch surveys. We have results of clutch surveys in the Santa Clara River Basin (Piru, Agua Blanca, and Sespe Creeks) occurrence (Sweet 2006, pp. 1–3; Sandburg 2008, p. 1–66; ESA 2012, pp. 1–41+). The Santa Ynez River Basin (Upper Santa Ynez River, Mono and Indian Creeks) and the Santa Maria River Basin (Sisquoc River) occurrences are also surveyed, but they are not surveyed every year.

*Southern Recovery Unit*
For occurrences located in the Southern Recovery Unit, most of our information on arroyo toads comes from occasional surveys or incidental observations, and some of our observation data are old (Table 1). Some of the most recent observations predate the lifespan of arroyo toad (*e.g.*, 2005 and earlier) or multiple lifespans (*e.g.*, 2000 and earlier). According to Winter (Cleveland National Forest, pers. comm. 2012), arroyo toads have persisted on the Cleveland National

Forest (CNF), but cannot be described as “secure.” We suspect that some arroyo toad occurrences may be declining on the CNF, but we do not have enough information to confirm whether or not this is the case; toads have not been observed on San Mateo Creek on the CNF since 1999. Aquatic predators are a having adverse effects on arroyo toads in San Mateo Creek and are not being managed by CNF. We do not know if there are arroyo toads in the Upper Sweetwater River on CNF lands, but where they do exist upstream on State Park lands, evidence suggests recruitment has plummeted from invasion of watercress and associated degradation of habitat. Similarly, the only survey information we have for streams such as Agua Caliente Creek of Upper San Luis Rey River Basin and Morena Creek of Upper Cottonwood Creek Basin is from 1999, and while other streams in these basins have more recent information, only low numbers of arroyo toads were reported.

Occurrences on CNF are mostly small and threatened by roads, drought, and aquatic predators (Winter, pers. comm. 2012). Most of these occurrences are along ephemeral streams upstream of large reservoirs in upper elevations, which increase the risk of extirpation from drought and climate change as individuals are blocked from dispersing downstream. As recolonization into these river basins from occurrences downstream is unlikely, individuals would need to disperse upland and across river basins to recolonize these areas. The extent to which this could take place in higher elevations (observations of lateral dispersal across river basins are from flat or coastal areas) is unknown. Finally, new information since the 5-year review suggests feral pigs are likely on the verge of population expansion in these same areas.

*Desert Recovery Unit*
For the Desert Recovery Unit, we do have some information on the Mojave River Basin occurrence of arroyo toads that is on private lands. A well-studied population of arroyo toads occurs on West Fork Mojave River and Little Horsethief Creek within private property near Silverwood Lake (Ramirez 2007, pp. 1–116). According to Ramirez (2007) in this report, horse and cattle grazing have impacted arroyo toads along the West Fork Mojave River and beaver dams have reduced arroyo toad breeding habitat there as well. Deep pools created by beavers are providing habitat for bullfrogs, nonnative fish, and crayfish in Horsethief Creek and the West Fork Mojave River.

*In Summary*

At the time of listing, arroyo toads were known from 22 river basins in the coastal and desert areas of nine Counties along the central and southern coast of the United States. The range extended into Baja California, Mexico, in seven river basins. Currently, arroyo toads continue to occupy the same geographic range since listing and they have been detected within 10 river basins in Baja California, Mexico.

We classified threats to arroyo toads and habitat as follows:

- Threats with low impacts to arroyo toads and habitat are mining and prospecting, and livestock grazing.
- Threats with medium impacts to arroyo toads and habitat are agriculture, roads and road maintenance, recreation, invasive plants, and fire and fire suppression,

- Threats with high impacts to arroyo toads and habitat are urban development, operation of dams and water diversions, climate change, and drought.
- Threats with very high impacts to arroyo toads and habitat are from introduced predator species.

*Recovery Units*

The best available information indicates arroyo toad occurrences on Federal lands in the Northern Recovery Unit likely contain small to medium numbers of individuals (30 to 100 toads; Table 1) that are impacted by recreation, OHVs, flow regulation from dams and water diversions, introduced predators, fire, drought, and climate change. Arroyo toads are particularly susceptible to introduced predators on the Los Padres National Forest and to the habitat damage caused by increasing recreational use of large riparian corridors and streamside campgrounds.

The best available information indicates arroyo toad occurrences on Federal lands in the Southern Recovery Unit likely contain small numbers of individuals (10 to 30 toads; Table 1) that are impacted by roads, flow regulation from dams and water diversions, introduced predators, drought, and climate change. Arroyo toads are particularly susceptible to aquatic predators in upper elevations on the Cleveland National Forest. Also, dams and reservoirs block arroyo toads from dispersing downstream or upstream to recolonize. Information since the 5-year review suggests feral pigs are likely on the verge of population expansion in these areas.

Arroyo toad occurrences on Federal lands in the Desert Recovery Unit contain small numbers of individuals (10 to 30 toads) that are impacted by flow regulation from dams and water diversions, introduced predators, drought, and climate change.

Current available information indicates that arroyo toads are persisting or may be persisting on Federal lands in 17 river basin occurrences in California and are persisting or may be persisting in 6 watersheds in Baja California, México, as listed below. Five additional occurrences are persisting or may be persisting on non-Federal lands in California, for a total of 22 extant or presumed to be extant occurrences (Table 1). For the other three river basin occurrences identified or rediscovered since listing in the United States (Lower Santa Ana River, Upper Santa Ana River, and Murrieta Creek basins), we do not have sufficient information to confirm whether or not arroyo toads are or may be persisting (Table 1).

*Northern Recovery Unit*

Occurrence 1 – Salinas River Basin -- San Antonio River, Fort Hunter Liggett;
Occurrence 2 – Santa Maria River Basin -- Sisquoc River, Los Padres National Forest;
Occurrence 3 – Upper Santa Ynez River Basin – Upper Santa Ynez River, Mono Creek, and Indian Creek, Los Padres National Forest;
Occurrence 4 – Santa Clara River Basin -- Sespe Creek, Upper Piru and Lower Piru Creek, Los Padres National Forest, and Castaic Creek on the Angeles National Forest;
Occurrence 5 – Los Angeles River Basin -- Upper Big Tujunga Creek, Mill Creek, and Alder Creek, Angeles National Forest.

*Southern Recovery Unit*

Occurrence 8 – San Jacinto River Basin -- Bautista Creek, San Bernardino National Forest;

Occurrence 9 – San Juan Creek Basin -- San Juan Creek, Cleveland National Forest;
Occurrence 10 – San Mateo Creek Basin -- San Mateo and Talega creeks, MCB Camp Pendleton;
Occurrence 11 – San Onofre Creek Basin -- San Onofre Creek, MCB Camp Pendleton;
Occurrence 12 – Lower Santa Margarita River Basin -- Santa Margarita River, De Luz Creek, and Roblar Creek, MCB Camp Pendleton;
Occurrence 13 – Upper Santa Margarita River Basin -- Arroyo Seco Creek, Cleveland National Forest;
Occurrence 16 – Upper San Luis Rey River Basin -- West Fork San Luis Rey River, San Luis Rey River, Agua Caliente Creek, Cleveland National Forest;
Occurrence 17 – Lower Santa Ysabel Creek Basin -- Santa Ysabel Creek, Cleveland National Forest;
Occurrence 19 – Upper San Diego River Basin -- San Diego River, Cleveland National Forest;
Occurrence 23 – Upper Cottonwood Creek River Basin -- Pine Valley, Noble, Cottonwood, Kitchen, Morena, and La Posta creeks, Cleveland National Forest.

*Desert Recovery Unit*
Occurrence 24 – Antelope-Fremont River Basin – Little Rock Creek, Angeles National Forest.

*Baja California, México*
Occurrence 26 – Rio Las Palmas
Occurrence 27– Rio Guadalupe
Occurrence 31 – Rio San Vicente
Occurrence 32 – Rio San Rafael
Occurrence 33 – Rio San Telmo
Occurrence 34 – Rio Santo Domingo

Note: Occurrences 10 and 11 were grouped together as one "metapopulation" in the Recovery Plan.

## SUMMARY

One of the purposes of a 5-year review is to focus on what progress has been made toward recovery since the species was listed, and in that context, what progress has been made in fulfilling the recovery criteria for the species (Service 2009, pp. 1–47). As we discussed above, the recovery criteria for downlisting the arroyo toad is very specific and essentially states that Federal agencies should implement approved management plans for arroyo toads on their lands and that 20 self-sustaining populations at a minimum should be maintained in specific river basins. The recovery plan for the arroyo toad has not been updated since it was completed in 1999.

According to the recovery criteria for arroyo toads, progress is made toward recovery by eliminating or reducing the threats to the species at the time of listing and since it was listed. In the arroyo toad 5-year review, we noted that threats to the arroyo toad remained basically the same as when it was listed in 1994: habitat destruction and alteration from water storage reservoirs, flood control structures, roads, agriculture, urban development, recreational facilities, mining activities, and nonnative plants. Introduced nonnative predators, disease, fire, drought, and climate change were also discussed in the report.

In the 5-year review, we recommended downlisting the species from endangered to threatened based on improvement in the status of the arroyo toad and conservation management to control threats to the species since it was listed. Our recommendation was based on the following conclusions: (1) arroyo toads still occupied the same river basins as when the species was listed, (2) the known range of the species had been expanded with discovery of the Fort Hunter Liggett population in Monterey County, (3) several dams had developed a more natural flow release regime to improve downstream habitat for arroyo toads, and (4) Federal land management plans on the national forests and military bases had been approved and implemented (Service 2009, p. 19).

For the 5-year review, available information indicated that arroyo toad populations, while perhaps not self-sustaining according to the recovery criteria, continued to occur within the same localities as when the species was listed. For this report, we have obtained more detailed information than was available for the 5-year review and it has provided us with a better understanding of the status of arroyo toads and the threats that impact habitat and individuals. We now know more about the Baja California populations and that they are being affected by the same threats as the California populations, perhaps even more so because urbanization and agriculture is rapidly increasing in México. However, México has only recently listed the arroyo toad as an endangered species and we have no information on whether anything has been done to reduce the threats to those populations. Two major areas of uncertainty are climate change and disease.

Five HCPs were developed to minimize impacts to arroyo toad at eight occurrences from development and associated infrastructure. Reserves will be established within these plan areas to provide protection to the toad and habitat through long-term management and monitoring. In the Northern Recovery Unit, a Natural Resource Management Plan was developed at Newhall Ranch to minimize impacts from development in the northern recovery unit. Approximately 1,011 ac (409 ha) of Newhall lands have been conveyed to the California Department of Fish and Wildlife and additional easements are waiting approval. In the Southern Recovery Unit, the following HCPs were developed that protect or are anticipated to protect portions of seven occurrences:

- Western Riverside County Multiple Species Habitat Conservation Plan. Portions of two occurrences in permittee area. Of these portions, some land in dedicated reserves and some land identified for future placement in reserves by varying degrees.
- Orange County Central-Coastal Subregional Natural Community Conservation Plan/Habitat Conservation Plan (Orange County Central-Coastal NCCP). Portion of one occurrence in plan area. Of this portion, most in dedicated reserve.
- Orange County Southern Subregion Habitat Conservation Plan. Portions of two occurrences in permittee area. Of these portions, some in dedicated reserves, and the rest of breeding habitat identified for future placement in reserves.

- City of San Diego Subarea Plan and County of San Diego Subarea Plan under the San Diego Multiple Species Conservation Program (MSCP). Portions of three occurrences within these subarea plans. Of these portions, some land in dedicated reserves and some land identified for future placement in reserves by varying degrees.

Since the species was listed in 1994, arroyo toads continue to occur in 22 river basins and have been identified in 3 additional river basins, in the United States. Of the 22 occurrences, 17 occurrences are within or partially within Federal lands. Five additional occurrences (Lower and Middle San Luis Rey River, Upper Santa Ysabel Creek, Lower Sweetwater River, Upper Sweetwater River, and Lower Cottonwood Creek basins) are extant or presumed to be extant on non-Federal lands. Arroyo toads have been detected in 10 watersheds in Baja California, México, and are known to persist or may be persisting in 6 of these watersheds.

Since listing, the types of threats to arroyo toads remain the same and are ongoing, but efforts are in place to reduce some of the impacts of these identified threats to the species. These efforts are being implemented in approximately 17 arroyo toad occurrences on Federal lands through the Land Management Plans for each of the four southern California National Forests (Los Padres, Angeles, San Bernardino, and Cleveland), through the Integrated Natural Resources Management Plans on Marine Corps Base Camp Pendleton and Fort Hunter Liggett. Some arroyo toad habitat has been acquired since listing at three additional occurrences on non-Federal land (Lower and Middle San Luis Rey River, Upper Santa Ysabel Creek, Lower Cottonwood Creek basins) through HCPs or other mechanisms such as grants and section 7 consultations. Additionally, the Lower Sweetwater River Basin occurrence (non-Federal land) is partially within the County Subarea Plan under the San Diego MSCP, and some areas could be placed in reserves in the future. One additional occurrence on non-Federal land (Upper Sweetwater River Basin) is partially within a State Park. In México, four occurrences are within or partially within a national park. Other threats, such as nonnative plant species (tamarisk, giant reed), persist at 15 occurrences and are reduced at 7 occurrences. Introduced predators (bullfrogs, crayfish, green sunfish) persist at 28 arroyo toad occurrences and efforts are being made to remove them at 5 occurrences, making introduced predators the most serious ongoing threat. In addition, threats such as drought, and those identified subsequent to listing – climate change, chytrid (Bd) infection, and wildfire suppression – are poorly understood and have been only slightly reduced at arroyo toad occurrences.

LITERATURE CITED

Alley, W.M., T.E. Reilly, and O.L. Franke. 1999. Sustainability of Ground-Water Resources. U.S. Geological Survey Circular 1186. Denver, Colorado.

Barrett, R.H. and G.H. Birmingham. 1994. Wild Pigs. Chapter D, pp. 65–70. *In*: Prevention and Control of Wildlife Damage. Editors, Scott E. Hygnstrom, Robert M. Timm, Gary E. Larson. University of Nebraska-Lincoln, Nebraska.

Beebee, T.J.C. and R.A. Griffiths. 2005. The amphibian decline crisis: A watershed for conservation biology? Biological Conservation 125 (2005) 271-285.

[BIP] Biodiversity Indicators Partnership. 2012. On the Internet at http://www.bipindicators.net/language/en-us/riverfragmentation. Visited October 15, 2012.

Blaustein, A.R., L.K. Belden, D.H. Olson, D.M. Green, T.L. Root, and J.M. Kiesecker. 2001. Amphibian Breeding and Climate Change. Conservation Biology 15(6): 1804–1809.

Bloom, P. H. 1998. Report on spring and summer survey for arroyo toads in the Orange County Southern Subregion NCCP area. Unpublished report submitted to Dudek and Associates. 5 pp.

Bloom Biological, Inc. 2007. Field Survey raptor nests (including owls (Feb-May 2007; ongoing). Bloom Biological, Inc.

Boone, Michelle D, Paul S. Corn, Maureen A. Donnelly, Edward E. Little, and Peter H. Niewiarowski. 2003. Physical stressors. p. 129-151. *In* Greg Linder, Sherry K. Krest and Donald W. Sparling, editors, Global decline of amphibian populations: an integrated analysis of multiple stressor effects. Society of Environmental Toxicology and Chemistry, Pensacola, Florida.

Boone, M.D., R.D. Semlitsch, E.L. Little, and M.C. Doyle. 2003. Multiple stressors in amphibian communities: effects of chemical contamination, bullfrogs, and fish. Ecological Applications 17: 291–301.

Bosch, J., L.M. Carrascal, L. Duran, S. Walker, M.C. Fisher. 2007. Climate change and outbreaks of amphibian chytridiomycosis in a montane of Central Spain; is there a link? Proceedings of the Royal Society B. (2007)274: 253–260.

Brehme, C.S., S.L. Schuster, C.J. Rochester, S.A. Hathaway and R.N. Fisher., 2006. MCBCP Arroyo Toad Monitoring Program: 3-Year Trend Analyses for 2003-2005. U.S. Geological Survey Data Summary prepared for Marine Corps Base Camp Pendleton. 102pp.

Brehme, C.S., T.A. Matsuda, G.M. VanScoy, and R.N. Fisher. 2011. MCBCP Arroyo Toad Monitoring Results for 2010 with Multi-Year Trend Analysis. U.S. Geological Survey Data Summary prepared for Marine Corps Base Camp Pendleton. 48 pp.

Brown, T. 1978. Fishes, Amphibians, and Reptiles of the Lower Mojave River System. Contract CA-060-CT8-000046. Prepared for Bureau of Land Management, Riverside, California. Completed August 1978.

[CBI] Conservation Biology Institute. 2009. An Assessment of the Known and Potential Impacts of Feral Pigs (*Sus scrofa*) in and near San Diego County with Management Recommendations. Unpublished document prepared for The Nature Conservancy, Ramona, California.

[CDFG] California Department of Fish and Game. 2005. California Wildlife: Conservation Challenges. California's Wildlife Action Plan and affiliated Web publications (available on the Web at http://www.dfg.ca.gov/habitats/wdp/index.html). Visited 18 March 2009.

[CDWR] California Department of Water Resources. 2012. Drought in California. Document prepared by the California Department of Water Resources, Sacramento, California.

[CEC] California Energy Commission. 2009. Climate change-related impacts in the San Diego Region by 2050 – Final Paper. From: California Climate Change Center. Prepared by: S. Messner, S. C. Miranda, K. Green, C. Phillips, J. Dudley, D. Cayan, and E. Young. August 2009, CEC-500-2009-027-F. Sacramento, California.

[CEC] California Energy Commission. 2011. Cal-Adapt. Under Climate Tools, Local Climate Snapshots, viewed Temperature and Snow Pack. Website viewed on February 1, 2013. *http://cal-adapt.org/page/about-caladapt/*

[CNDDB] California Natural Diversity Data Base. 2010. Element Occurrence Reports for *Bufo californicus*. Unpublished cumulative data accessed on the Internet at http://www.dfg.ca.gov/biogeodata/cnddb/.

[CNDDB] California Department of Fish and Game, Natural Diversity Data Base. 2012. Occurrence Report for *Anaxyrus californicus.* Unpublished cumulative data current to October 29, 2012.

[CNF] Cleveland National Forest. 2005. Arroyo toad field survey forms and maps. Unpublished documents submitted to the U.S. Fish and Wildlife Service, Carlsbad, California. 31 pp.

Campbell, L.A., T.B. Graham, L.P. Thibault, and P.A. Stine. 1996. The arroyo toad (*Bufo microscaphus californicus*), ecology, threats, recovery actions, and research needs. U.S. Department of the Interior, National Biological Service, California Science Center, Technical Report (NBS/CSC-96-01). ii + 46 pp.

Camp, C.L. 1915. *Batrachoseps major* and *Bufo cognatus californicus*, new amphibia from southern California. University of California Publications in Zoology 12 (12): 327 – 334.

Carey, C. and M.A. Alexander. 2003. Climate change and amphibian declines: is there a link? Diversity and Distributions (2003)9: 111–121.

Carey, C. 1993. Hypothesis concerning the causes of the disappearance of boreal toads from the mountains of Colorado. Conservation Biology 7: 355–361.

Carpenter, A.T. 2004. Element Stewardship Abstract: Tamarisk. Prepared for The Nature Conservancy, Arlington, Virginia. 30 pp.

Chambers Group, Inc. 2011. Arroyo Toad (*Anaxyrus californicus*) Focused Survey Report for the San Diego Gas & Electric Cleveland National Forest Master Services Permit Project, San Diego County, California. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

Clark, D.R., C.S. Brehme, and R.N. Fisher. 2011. Arroyo Toad Monitoring Results at Naval Base Coronado, Remote Training Site, Warner Springs, 2010. U.S. Geological Survey Technical Report prepared for Environmental Department, Naval Base Coronado. 33 pp.

Climate Wizard. 2013. Climate Wizard. Selected "Past 50 Years" under "Time Period." Website viewed on February 5, 2013. *http://www.climatewizard.org*

Coffman, G.C., R.F. Ambrose, and P.W. Rundel. 2010. Wildfire promotes dominance of invasive giant reed (Arundo donax) in riparian ecosystems. Biological Invasions (2010) 12:2723–2734.

Cole, D.N. and P.B. Landres. 1995. Indirect Effects of Recreation on Wildlife. *In* Wildlife and Recreationists–Coexistence Through Management and Research, R.L. Knight and K.L. Gutzwiller, Eds. Washington, DC. Island Press: Chapter 11, 183-202.

Compliance Biology, Inc. 2004. Results of Focused Surveys for Arroyo Toad and Special Status Aquatic Reptiles and Amphibians, River Village Project: Newhall Ranch Company, Valencia, California.

Corn, P.S. 2005. Climate change and amphibians. Animal biodiversity and Conservation 28.1:59–67.

Cunningham, J. D. 1962. Observations on the natural history of the California toad, *Bufo californicus* Camp. Herpetologica 17(4):255-260.

Cushman, S.A. 2006. Effects of habitat loss and fragmentation on amphibians: a review and prospectus. Biological Conservation 128: 231 –240.

DeLong, B. 2002. The Dreaded Yellow Star Thistle. http://www.j-bradford-delong.net/movable_type/2003_archives/000638.html (1/8/14).

Dettinger, M. 2011. Climate change, atmospheric rivers, and floods in California – a multimodel analysis of storm frequency and magnitude changes. Journal of the American Water Resources Association (JAWRA) 47(3):514–523.

Dixo, M, J.P. Metzger, J.S. Morgante, and K.R. Zamudio. 2009. Habitat fragmentation reduces genetic diversity and connectivity among toad populations in the Brazilian Atlantic Coastal Forest. Biological Conservation 142: 1560–1569.

Ecological Sciences, Inc. 2005. Results of focused Arroyo Toad Surveys, San Francisquito, Santa Clarita, California (August 21, 2005; 2005B). Prepared for Mr. Sam Rojas, Newhall Ranch Company, Valencia, California.

ECORP Consulting, Inc. 2004. San Mateo steelhead restoration program habitat assessment data report. Unpublished report submitted to the U.S. Fish and Wildlife Service.

Environmental Defense Center (EDC). 2012. East Area 1 Project. On the Internet at: http://www.edcnet.org/learn/current_cases/east_area1.html. Visited November 28, 2012.

[EPA] U.S. Environmental Protection Agency. 1989. The Potential Effects of Global Climate Change on the United States, J.B. Smith and D. Tirpak, editors. Report to Congress, December 1989.

[EPA] U.S. Environmental Protection Agency. 2012a. Climate change: Snowpack. On the Internet at: http://epa.gov/climatechange/science/indicators/snow-ice/snowpack.html. Visited September 4, 2012.

[EPA] U.S. Environmental Protection Agency. 2012b. Climate change: Southwest Impacts & Adaptation. On the Internet at: http://epa.gov/climatechange/impacts-adaptation/southwest.html. Visited September 4, 2012.

[EPA] U.S. Environmental Protection Agency. 2013. Climate Change, Water Resources Impacts & Adaptation. Website viewed January 22, 2013. *http://epa.gov/climatechange/impacts-adaptation/water.html*

Ervin, E. and K. Beaman. 2010. Summary of the four transmontane arroyo toad (*Bufo californicus*) populations from Riverside and San Diego Counties that have recently been determined to be erroneous. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

Ervin, E.L., K.R. Beaman, and R.N. Fisher. 2013. Correction of locality records for the endangered arroyo toad (Anaxyrus californicus) from the desert region of Southern California. Bulletin, Southern California Academy of Sciences 112: 197–205.

ESA. 2012. Middle Piru Creek: 2012 Arroyo Toad (*Anaxyrus californicus*) Clutch Surveys and Sensitive Species Monitoring (#206008.09). September 2012. Prepared for California Department of Water Resources By ESA, Woodland Hills, California.

Fisher, M.C., T.W.J. Garner, and S.F. Walker. 2009. Global emergence of *Batrachochytrium dendrobatidis* and amphibian chytridiomycosis in space, time, and host. Annual Review of Microbiology 63: 291–310.

Frost, D. R., T. Grant, J.N. Faivovich, R. H. Bain, A. Haas, CE´ L. F.B. Haddad, R. O. DE SA´ , A. Channing, M. Wilkinsen, S. C. Donnellan, C. J. Raxworthy, J. A. Campbell, B. L. Blotto, P. Moler, R. C. Drewes, R. A. Nussbaum, J. D. Lynch, D. M. Green, and W. C. Wheeler. 2006. The Amphibian Tree of Life. Bulletin of the American Museum of Natural History No. 297, 370 pp., 71 figures, 5 tables, 7 appendices.

Frost, D.R., R.W. McDiarmid, and J.R. Mendelson III. Anura—Frogs, pp. 2–12. *IN* Crother, B. I. (ed.). 2008. Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, pp. 1–84. SSAR Herpetological Circular 37.

Ganguly, A., K. Steinhaeuser, D. Erickson, M. Branstetter, E. Parish, N. Singh, J. Drake, and L. Buja. 2009. Higher trends but larger uncertainty and geographic variability in 21st century temperature and heat waves. PNAS 106: 15555–15559.

Glenn Lukos Associates. 2005. East Orange Planned Community Project in Orange County California – Letter report on focused surveys for the arroyo toad. Report prepared for The Irvine Company, Newport Beach, California. July 8, 2005. 5 pp.

Glick, P., B.A. Stein, and N.A. Edelson (eds.). 2011. Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. National Wildlife Federation, Washington, DC. 168 pp.

Griffin, P.C., and T.J. Case. 2001. Terrestrial habitat preferences of adult arroyo southwestern toads. J. Wildlife Management 65(4):633-644.

Griffin, P.C., T.J. Case, and R.N. Fisher. 1999. Radio telemetry study of *Bufo californicus*, arroyo toad movement patterns and habitat preferences. Contract Report to California Department of Transportation Southern Biology Pool.

Haas, W. E. 2005. Results of Directed Surveys for the Arroyo Toad in Scove Canyon, Pine Valley, San Diego County, California. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California

Hancock, J.P. 2009. Arroyo Toad (*Anaxyrus californicus*) Life History, Population Status, Population Threats, and Habitat Assessment of Conditions at Fort Hunter Liggett, Monterey County, California. Master's Thesis, California Polytechnic University, San Luis Obispo, California. 74 pp.

Hahr, M. 2006. Chytrid fungus discovered in western toads in Klondike Gold Rush National Historical park, Skagway, Alaska. http://www.mail-archive.com/akherps@stikine.org/msg00306/**Chytrid**_Fungus_KLGO_051506.doc. Accessed November 24, 2008.

Hitchcock, C.J., A.R. Backlin, and R.N. Fisher. 2004. Surveys for arroyo toads (*Bufo californicus*) throughout the San Gabriel, San Bernardino, and San Jacinto Mountains, 2003. U.S. Geological Survey final report. 40 pp.

Holland, D.C. 1995. Sensitive Species Hydroecological Evaluation – Santa Margarita River: Arroyo Southwestern Toad (*Bufo microscaphus californicus*) Camp. Camp Pendleton. 14 pp.

Hovore, F., T. Even, D. Wing, K. Penrod, R. Ramirez, and T. Savaikie. 2008. Santa Clara River Watershed Amphibian and Benthic Macroinvertebrate Bioassessment Project. Prepared for the Santa Clara River Trustee Council by The Wishtoyo Foundation. 145 pp.

Hubbartt, V.K. and T.G. Murphey. 2005. Surveys for California red-legged frog and arroyo toad on the Los Padres National Forest. *In* Planning for biodiversity: bringing research and management together: Proceedings of a symposium for the South Coast Ecoregion. B.E. Kus and J.L. Beyers, tech. coords. Gen. Tech. Rep. PSW-GTR-195. Albany, California: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 274 pp.

Huber, M., and R. Knutti. 2011. Anthropogenic and natural warming inferred from changes in Earth’s energy balance. Nature Geoscience. Published online December 4, 2011; DOI: 10.1038/NGEO1327. 6 pp. plus supplemental material.

ICF International. 2010. Results of Amphibians Surveys for the Long Potrero Mitigation Property. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: the physical science basis. Summary for policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC Secretariat, World Meteorological Organization and United Nations Environment Programme, Geneva, Switzerland.

[IPCC] Intergovernmental Panel on Climate Change. 2002. Climate Change and Biodiversity. [H. Gitay, A. Suárez, R.T. Watson, and D.J. Dokken (eds.)]. IPCC, Geneva, Switzerland. 86 pp.

[IPCC] Intergovernmental Panel on Climate Change. 2007a. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K., and A. Reisinger (eds.)]. IPCC, Geneva, Switzerland. 104 pp.

[IPCC] Intergovernmental Panel on Climate Change. 2007b. Summary for Policymakers. Pp. 1–18. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY. 996 pp.

Jennings, M.R. and M.P. Hayes. 1994. Amphibian and reptile species of special concern in California. Report to the California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California. 255 pp.

[JFSP] Joint Fire Science Program. 2007. The Fire-Climate Connection. Fire Science Digest, Issue 1, October 2007, Boise, ID.

Jolley, D.B., S.S. Ditchkoff, B.D. Sparkling, L.B. Hanson, M.S. Mitchell, and J.B. Grand. 2010. Estimate of herpetofauna depredation by a population of wild pigs. Journal of Mammalogy, 91(2):519–524.

Kirshtein, J.D., C.W. Anderson, J.S. Wood, J. E. Longcore, and M.A. Voytek. 2007. Quantitative PCR detection of *Batrachochytrium dendrobatidis* DNA from sediments and water. Dis. Aquat. Org. 77:11-15, 2007.

Lambert, A.M, C.M. D'Antonio, and T.L. Dudley. 2010. Invasive Species and Fire in California Ecosystems. Fremontia 38:2/38:3, pp. 29–36.

Lanoo, M., Ed. 2005. Amphibian Declines: The Conservation Status of United States Species. University of California Press. Modified for the internet at AmphibiaWeb: http://amphibiaweb.org/cgi/amphib_query?where-genus=Anaxyrus&where-species=californicus. Visited February 5, 2013.

[LADWP] Los Angeles Department of Water and Power. 2009. Letter dated October 7, 2009 regarding Castaic Power Plant Sediment Removal Project and Arroyo Toad Survey Report. Prepared for Della Snyder-Velto, U.S. Fish and Wildlife Service, Ventura, California.

[LEI] Labat Environmental, Inc. 2008. Determination of Findings, Federally Listed Endangered Arroyo Toad Survey Results, Campo Creek, CA, International Fuel Break Project. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

Lawler, J.J., S.L. Shafer, and A.R. Blaustein. 2010. Projected climate impacts for the amphibians of the western hemisphere. Conservation Biology 24: 38–50.

Lovich, R.E. 2009. Phylogeography and Conservation of the Arroyo Toad (Bufo californicus). Ph.D. Dissertation, Loma Linda University, Loma Linda, California. 140 pp.

[LSA] LSA Associates, Inc. 2012. Results of Focused Surveys for the Arroyo Toad (July 2011-June 2012) within San Juan Creek in the Cleveland National Forest and Caspers Wilderness Park, Orange County, California; Caltrans EA Nos. 0L9003 and 0M0603, Task Order 6A, Amendment 2. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

[LSA and Bonterra] LSA Associates, Inc. and BonTerra Consulting. 2012. Invasive Species Removal Summary Report 2011–2012 for the Upper SR-74 (Ortega Highway), Orange County, California; Caltrans EA Nos. 0L9003 and 0M0603, Task Order 6A, Amendment 2. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

Madden-Smith, M. C., E. L. Ervin, K. P. Meyer, S. A. Hathaway, and R. N. Fisher. 2005. Distribution and status of the arroyo toad (*Bufo californicus*) and western pond turtle (*Emys marmorata*) in the San Diego MSCP and surrounding areas. U.S. Geological Survey final report prepared for County of San Diego and California Department of Fish and Game. San Diego, California.

Master, L., D. Faber-Langendoen, R. Bittman, G.A. Hammerson, B. Heidel, J. Nichols, L. Ramsay, and A. Tomaino. 2009. NatureServe conservation status assessments: factors for assessing extinction risk. NatureServe, Arlington, VA. http://www.natureserve.org/publications/ConsStatusAssess_StatusFactors.pdf

Maxell, B. A., and D. G. Hokit. 1999. Amphibians and Reptiles. Pages 2.1-2.29 in G. Joslin and H. Youmans, coordinators. Effects of recreation on Rocky Mountain wildlife: A Review for Montana. Committee on Effects of Recreation on Wildlife, Montana Chapter of The Wildlife Society. 307 pp.

Meehl, G.A., T.F. Stocker, W.D. Collins, P. Friedlingstein, A.T. Gaye, J.M. Gregory, A. Kitoh, R. Knutti, J.M. Murphy, A. Noda, S.C.B. Raper, I.G. Watterson, A.J. Weaver, and Z.C. Zhao. 2007. Global Climate Projections. Pp. 747–845. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY. 996 pp.

Merkel & Associates, Inc. 2008. 30-day Summary Report of Arroyo Toad Survey Guidelines for the Santa Maria Spray Field Project, Located in the Community of Ramona, San Diego County. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

Miller, L. and A.H. Miller. 1936. The northward occurrence of Bufo californicus in California. Copeia 1936:176.

Miller, D., M. Gray, and A. Storfer. Ecopathologoy of Ranaviruses infecting amphibians. Viruses 3: 2351–2373.

Miller, D.A.W., C.S. Brehme, J.E. Hines, J.D. Nichols, and R.N. Fisher. 2012. Joint estimation of habitat dynamics and species interactions: disturbance reduces co-occurrence of non-native predators with an endangered toad. Journal of Animal Ecology 2012.

Moore, F., G. Miller, and M.J. Tidman. 2000. Fencing cattle away from creeks. On the Internet at: http://www.ipm.iastate.edu/ipm/icm/2000/7-10-2000/cattlecreeks.html.

Myers, G.S. 1930. The status of the southern California toad, *Bufo californicus* (Camp). Proceedings of the Biological Society of Washington. 43 (11): 73–78.

Nichols, D.K. 2003. Tracking down the killer chytrid of amphibians. Herpetological Review 34(2): 101-104. http://www.redorbit.com/news/science/17011/tracking_down_the_killer_chytrid_of_amphibians/#. Accessed April 4, 2009.

Opdam, P. and D. Wascher. 2004. Climate change meets habitat fragmentation: linking landscape and biogeographical scale levels in research and conservation. Biological Conservation 117: 285–297.

Perry, L.G., D.C. Andersen, L.V. Reynolds, S.M. Nelson, and P.B. Shafroth. 2012. Vulnerability of riparian ecosystems to elevated $CO_2$ and climate change in arid and semiarid western North America. Global Change Biology (2012) 18, 821–842.

Pounds, J.A., M.R. Bustamante, L.A. Coloma, J.A. Consuegra, M.P.L Fogden, P.N. Foster, E. La Marca, K.L. Masters, A. Merino-Viteri, R. Puschendorf, S.R. Ron, G.A. Sanchez-Azofeifa, C.J. Still, and B.E. Young. 2006. Widespread amphibian extinctions from epidemic disease driven by global warming. Nature 439: 161–167.

Pilliod, D.S., R.B. Bury, E.J. Hyde, C.A. Pearl, and P.S. Corn. 2003. Fire and amphibians in North America. Forest Ecology and Management 178:163-181.

[PRBO] PRBO Conservation Science. 2011. Projected Effects of Climate Change in California: Ecoregional Summaries Emphasizing Consequences for Wildlife. Version 1.0. *http://data.prbo.org/apps/bssc/climatechange.* Accessed May 4, 2011.

Prinn, R., S. Paltsev, A. Sokolov, M. Sarofim, J. Reilly, and H. Jacoby. 2011. Scenarios with MIT integrated global systems model: significant global warming regardless of different approaches. Climatic Change 104: 515–537.

Ramirez , R.S., Jr. 2002. Arroyo toad (*Bufo californicus*) radio telemetry and pitfall trapping studies, Little Horsethief Canyon, Summit Valley Ranch, San Bernardino County. Final Report to California Department of Transportation.

Ramirez, R.S., Jr. 2003. Arroyo toad (*Bufo californicus*) hydrogeomorphic habitat baseline analysis/radio telemetry study - Rancho Las Flores San Bernardino County, California. Final report to Rancho Las Flores Limited Partnership by Cadre Environmental, Carlsbad, California. vi + 101 pp.

Ramirez, R.S., Jr. 2005. Arroyo toad (*Bufo californicus*) habitat assessment, Summit Valley Ranch, San Bernardino County, California. Final Report prepared for Summit Valley Management Company, Hesperia, California.

Ramirez, R.S., Jr. 2007. Arroyo toad (*Bufo californicus*) hydrogeomorphic habitat baseline analysis/radio telemetry study - Rancho Las Flores – West Fork Mojave River & Grass Valley Creek – San Bernardino County, California. Prepared for Rancho Las Flores Limited Partnership by Cadre Environmental, Carlsbad, California. vi + 116 pp.

Riley, Seth P.D., G.T. Busteed, L.B. Kats, T. L. Vandergon, L.F.S. Lee, R.G. Dagit, J.S. Kerby, R.N. Fisher, and R.M. Sauvajot. 2005. Effects of Urbanization on the Distribution and Abundance of Amphibians and Invasive Species in Southern California Streams. Conservation Biology 1894–1907.

Sandburg, N. 2008. Middle Piru Creek arroyo toad (*Bufo californicus*) clutch surveys 2007. Prepared for United Water Conservation District, Santa Paula, California. 20 pp.

[SDNHM] San Diego Natural History Museum. 2010. Feral Pig Distribution Survey Report. Unpublished document prepared for The Nature Conservancy, Ramona, California.

[Service] U.S. Fish and Wildlife Service. 1995. Biological opinion for programmatic activities and conservation plans in riparian and estuarine/beach ecosystems on Marine Corps Base, Camp Pendleton, California (1-6-95-F-02). Carlsbad Field Office, Carlsbad, California. October 30, 1995.

[Service] U.S. Fish and Wildlife Service. 1999. Arroyo southwestern toad (*Bufo microscaphus californicus*) recovery plan. Portland, Oregon. 119 pp.

[Service] U.S. Fish and Wildlife Service. 2000. Programmatic biological opinion for the maintenance, repair and replacement of low water road crossings, Los Padres National Forest, Monterey, San Luis Obispo, Santa Barbara, Ventura, and Los Angeles Counties, California (1-8-97-F-33). Ventura Fish and Wildlife Office, Ventura, California. January 11, 2000.

[Service] U.S. Fish and Wildlife Service. 2000a. Biological opinion on the effects of ongoing forest activities that may affect listed riparian species on the Cleveland National Forest, the Los Padres National Forest, the San Bernardino National Forest and Angeles National Forest in southern California (1-6-99-F-21). U.S. Fish and Wildlife Service. Carlsbad and Ventura Fish and Wildlife Offices.

[Service] U.S. Fish and Wildlife Service. 2001a. Reinitiated biological opinion on the Cleveland National Forest's livestock grazing program, Orange, Riverside, and San Diego Counties, California (1-6-01-F-1694). Carlsbad Fish and Wildlife Office, Carlsbad, California. 65 pp.

[Service] U.S. Fish and Wildlife Service. 2001b. Biological opinion on the San Bernardino National Forest's livestock grazing program on four allotments (FWS-SB-1464.2). Carlsbad Fish and Wildlife Office, Carlsbad, California.

[Service] U.S. Fish and Wildlife Service. 2003. Biological Opinion for the Bouquet and Copper Fire Suppression and Rehabilitation Activities, Los Angeles County, California (1-8-02-F-60). Ventura Fish and Wildlife Office, Ventura, California.

[Service] U.S. Fish and Wildlife Service. 2004a. Biological Opinion on the Effects of Permitted Grazing Allotments on the Smith's Blue Butterfly on the Monterey Ranger District, Los Padres National Forest, Monterey County, California (1-8-03-F-53). Ventura Fish and Wildlife Office, Ventura, California.

[Service] U.S. Fish and Wildlife Service. 2005a. Biological Opinion for the State Route 74 (SR 74) Safety Improvements Project in the County of Orange, California (1-6-05-F-1688.6). Carlsbad Fish and Wildlife Office, Carlsbad, California. September 30, 2005.

[Service] U.S. Fish and Wildlife Service. 2005b. Biological and conference opinions on the revised land and resource management plans for the four southern California national forests, California (1-6-05-F-773.9). September 15, 2005.

[Service] U.S. Fish and Wildlife Service. 2008. Biological Opinion for Mining Operation in the Sisquoc River, Santa Maria, Santa Barbara County, California (1-8-08-F-15R) (File No. 94-50249-TW). Ventura Fish and Wildlife Office, Ventura, California. November 20, 2008.

[Service] U.S. Fish and Wildlife Service. 2009. Arroyo toad (*Anaxyrus californicus*) 5-Year Review: Summary and Evaluation. Ventura Fish and Wildlife Office, Ventura, California.

[Service] U.S. Fish and Wildlife Service. 2011. Biological Opinion for the Newhall Ranch Resource Management and Development Plan, Santa Clarita, Los Angeles County, California (File Number 2003-01264-AOA) (8-8-09-F-44). Ventura Fish and Wildlife Office, Ventura, California.

[Service] U.S. Fish and Wildlife Service. 2013. Biological Opinion for Ongoing Activities Related to Transportation Facility Maintenance and Use, Los Padres National Forest, California (8-8-12-F-43). Ventura Fish and Wildlife Office, Ventura, California.

Snyder, M.A., L.C. Sloan, and J.L. Bell. 2004. Modeled regional climate change in the hydrologic regions of California: a $CO_2$ sensitivity study. Journal of the American Water Resources Association (JAWRA) 40(3):591–601.

Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker,

P. Whetton, R.A. Wood, and D. Wratt. 2007. Technical Summary. Pp. 19–91. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor, and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY. 996 pp.

Stebbins, R.C. 1951. Amphibians of western North America. University of California Press, Berkeley and Los Angeles, California. ix + 539 pp.

Stebbins, R.C. 2003. A field guide to western reptiles and amphibians, third edition. Houghton Mifflin Company, Boston, Massachusetts. xiii + 533 pp.

Sweet, S.S. 1992. Initial report on the ecology and status of the arroyo toad (*Bufo microscaphus californicus*) on the Los Padres National Forest of southern California, with management recommendations. Report to United States Department of Agriculture, Forest Service, Los Padres National Forest, Goleta, California. ii + 198 pp.

Sweet, S.S. 1993. Second report on the biology and status of the arroyo toad (*Bufo microscaphus californicus*) on the Los Padres National Forest of Southern California. Contract report to the USDA Forest Service, Los Padres National Forest, Goleta, California. ii + 73 pp.

Sweet, S.S. 2006. Arroyo Toad Clutch Surveys. Unpublished report submitted to the U.S. Fish and Wildlife Service.

Sweet, S.S. 2007a. Field report, Zaca fire-related damage in *Bufo californicus* critical habitat, upper Santa Ynez River drainage (Santa Barbara County, California). October 9, 2007. Unpublished report prepared for U.S. Fish and Wildlife Service, Ventura, California.

Sweet, S.S. 2007b. Second field report, Zaca fire-related damage in *Bufo californicus* critical habitat, upper Santa Ynez River drainage (Santa Barbara County, California). 30 November 2007. Unpublished report prepared for U.S. Fish and Wildlife Service, Ventura, California.

Sweet, S.S. 2012. Letter prepared for Dr. Chris Kofron, Recovery Permit Coordinator, U.S Fish and Wildlife Service, Ventura, California. 2011 Annual Report for recovery permit TE-025732-5 covering activities in 2011. 30 pp.

Sweetwater Authority. 2006. Standard Operating Procedure: Loveland to Sweetwater Reservoir Water Transfer. Prepared by Water Resources, June 21, 2006. Chula Vista, California.

Tierra Data, Inc. 2007. Biological Resources Surveys 2005 – 2006 at Remote Training Site Warner Springs, U.S. Naval Base Coronado, California. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

U.S. Army Reserve Command. 2004. Endangered species management plan for arroyo toad (*Bufo californicus*), Fort Hunter Liggett, California. Fort Hunter Liggett, California.

[USDA] U.S. Department of Agriculture, Forest Service. 2012. Environmental Assessment, Feral Pig Damage Control Project on Cleveland National Forest and Bureau of Land Management Lands, San Diego, Orange and Riverside Counties, California. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California. 56 pp.

[USFS] U.S. Forest Service. 2005. Los Padres National Forest Land Management Plan. Los Padres National Forest, Pacific Southwest Region, R5-MB-083. September 2005. Online at www.fs.fed.us/r5/scfpr/projects/lmp/read.htm.

[USFS] U.S. Forest Service. 2007. Draft Biological Assessment for Wildlife: Piru Allotments (Piru, Pot Holes, and Temescal) Grazing Permit Issuance, Ojai Ranger District, Los Padres National Forest, November 2007. Prepared for Ventura Fish and Wildlife Office, Ventura, California. 23 pp.

[USFS] U.S. Forest Service. 2009. Arroyo toad survey information from Cleveland National Forest, Trabuco Ranger District. Unpublished documents submitted to the U.S. Fish and Wildlife Service, Carlsbad, California. 23 pp.

[USFS] U.S. Forest Service. 2011. Annual report for endangered species monitoring, 2011. Angeles National Forest, Arcadia, California. 3 pp.

[USFS] U.S. Forest Service. 2012a. Programmatic Biological Assessment of Federally Listed Wildlife Species That May Be Affected By: Transportation Facility Maintenance and Use (2012-2022) on the Los Padres National Forest, August 15, 2012. Los Padres National Forest, Goleta, California.

[USFS] U.S. Forest Service. 2012b. Biological assessment for Forest Service ongoing activities associated with recreation, roads/trails and administrative sites on the Angeles National Forest. Unpublished document submitted to the Carlsbad and Ventura Fish and Wildlife Offices. 202 pp.

[USFS] U.S. Forest Service. 2013a. Programmatic Biological Assessment on the Effects of Forest Activities on Federally Listed Wildlife Species, Los Padres National Forest. May, 2013. Los Padres National Forest, Goleta, California.

[USFS] U.S. Forest Service. 2013b. Programmatic Biological Assessment of Federally Listed Wildlife Species for the Hiking Program, Los Padres National Forest, May 9, 2013. Los Padres National Forest, Goleta, California.

[USGS] U.S. Geological Survey. 2000. Year 2000 Arroyo Toad Surveys, Arroyo Seco Creek/Dripping Springs Campground, Palomar Ranger District, Cleveland National Forest. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California. 11 pp.

[USGS 2012] Barlow, P.M., and Leake, S.A., 2012, Streamflow depletion by wells—Understanding and managing the effects of groundwater pumping on streamflow: U.S. Geological Survey Circular 1376, 84 p.

[MCB Camp Pendleton] U.S. Marine Corps. 2007. Marine Corps Integrated Natural Resources Management Plan. U.S. Marine Corps Base, Camp Pendleton, California.

Varanus Biological Services, Inc. 1999a. Annual report for the U.S. Fish & Wildlife Service: Arroyo toad survey. Survey report forms.

Varanus Biological Services, Inc. 1999b. Results of Red-legged Frog and Arroyo Toad Habitat Assessment, Lost Valley Scout Reservation, Aguanga, San Diego County, California. Unpublished document submitted to the U.S. Fish and Wildlife Service, Carlsbad, California.

[Ventura County] Ventura County Planning Division. 2006. Guide to Native and Invasive Streamside Plants: Restoring Riparian Habitats in Ventura County & along the Santa Clara River in Los Angeles County. Ventura County Planning Division, May 2006. 84 pp.

Vredenburg, V.T. and D.B. Wake. 2007. Global declines of amphibians. Encyclopedia of Biodiversity: 1–11.

Welsh, H.H., Jr. 1988. An ecogeographic analysis of the herpetofauna of the Sierra San Pedro Mártir region, Baja California: With a contribution to the biogeography of Baja California herpetofauna. Proc. California Acad. Sci., 4th series, 46:1-72.

Westerman, A. G., W. van der Schalie, S. L. Levine, B. Palmer, D. Shank, and R.G. Stahl. 2003a. Linking stressors with potential effects on amphibian populations. *In* G. Linder, S.K. Krest, and D.W. Sparling (eds.), Amphibian Declines: An Integrated Analysis of Multiple Stressor Effects, pp. 73-109. Springer-Verlag, New York.

White and Leatherman Bioservices. 2000. Results of Arroyo Toad Habitat Assessment at Tesoro Del Valle (July 18, 2000). Prepared for Tom Smith, Bonterra Consulting, Costa Mesa, California.

Wilcox, J.T. and D.H. Van Vuren. 2009. Wild pigs as predators in oak woodlands of California. Journal of Mammology, 90(1):114–118.

[WRCRCA] Western Riverside County Regional Conservation Authority. 2006. Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) Biological Monitoring Program, Arroyo Toad (*Bufo californicus*) Survey Report 2005. Unpublished document dated September 19, 2006. *http://wrcrca.com/library.asp* Accessed December 14, 2012.

[WRCRCA] Western Riverside County Regional Conservation Authority. 2011. Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) Biological Monitoring Program, Arroyo Toad (*Anaxyrus californicus*) Survey Report 2010.

Unpublished document dated March 23, 2011. *http://wrcrca.com/library.asp* Accessed December 14, 2012.

Young, A. T. Boyle, and T. Brown. 1996. The population genetic consequences of habitat fragmenatation for plants. Tree 11: 413–418.

IN LITTERIS

Bloom, P. 1998. Wildlife Biologist. Western Foundation of Vertebrate Zoology, Camarillo, California.

Cooper, K. 2009. Electronic mail dated March 12, 2009. Forest Biologist. Los Padres National Forest, Santa Barbara, California.

Haase, R. 2005. Presence of the arroyo toad (*Bufo californicus*) in Silverado and Santiago Creeks; Orange County, California; a report of field observations from April 29, May 6, and May 8, 2005. Unpublished report submitted to the U.S. Fish and Wildlife Service.

Haase, R. 2008. Presence of the arroyo toad (*Bufo californicus*) larvae in Silverado Creek; Orange County, California; a report of field observations from March 22, 2008. Unpublished report submitted to the U.S. Fish and Wildlife Service.

Haase, R. 2009. Environmental Scientist, Marine Corps Air Station, Camp Pendleton, California. Electronic correspondence to Stacey Love, dated January 27, 2009. Subject: Bell Canyon and Wilson Creek.

Holland, D. 2000. Comment letter to the Ventura Fish and Wildlife Office on August 6, 2000 addressing designation of proposed critical habitat for the arroyo toad, 31 pp. + maps and references. Biological Consultant. San Diego, California.

Loe, S.A. 1997. U.S. Forest Service, San Bernardino National Forest, San Bernardino, California.

Lovich, R. 2010. Herpetologist, San Diego, California. Electronic correspondence to Stacey Love, dated February 19, 2010, Subject: 2009 Lovich Final Dissertation.

Ortega, B. 2001. Dudek Associates, Encinitas, California.

PERSONAL COMMUNICATIONS

Backlin, A. and Brehme, C. 2012. Biologists, U.S. Geological Survey. Electronic correspondence to Stacey Love, dated October 17, 2012, Subject: Final notes from phone conversation re: arroyo toad.

Brown, C. 2012. Biologist, U.S. Geological Survey. Electronic correspondence to Stacey Love, dated November 28, 2012. Subject: Final notes from phone conversation re: arroyo toad.

Famolaro, P. 2013. Watershed Manager, Sweetwater Authority. Electronic correspondence to Stacey Love, dated May 2, 2013. Subject: Arroyo toad observations in Sloan Canyon.

Holland, D. 2005. Personal communication. Biological Consultant. San Diego, California.

Hollingsworth, B.D. 2013. Curator, Department of Herpetology, San Diego Natural History Museum. Electronic correspondence to Stacey Love on June 11, 2013. Subject: Arroyo toads in Baja.

Hovey, T.E. 2013. Environmental Scientist, California Department of Fish and Wildlife. Phone conversation with Stacey Love on May 6, 2013. Subject: Arroyo toads in Boden Canyon.

Love, S. 2013. Biologist. U.S. Fish and Wildlife Service, Carlsbad, California. Projected changes in snow water equivalence for mountains of southern California using Cal-Adapt data. Notes dated February 1, 2013.

McGinnis, N. 2012. Natural Resources Manager, City of San Diego. Phone conversation with Stacey Love on December 4, 2012. Subject: status of arroyo toad habitat and management on City of San Diego Water Department lands.

Moreno, M. 2012. Personal communication. Biologist. U.S. Fish and Wildlife Service, Carlsbad, California.

Peralta, A. and J. Valdez 2013. Centro de Investigaciones Biológicas del Noroeste, S.C. Electronic correspondence to Stacey Love, dated June 8, 2013. Subject: arroyo toads in Baja.

Sandburg, N. 1997. Personal communication. Biologist. Los Padres National Forest, Goleta, California.

Sweet, S. 2011. Personal communication via electronic mail dated 8 February 2011. Comments on Middle Piru Creek arroyo toad survey program, 2010, Sam Sweet, UC Santa Barbara.

Sweet, S. 2012. Personal communication via electronic mail to Chris Kofron, biologist, Ventura Fish and Wildlife Office on August 31, 2012; Forwarded by Chris Kofron to Della Snyder-Velto, biologist, Ventura Fish and Wildlife Office, on August 31, 2012. Subject: Could prescribed fire be used to benefit the arroyo toad in the San Antonio River on Fort Hunter Liggett?

Snyder-Velto, D. 2013a; 2013b. Personal observations. Senior Biologist. U.S. Fish and Wildlife Service, Ventura, California.

Welch. L.R. 2012. Biologist, U.S. Forest Service. Phone conversation with Della Snyder-Velto on July 11, 2012. Subject: Arroyo toad survey results in Big Tujunga Creek on the Angeles National Forest, conducted first week of June, 2012.

Winchell, C. 2012. U.S. Fish and Wildlife. Notes from meeting with Clark Winchell on October 1, 2012. Subject: feral pig threat to arroyo toad.

Winter, K. 2012. Forest Biologist, Cleveland National Forest, San Diego, California. Electronic mail to Stacey Love, U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office.

**Federal Register Documents**

**50 FR 37958; September 18, 1985**. Endangered and Threatened Wildlife and Plants; Review of Vertebrate Wildlife. Notice of Review.

**59 FR 64859; December 16, 1994.** Endangered and Threatened Wildlife and Plants; Determination of endangered status for the arroyo southwestern toad. Final Rule.

**59 FR 64859; December 16, 1994.** Endangered and Threatened Wildlife and Plants; Determination of endangered status for the arroyo southwestern toad. Final Rule.

**74 FR 52612; October 13, 2009.** Endangered and Threatened Wildlife and Plants; Revised critical habitat for the arroyo toad (*Anaxyrus californicus*). Proposed rule.

**76 FR 7246; February 9, 2011.** Endangered and Threatened Wildlife and Plants; Revised critical habitat for the arroyo toad. Final rule.