

The Rio Grande leopard frog (*Lithobates berlandieri*) and other introduced and native riparian herpetofauna of the Coachella Valley, Riverside County, California

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The Coachella Valley of southeastern California has gradually developed a riparian herpetofauna since the conversion of desert land to agricultural and urban landscapes and the formation of the Salton Sea in the early 1900s. Most of these species originally spread from the Colorado River to the Imperial Valley through natural channel shifts long ago, and more recently through the All-American Canal. Some of these riparian species then moved northward into the Coachella Valley of Riverside County, situated at the north end of the Salton Sea, namely, Woodhouse's Toad (*Anaxyrus woodhousii*), Great Plains Toad (*Anaxyrus cognatus*), Rio Grande Leopard Frog (*Lithobates berlandieri*), Spiny Softshell (*Apalone spinifera*), and Checkered Gartersnake (*Thamnophis marcianus*). The Red-eared Slider (*Trachemys scripta elegans*) was introduced from captivity, and the American Bullfrog (*Lithobates catesbeianus*) may have arrived from multiple sources. The most recent immigrant is the Rio Grande Leopard Frog. This species has colonized the agricultural southern part of the Coachella Valley and has begun to move into the urbanized northern portion. This frog has the potential to negatively affect native anurans if it spreads further. The current distribution, timing of introduction, and suspected origins of all riparian herpetofauna in the Coachella Valley are discussed.

Key words: amphibians, Coachella Valley, herpetofauna, introduced species, reptiles, Rio Grande Leopard Frog

This article documents the spread of the Rio Grande Leopard Frog (*Lithobates berlandieri*) and other riparian species into the Coachella Valley of southeastern California. Riparian reptiles and amphibians of various origins have over time colonized the artificial wetlands now scattered across the previously arid Coachella Valley. The established assemblage now consists of the following species: American Bullfrog (*Lithobates catesbeianus*),

Rio Grande Leopard Frog, Great Plains Toad (*Anaxyrus cognatus*), Woodhouse's Toad (*Anaxyrus woodhousii*), Spiny Softshell (*Apalone spinifera*), Red-eared Slider (*Trachemys scripta elegans*), and Checkered Gartersnake (*Thamnophis marcianus*).

The Coachella Valley is situated at the northwestern edge of the Colorado Desert and is separated from the coastal plain of California by the San Bernardino Mountains to the north, the Santa Rosa and San Jacinto Mountains to the west, and San Geronio Pass between those ranges (Figures 1 and 2). Its southern border is the north end of the Salton Sea. Mean annual precipitation varies from 81 mm in Mecca to 88 mm in Indio and 123 mm in Palm Springs (USCD 2018). Natural wetlands consist of a small number of valley-edge palm oases and springs surrounded by desert and supported by artesian water welling up through earthquake faults or perennial streams flowing a short distance onto the valley from nearby mountains. Thousand Palms Oasis, Dos Palmas Oasis, and the Whitewater River are examples. In the early 1900s, there were still a handful of artesian springs on the valley floor. Three such springs near Indio, Thermal, and Mecca were searched for by California Department of Fish and Wildlife biologists, who concluded that they no longer exist and were probably capped and appropriated for irrigation (Black 1980). The Coachella Valley floor is now mostly irrigated and developed, with both agricultural and urban land uses. Agriculture began in the late 1800s in the upper Coachella Valley once settlers discovered the abundant artesian water, aided by the arrival of the railroad in 1876, facilitating crop transport (Downs 2015). The cities of Palm Springs, Palm Desert, and others gradually replaced the farmland. Country clubs and golf resorts abound, most of which have ponds that are potential habitat for riparian reptiles and amphibians.

The lower Coachella Valley is mainly agricultural and is similar to a swath of canal-irrigated farmland from the Imperial Valley down into Mexico, and from there east to the Colorado River (Figure 1). The Coachella Valley is isolated from the Imperial Valley by the hypersaline Salton Sea and along its sides by about 35 km of barren desert, though a small number of springs have potential use as stepping stones for riparian species.

The Coachella Canal, constructed in the 1940s, bridges this gap and brings water to the Coachella Valley as an extension of the All-American Canal from the Colorado River. A network of feeder lines, holding ponds, and open ditches take water to and from the farms, eventually ending up in the low-lying Salton Sea. Most of the ponds, canals, and ditches develop algal mats, cattails, and other adventitious plants, but are periodically cleaned out to expedite water movement. Additional riparian habitat is found in fish farms, duck-hunting ponds, and poorly drained areas in agricultural fields and groves.

The Whitewater River is the main waterway through the Coachella Valley. The upper reach of the Whitewater River where it exits the mountains is characterized by swift, cold water, with little vegetation along its banks. It flows through the desert of the far upper Coachella Valley, where it terminates at a series of infiltration basins that supplement the aquifer for desert cities. Rainfall is normally so low that there is no surface flow from these basins for approximately 9 km where the dry channel reaches the edge of Palm Springs. From there, the Whitewater River is a mostly a dry flood control channel with small perennial seeps from urban and golf course runoff. These urban seeps can function as refugia for herpetofaunal survival and/or breeding. Surface flows return in Indio as discharge from a wastewater treatment plant. The Salton Sea itself is too saline to support any herpetofauna, but small marshes at the mouth of the Whitewater River and other drain outfalls into the Sea constitute important habitat for introduced species, as well as for the endangered native desert pupfish (*Cyprinodon macularius*) (Keeney 2012).

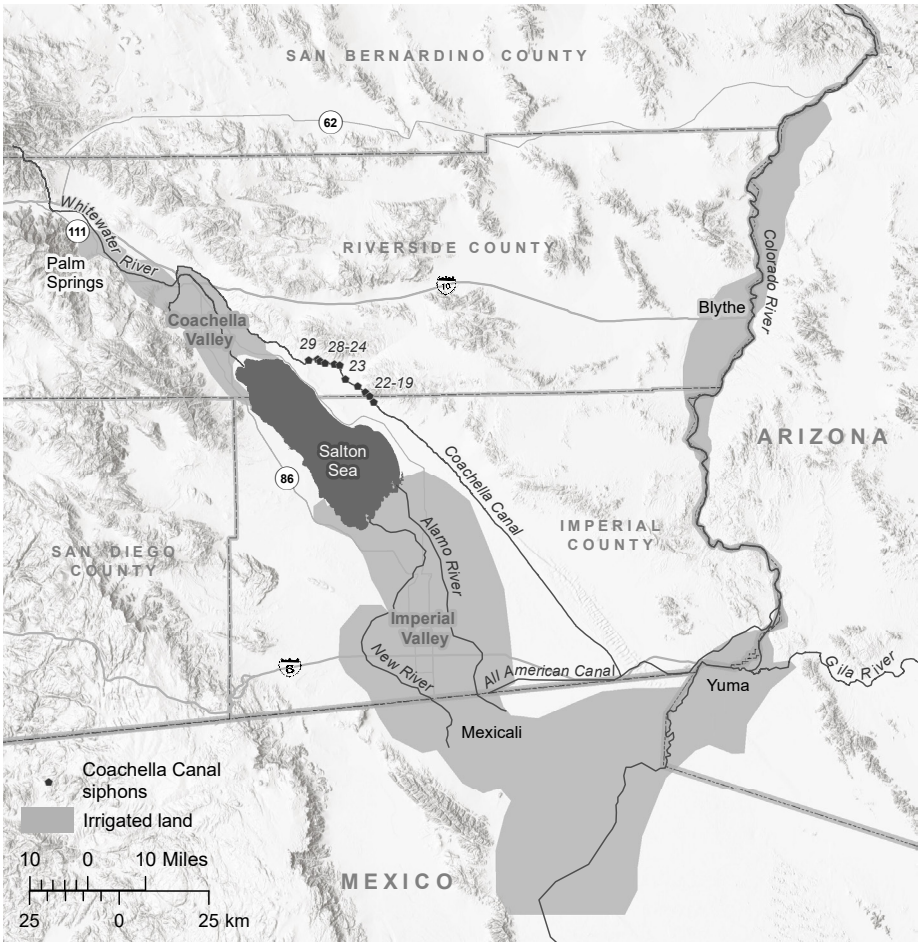


FIGURE 1.—Area overview.

While most of the introduced herpetofauna do not pose an ecological threat, the most recent immigrant to the Coachella Valley, the Rio Grande Leopard Frog (RGLF) is of concern. This native of Texas and northern Mexico was accidentally introduced to the lower Colorado River near Yuma, Arizona, first detected in 1981 (Platz et al. 1990). For further history on the early spread of RGLF and possible interactions with other species of leopard frogs, see Discussion section and Hillis (1981), Kocher and Sage (1986), Jennings and Fuller (2004), Sredl (2005), Rorabaugh and Servoss (2006), and Thomson et al. (2016).

MATERIALS AND METHODS

Survey methods.—From 2005-2018, we conducted opportunistic searches by car and on foot throughout the Coachella Valley for riparian herpetofauna, in both daylight and nighttime, particularly during rainy periods. For RGLF, we conducted systematic searches of Dos Palmas Preserve (site R5) in 2005, 2008, and 2018. The survey area on all three years

consisted of all the ponds and ditches from the headquarters northward to the Coachella Canal, and the small set of ponds south of the headquarters, totaling about 160,000 m². We spent three to four hours starting at dusk slowly walking the berms between all the ponds, spotlighting the banks, algal mats, and edges of cattail stands, counting all individuals seen and heard. To document the potential role of the Coachella Canal in the spread of RGLF into Riverside County, we visually examined the Canal from Siphon 19 in Imperial County across the county line up to Siphon 26, including the wildlife drinkers adjacent to each siphon (Figure 1). To monitor the potential spread of RGLF into the upper Coachella Valley via the Whitewater River, we established reference locations in the river northwest of their documented range. These locations are urban seeps in La Quinta (sites A8-11), Palm Desert (sites A12-13), and Indian Wells (site A19). After a five-year hiatus, due in part to low rainfall that would inhibit overland dispersal, we resumed targeted searches in 2017 to determine if RGLF had moved upstream. Turtles were visually located with binoculars during daylight hours, both opportunistically and by focused searches of the Coachella Canal, golf course ponds, and other wetlands.

Museum and database searches.—We used VertNet.org to search online museum databases for all target species in Riverside and Imperial counties. Our museum search located pertinent specimens from the California Academy of Sciences (CAS), the Los Angeles County Museum (LACM), the Museum of Vertebrate Zoology at Berkeley, California (MVZ), the National Museum of Natural History (NMNH), the San Bernardino County Museum (SBCM), and the San Diego Natural History Museum (SDNHM). We also queried the California Natural Diversity Database (CNDDB) and iNaturalist.org. We deposited voucher specimens at LACM (see Appendix A).

Taxonomy.—Since taxonomic opinions are beyond the scope of this paper, we follow the taxonomy of Scientific and Standard English Names of Amphibians and Reptiles of North America, Eighth Edition (Crother 2017).

RESULTS

Rio Grande Leopard Frog.—The account below chronicles the spread of this species northwestward from the Coachella Canal near the Imperial County border. Refer to Figures 1 and 2 for locations.

In 2005, leopard frogs were found at shallow pools emanating from leaks in the Coachella Canal, 14 km below the Riverside County border in Imperial County, (C. McGaugh, Amec Foster Wheeler Inc., personal communication). Ranid tadpoles were in one such pool on 16 January 2006, and a subadult frog was photographed and confirmed as RGLF by J. Rorabaugh, U.S. Fish and Wildlife Service.

RGLF was first detected in Riverside County in 2005 at ponds at Dos Palmas Preserve adjacent to the Coachella Canal (N. Moorhatch, Amec Foster Wheeler, Inc., personal communication). Table 1 illustrates the initial small numbers of RGLF at the preserve in 2005 followed thereafter by population increases. The RGLF in 2005 were concentrated in one pond, and in subsequent years spread throughout the preserve.

In January 2007, B. Claypool found two RGLF infected with chytrid fungus near Mecca (Lovich et al. 2008), providing the first published record of this frog in Riverside County.

In April 2008, we found three of the Coachella Canal wildlife drinkers had been colonized by RGLF, at about 1, 3, and 7 km north of the Imperial County line at Siphons

TABLE 1.—Numbers of Rio Grande leopard frog (RGLF) and American Bullfrog (AMBU) at Dos Palmas Preserve, site R5. Frogs of all ages were counted, both seen and heard.

Date	RGLF	AMBU	Unidentified
10 May 2005	6	44	8
24 July 2008	61	66	11
11 July 2018	91	32	8

21, 22, and 23 (Figure 1). We captured an individual for species verification at Siphon 23 (site R4) and photographed a RGLF egg mass in the drinker at Siphon 21. We also observed RGLF in 2008 on the banks of the canal from Siphon 19 in Imperial County up to Siphon 26 in Riverside County. An irrigation pond next to the canal in Mecca had at least a dozen RGLF, including juveniles (site R12), while ponds farther away had no frogs.

From 2009-2011, another set of RGLF occurrences were documented about 8 km southwest of Mecca in irrigation ponds and a fish farm near Oasis.

In 2012, searches were resumed following late summer thunderstorms, and a third area was found to have been colonized by RGLF, this one in Indio, about 22 km north of Mecca, adjacent to the Coachella Canal. In August 2012, we found multiple adult and juvenile RGLF at golf course ponds and overflow seeps 100-300 m from the Coachella Canal (sites R13-R16) as well as in the Coachella Canal itself.

In 2012, we surveyed seeps at and around the Coachella Canal undercrossing at the Whitewater River in Indio and documented RGLF in the river, including several individuals dispersing into the river from a pond in a plant nursery (Sites R17-19). Surveys both upstream and downstream from that site were negative for RGLF (sites A4, SO14, A15, and A17).

After several years of low rainfall, we resumed searches in 2017 after substantial rains and found RGLF still had apparently not moved up the Whitewater River into the resort communities but had moved into the lower Whitewater River (site R28) and drain outfalls at the edge of the Salton Sea (R26 and 27).

In summary, from 2005-2018, RGLF moved into the Coachella Valley, likely via the Coachella Canal, dispersed widely and reproduced successfully. We found RGLF broadly distributed in the lower agricultural part of the Coachella Valley, as well as locally in Indio in areas adjacent to the Coachella Canal. They do not appear to have colonized all available habitat within their current range.

American Bullfrog.—Currently, bullfrogs occur throughout both the upper and lower Coachella Valley, and can be quite abundant locally, such as in the Whitewater River, fish farms, and Dos Palmas Oasis (Figure 2). Bullfrogs were found in the unlined part of the Coachella Canal when it was drained in 2007 (J. Crayon, California Dept. Fish and Wildlife, personal communication). Bullfrogs have spread farther northwest into the upper Coachella Valley than RGLF, where most of our bullfrog sightings are from small seeps and wet portions of the Whitewater River as it winds through golf resorts and urban areas.

Great Plains Toad.—At present, this species is most common in the agricultural southern Coachella Valley (Figure 3). Breeding congregations have been found primarily in date palm groves but also at the edges of field crops, both of which are flood irrigated. The permanent irrigation ponds do not appear to be attractive to Great Plains Toad, though one basin that had been dry for some time and started to grow grassy vegetation attracted a chorus after it was refilled (site G2). Currently, the upper Coachella Valley supports Great

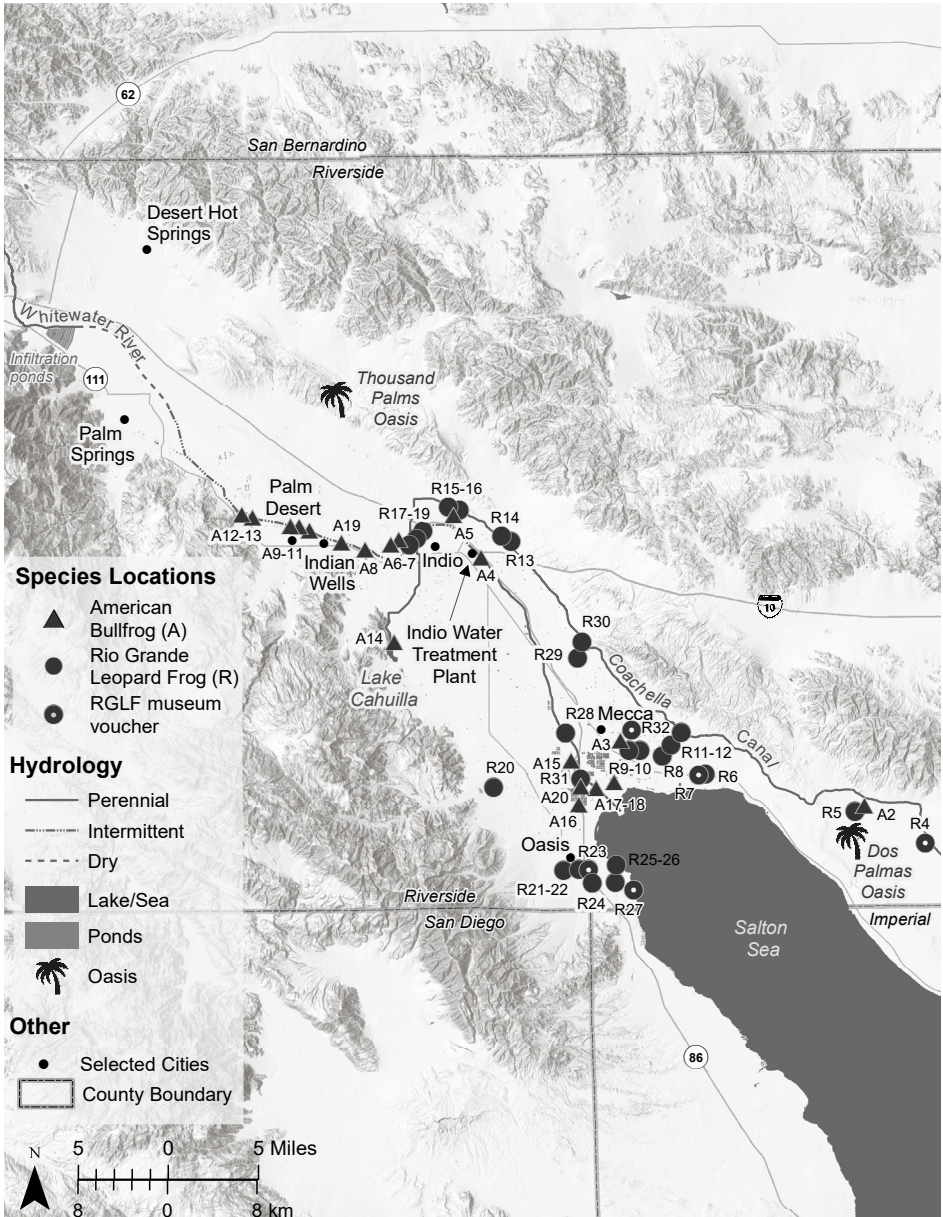


FIGURE 2.—Location map for Rio Grande leopard frog and American Bullfrog. Coordinates and site details are listed in Appendix B. All records shown are detections (solid symbols) and vouchered specimens or photos (hollow symbols) from this study.

Plains Toad only locally, such as in suitable grassy sections of the Whitewater River channel (e.g., site G10), but there are many museum specimens from the 1930s to the 1970s from the upper valley, including north of Interstate 10. Examples are Indio: 1952, MVZ 563; Palm Springs: 1964, LACM 74549; Whitewater Canyon: 1965, LACM 171036; near Thousand Palms Oasis: 1975, SBCM 2401. These records may reflect the decline of farming and spread of urbanization in the upper valley. Figure 3 shows only our recent locations for this species.

Woodhouse's Toad.—At present, this species is common throughout the lower agricultural part of the valley (Figure 3) where it is seen more frequently than Great Plains Toad, with individuals on the roads at night through citrus groves and vineyards from spring through fall. Woodhouse's Toad is reported to be increasing in the Palm Springs area in the urban northern Coachella Valley (Sullivan 2005) and is found sparingly north of I-10 (See Figure 3, iNaturalist records). Woodhouse's Toad was previously found occasionally at Thousand Palms Oasis, though not in recent years (G. Short, Center for Lands Management, personal communication) and 1987 (MVZ 233366). Adults call and form small congregations in irrigation ponds and can be found in small numbers in canals and ditches. Woodhouse's Toad bred at Palm Island Drive, where tadpoles and transformed toadlets

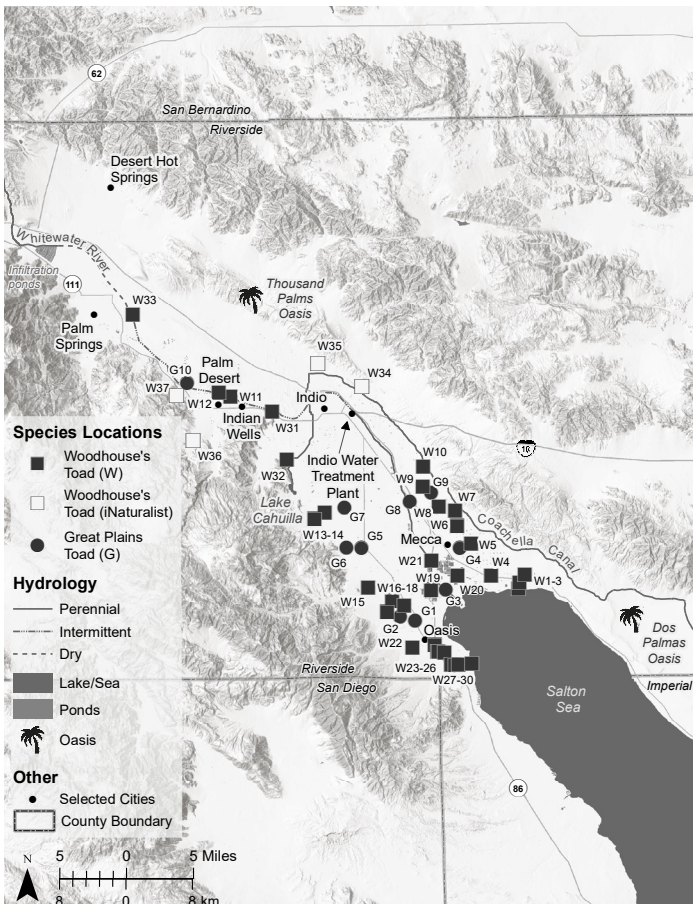


FIGURE 3.—Location map for Great Plains toad and Woodhouse's toad. Coordinates and site details are listed in Appendix B. Museum specimens mentioned in the text are not mapped. All records shown are detections from this study (solid symbols) or iNaturalist records (hollow symbols).

were found at the edge of the Salton Sea in the drain’s fresh water where it passed through the barnacle and salt-encrusted shoreline (site W1), and subadults and adults were found in similar conditions at Ave. 84 (site W31). A 2016 record on iNaturalist from Whitewater Canyon (not mapped) indicates Woodhouse’s Toad may have moved up the Whitewater River channel from the Coachella Valley.

Spiny Softshell.—Spiny Softshells are currently found along the length of the Coachella Canal, and presumably moved up into the Coachella Valley soon after the canal become operational in 1948. Our sightings of this species from 2006-2009 in the Coachella Canal encompass its entire length in Riverside County, from near the county line to within 2 km of its terminus at Lake Cahulla (Figure 4). Softshells can be seen basking on the concrete banks of the canal in the morning or resting just below the surface. Twenty-three softshells were seen in a drain leading to the northern part of the Salton Sea (site SO11). They are found in the Whitewater River at the Indio Wastewater Treatment Plant outfall (site SO14), and downstream to the edge of the Salton Sea (site SO12). We have not observed eggs or hatchlings in the Coachella Valley.

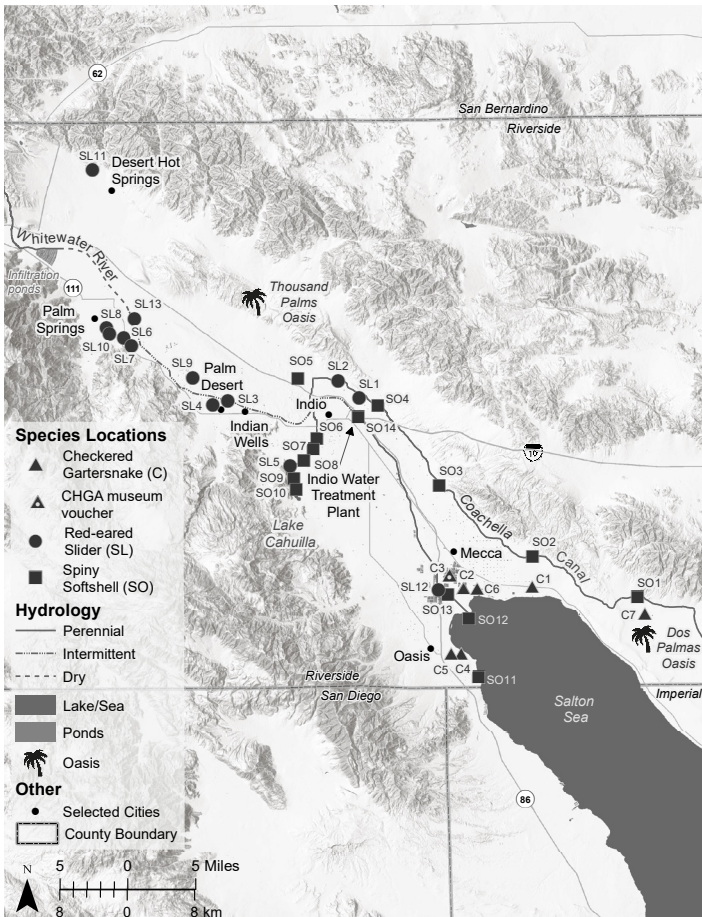


FIGURE 4.—Location map for Spiny Softshell, Red-eared Slider, and Checkered Gartersnake. Coordinates and site details are listed in Appendix B. All records shown are detections (solid symbols) and voucher specimens (hollow symbols).

Red-eared Slider.—Red-eared Slider is more known from the coastal slope than from desert communities, but we found that this species is widely distributed in the upper Coachella Valley (Figure 4). It can be quite abundant in golf course and other ponds where algae and at least a modicum of emergent vegetation can grow. For example, the ponds at the Palm Desert Civic Center (SL4) were drained in 2015 and about 300 sliders of all ages were removed (B. Chuck, City of Palm Desert, personal communication). We found one slider in the Whitewater River in an urban seep pool in an otherwise dry section of the river (site SL3). Only one of our records is from the Coachella Canal (site SL2), but this points to the canal as another potential conduit for dispersal. We obtained proof of attempted breeding on 18 July 2018, with a clutch of 17 slider eggs near Mecca, laid in damp soil found between two ponds (site SL12).

Checkered Gartersnake.—We have undated recent sightings of this species at Dos Palmas Preserve adjacent to the Canal (J. Cornett, Palm Springs Desert Museum, personal communication) and from the Grant Street drain east of Mecca (J. Crayon, California Dept. of Fish and Wildlife, personal communication). We contribute three additional records from the vicinity of Mecca, in or near irrigation drains, and two records adjacent to the northwest part of the Salton Sea (Figure 4). It appears to be established but uncommon in suitable habitat in the southernmost agricultural part of the Coachella Valley.

Species Not Established.—Western Toad (*Anaxyrus boreas*).—This montane and cismontane species was found in residential Palm Springs in 2018 (two iNaturalist records), and in Indio in 2005 (this study, LACM 160934). A Western Toad was reported to have been seen near Thousand Palms Oasis in the 1980s (C. Barrows, University of California, Riverside, personal communication). These may be strays from the foothills, or from heretofore undetected breeding locations.

California Treefrog (*Pseudacris cadaverina*).—Tadpoles and a recently transformed frog at the Palm Springs water infiltration ponds on 18 July 2018 probably originated as eggs or larvae washed down the Whitewater River. Treefrogs probably of this species previously occupied Thousand Palms Oasis but were last seen in the 1970s following impacts of intense flooding and introduced species (C. Barrows, University of California, Riverside, personal communication).

Baja California Treefrog (*Pseudacris hypochondriaca*).—This montane and cismontane species has become established at other desert locations in California (Stebbins 2003). Two iNaturalist records are from residential Palm Springs and the City of Thousand Palms, both in 2017. Well-irrigated landscaping and ponds for breeding may allow this species to become established in the Coachella Valley.

Couch's Spadefoot (*Scaphiopus couchii*).—The California Natural Diversity Database (CNDDDB) has two recent sight records of this species in appropriate habitat in Riverside County at the southeastern edge of the Coachella Valley from 1993 and 2007, and a 2007 record in nearby Imperial County. The two Riverside County locations are adjacent to the Coachella Canal, suggesting this species is following the same conduit northward as RGLF and other herpetofauna. Potential breeding habitat is found along the Coachella Canal where rainwater backs up against the berms. The 1993 CNDDDB record reports breeding on 2 March, but this would be very unusual for what is an obligate summer breeder throughout its range. Nonetheless, establishment should be looked for in flooded desert habitat at the edges of the lower Coachella Valley.

African Clawed Frog (Xenopus laevis).—The California Department of Fish and Wildlife has received unverified reports of this species in the Coachella Valley, and it has been documented once from Imperial County (USFWS 2017). Clawed frogs were introduced into the United States in large numbers in the 1930s-1940s for medical use, laboratory study, and the pet trade, and since 1968 have become broadly established in coastal and inland southern California as well as Tucson, Arizona (Dodd 2013, USFWS 2017). Due to the ability of this species to tolerate elevated temperatures and brackish and poor-quality water (Munsey 1972), it would not be surprising if this species is eventually found in the Coachella Valley.

DISCUSSION

The Coachella Valley herpetofauna is a mix of species of different origins, most of which were either native to or introduced to the lower Colorado River Valley (LCRV). At least some of the species native to the LCRV also ranged westward to the Imperial Valley (see Figure 1). Great Plains Toad, Woodhouse's Toad, Sonoran Desert Toad (*Incilius alvarius*), Lowland Leopard Frog (*Lithobates yavapaiensis*), and Checkered Gartersnake may have arrived when the Colorado River flooded through a partially constructed canal in 1905-1906, entering the Imperial Valley and creating what is now the Salton Sea (McCullum 2000). However, several natural flooding events from the Colorado River into the Salton Sink took place during the 1800s and earlier. The Colorado overflowed into the Salton Sink in 1840, 1849, 1852, 1859, 1867, and in 1891 when a 48 km-long temporary lake formed (Ibid.). As described by T. F. Cronise (1868), in 1840, the Salton Sink was "...partially submerged by the waters of the Colorado. The New River, through which a portion of those waters now finds its way to the sea, had no existence until that year. A number of large lagoons remained for several years after that inundation."

It is not known exactly when these species made it to Imperial County, but most of them either did not spread north to the Coachella Valley or didn't persist there. However, one species, the Great Plains Toad, native to the LRCV (Camp 1915, Grinnell and Camp 1917) has been in the Coachella Valley for at least a century. The first museum record of Great Plains Toad in the region was a series collected by Charles Camp in Mecca in 1908, only three years after the formation of the Salton Sea (Storer 1925). It is possible that this species was able to move the approximately 30 km from northern Imperial County, and then become common enough to be noticed by the collector, all in only two to three years. One of the specimens collected by Camp was an adult measuring 82 mm in length. To reach adult size would take about four years (Ibid.) meaning that juvenile toads or large tadpoles would have to have been swept all the way to Mecca in 1905 when the Colorado River flowed into the Salton Sink.

A more plausible explanation for Great Plains Toad entering the Coachella Valley is entry during one or more of the natural flooding events in the 1800s or earlier, which would make it a species native to the Coachella Valley. Great Plains Toads could have survived dry periods in habitat afforded by temporary pools and permanent springs. Along the western edge of the Coachella and Imperial Valleys the 1853-54 Blake expedition (Blake 1858), encountered native Americans using spring water to grow crops and found "...a dense growth of weeds over a wide area near the mountains...The ground upon which they grew was moist and miry being supplied with water by numerous springs."

Indeed, Lowland Leopard Frog, previously known from the isolated San Felipe Springs on the western edge of the Salton Sink may have been a relic from earlier contact with the Colorado River system, perhaps from Lake Cahuilla, one of the major predecessors of the Salton Sea (Ruibal 1959).

The completion of the All-American Canal in 1940 and the Coachella Canal in 1948 to bring water from the Colorado River (Imperial Irrigation District 2018) facilitated the spread of other species up into the Coachella Valley. Between 1948 and 2007 much of the Coachella Canal was unlined (San Diego County Water Authority 2016), adding potential breeding habitat to the possibility of passive transport.

Woodhouse's Toad was found in the early 1900s in the Imperial Valley, (e.g. 1929, El Centro, CAS-SU(Amp) 3033-34) and was collected at Harpers Well in 1939 in the vicinity of San Felipe Creek, upstream from cultivated land in the western Imperial Valley (MVZ 31539). The only record for the Coachella Valley in Glaser (1970) is from Mecca. It is undated but can be assumed to be from the 1960s as Glaser believed Woodhouse's Toad was just beginning to enter Riverside County from Imperial County. The earliest museum records for this species in the Coachella Valley are from 1962, North Shore, LACM 88516; 1963, Mecca, LACM 88518 and Indio, LACM 88517. There are many subsequent records. Numerous collections of Great Plains Toads in the Coachella Valley from the 1930s to the 1960s are not paralleled with records of Woodhouse's Toads, suggesting a lack of collecting effort does not explain the lack of pre-1960s Woodhouse's Toads in museum collections. It appears this species did not get established or persist in the Coachella Valley with the 1905-06 or earlier floodwaters that created temporary wetlands in the Salton Sink. It is now widely distributed in the Coachella Valley.

The history of American Bullfrog's initial entry into southeastern California has been well-documented (Dill 1944) and summarized (Jennings and Hayes 1994). Bullfrogs were introduced deliberately to the LCRV in the 1920s and expanded rapidly from the 1930s to the 1950s. We suspect this species has taken the same route to the Coachella Valley as other riparian species, namely, the canals from the Colorado River and agricultural land in Mexico and Imperial County. However, bullfrogs quickly became so common in coastal southern California and elsewhere in the state that we cannot rule out direct introductions to the Coachella Valley in the latter half of the 20th century. By the late 1960s, it had colonized the Imperial Valley, but there was no evidence of the species in the Coachella Valley at that time (Stebbins 1966). Similarly, Glaser (1970) does not list this species in the Coachella Valley, and museum searches for specimens from that era were negative. Stebbins (1985) indicated bullfrogs had finally made it to the Coachella Valley, where they are now widespread.

Spiny Softshells were introduced to the Colorado and Gila rivers in Arizona around 1900 (Miller 1946, Bury and Luckenbach 1976). From the Colorado River, they presumably moved through irrigation canals and/or the New and Alamo Rivers from Mexico to Imperial County. Museum records show that this species had colonized the Imperial Valley by the 1940s and 1950s. Examples include 1942-45, Calipatria, CAS-SU 11755; 1952, shore of Salton Sea near Mullet Island, CAS-SU 15143; and 1955, 5 km NE of Holtville, MVZ 78792. Softshells only recently spread from the Imperial Valley up to the Coachella Valley in Riverside County. Glaser (1970) reports no records from Riverside County, but that "...a dead softshell was noted by Dr. Ernest Karlstrom in 1956 on the southeastern shore of the Salton Sea, about 12 miles south of the Riverside County Line." Stebbins (2003) does not

list spiny softshell as occurring north of the Imperial Valley, but California Department of Fish and Game (2005) lists this species in both Imperial and Riverside counties around the Salton Sea. We found this turtle now occupies the Coachella Canal, the lower Whitewater River, and drains feeding into the Salton Sea.

Red-eared Sliders are native to the southeastern United States. This turtle has been introduced around the world through the pet trade, including the Pacific slope of California where it often occurs in urban areas (Ernst and Lovich 2009). Most introductions are considered to be individuals released into ponds and reservoirs by pet owners (Spinks et al. 2003). The question of whether these turtles are breeding in the wild is complicated by continued releases of sliders by pet owners. Breeding in California is perhaps more often assumed than proven (e.g. California Department of Fish and Wildlife undated) though breeding has been confirmed in northern California (Bettelheim et al. 2006), and we documented attempted breeding in the Coachella Valley.

Evidence suggests the Checkered Gartersnake is a very recent addition to the Coachella Valley. They are native to the lower Colorado River (Yarrow 1882 cited in Grinnell and Camp 1917): specimen from 1855, Fort Yuma, USNM852. The first published record for the Coachella Valley is from Mecca in 1997 (Hollingsworth and Prosser 1997) about 2 km from the Coachella Canal. This species probably entered the Coachella Valley through the Coachella Canal, but the paucity of records makes it impossible to pinpoint when this species arrived.

Rio Grande Leopard Frog arrived in the Coachella Valley at the turn of the 21st century, with compelling evidence that they came via the Coachella Canal. From its first discovery in 1981 near Yuma, Arizona on the lower Colorado River (Platz et al. 1990), RGLF was subsequently found in Imperial County in farmland in the LCRV (Clarkson and Rorabaugh 1989) and further west in the Imperial Valley (Jennings and Hayes 1994). Rorabaugh et al. (2002) predicted its spread northward through the Coachella Canal into Riverside County. This species has also moved up the Salt and Gila Rivers of Arizona from the LCRV (Ibid.). We have shown in Results that RGLF is now well-established in the Coachella Valley where it has room and habitat to expand further.

Wildlife biologists have tried to control numbers of bullfrog at Dos Palmas because of their potential predation on desert pupfish. Preserve managers must now contemplate the potential risks of both species of introduced frogs. Adult RGLF in Arizona were found to feed predominantly on invertebrates and often on young leopard frogs but not fish (Platz et al. 1990), and in Texas they fed almost exclusively on terrestrial invertebrates (Parker and Goldstein 2004). Thus, they might not pose a serious threat to Desert Pupfish, which so far persist at Dos Palmas despite the presence of both species of frogs (J. Miner, Bureau of Land Management, personal communication). On the other hand, bullfrogs occasionally feed heavily on Desert Pupfish (Marsh and Sada 1993) despite few examples of predation on fish reported in prey studies of bullfrogs (e.g., Korschgen and Moyle 1955, Stewart and Sandison 1972, Clarkson and deVos Jr. 1986, Casper and Hendricks 2005). Similarly, RGLF, as generalist feeders, might prey on Desert Pupfish under certain conditions. The presence of RGLF at Dos Palmas and in drains at the edge of the Salton Sea therefore potentially puts Desert Pupfish at risk.

We have no evidence that RGLF has negatively affected the other anurans in the Coachella Valley, most of which are non-natives. While there is no immediate risk to native anurans from the colonization of the Coachella Valley by RGLF, there are still potential

future impacts. The Lowland Leopard Frog is the only native ranid previously known from extreme southeastern California, but it is now considered extirpated from the state (Black 1980, Sredl 2005). Lowland Leopard Frog probably declined or disappeared from the LCRV and the Imperial Valley before RGLF became established (Vitt and Ohmart 1978, Jennings and Hayes 1994, Jennings and Fuller 2004, Thomson et al. 2016). Nonetheless, RGLF is considered a competitive risk in Arizona, where it is encountering native ranids in the Gila and Salt River drainages, to Lowland Leopard Frog in particular (Rorabaugh et al. 2002). In some areas of Texas, RGLF is sympatric with other leopard frog species without hybridization (Hillis 1981), but in other areas they hybridize with Southern Leopard Frogs, (*Lithobates sphenocephalus*) (Kocher and Sage 1986) and Plains Leopard Frogs (*Lithobates blairi*) (Platz 1972). Local displacement of Plains Leopard Frog by RGLF was documented in Texas (Platz 1981).

Whether or not RGLF will displace or otherwise negatively affect native foothill anurans is a question that has not been tested. The recent reappearance of the federally Threatened California Red-legged Frog (*Rana draytonii*) at the Whitewater Preserve, (Backlin et al. 2017) only about 23 km upstream from Palm Springs may be a test of possible negative effects of the spread of RGLF. The dispersal ability of RGLF is impressive: colonization of a water tank 1.6 km from the nearest water source was documented in Arizona (Rorabaugh 2005), and RGLF moved an estimated 16 km/year along intermittent reaches of the Gila River (Platz et al. 1990). As pointed out by J. Rorabaugh (personal communication) colonization of Whitewater Canyon could facilitate eventual spread throughout the foothills of the San Bernardino Mountains and eventually the coastal slope of California where it could encounter a variety of native anurans. The coastal slope could also be reached westward through San Geronio Pass.

If RGLF continues to spread in the densely populated northern Coachella Valley, the chance of intentional or unintentional transport by people increases. RGLF is continuing to spread in the American Southwest and should be monitored closely.

Within the Coachella Valley, the riparian herpetofauna may eventually change in species composition through competition, habitat changes, and additional introductions. Colonization of the valley floor by native foothill species should be looked for in the future, as well as spread of valley species into the foothills.

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LITERATURE CITED

- BACKLIN, A. R., J. Q. RICHMOND, E. A. GALLEGOS, C. K. CHRISTENSEN, AND R. N. FISHER. 2017. An extirpated lineage of a threatened frog species resurfaces in southern California. *Oryx* 52:718-722.
- BETTELHEIM, M. P., R. B. BURY, L. C. PATTERSON, AND G. M. LUBCKE. 2006. *Trachemys scripta elegans* (Red-eared Slider) Reproduction. *Herpetological Review* 37:459-460.
- BLACK, G. F. 1980. Status of the Desert pupfish (*Cyprinodon macularius*) in California. California Department of Fish and Game, Inland Fisheries Endangered Species Program, Species Publication 80-1.
- BLAKE, W. P. 1858. Report of a geological reconnaissance in California. H. Bailliere, New York, New York, USA.
- BURY, R. B., AND R. A. LUCKENBACH. 1976. Introduced amphibians and reptiles in California. *Biological Conservation* 10:1-14.
- CALIFORNIA DEPARTMENT OF FISH AND GAME. 2005. Spiny softshell *Trionyx spiniferus*. California Wildlife Habitat Relationships. [web application] California Department of Fish and Game. California Interagency Wildlife Task Group. 2005. California Wildlife Habitat Relationships Version 8.1 Sacramento, California. Available from: <http://www.dfg.ca.gov/biogeodata/cwhr/cawildlife.aspx>
- CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE. Undated. Invasive Species Fact Sheet. Red-eared Slider, *Trachemys scripta elegans*. Available from: <https://www.wildlife.ca.gov/Conservation/Invasives/Species>
- CAMP, C. L. 1915. *Batrachoseps major* and *Bufo cognatus californicus*, new Amphibia from southern California. University of California Publications in Zoology 12:327-334.
- CASPER, G. S., AND R. HENDRICKS. 2005. *Rana catesbeiana* Shaw, 1802, American bullfrog. Pages 540-546 in M. J. Lannoo, editor. Amphibian Declines: The Conservation Status of United States Species. University of California Press, Berkeley, California, USA.
- CLARKSON, R. W., AND J. C. DEVOS, JR. 1986. *Rana catesbeiana* Shaw, in the lower Colorado River, Arizona-California. *Journal of Herpetology* 20(1):42-49.
- CLARKSON, R. W., AND J. C. RORABAUGH. 1989. Status of leopard frogs (*Rana pipiens* Complex: Ranidae) in Arizona and southeastern California. *The Southwestern Naturalist* 34:531-538.
- CRONISE, T. F. 1868. The Natural Wealth of California. H.H. Bancroft and Company, San Francisco, California, USA.
- CROTHER, B. I. 2017. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. Eighth Edition. Herpetological Circular No. 43, Society for the Study of Amphibians and Reptiles.
- DILL, W. A. 1944. The fishery of the Lower Colorado River. *California Fish and Game* 30:109-211.
- DODD, C. K., JR. 2013. Frogs of the United States and Canada, Volumes 1-2. Johns Hopkins University Press, Baltimore, Maryland, USA.
- DOWNES, M. 2015. How green is our valley. Palm Springs Life. Available from: <https://>

www.palmspringslife.com/how-green-is-our-valley-2/

- ERNST, C. H., AND J. E. LOVICH. 2009. Turtles of the United States and Canada. Second Edition. Johns Hopkins University Press, Baltimore, Maryland, USA.
- GLASER, H. S. R. 1970. The distribution of amphibians and reptiles in Riverside County, California. Natural History Series 1. Riverside Museum Press, Riverside, California, USA.
- GRINNELL, J., AND C. L. CAMP. 1917. A distributional list of the amphibians and reptiles of California. University of California Publications in Zoology 17:127-208.
- HILLIS, D. M. 1981. Premating isolating mechanisms among three species of the *Rana pipiens complex* in Texas and southern Oklahoma. Copeia 1981:312-319.
- HOLLINGSWORTH, B., AND T. R. PROSSER. 1997. *Thamnophis marcianus marcianus* (checkered garter snake). USA: California: Riverside County. Herpetological Review 28(4):211.
- IMPERIAL IRRIGATION DISTRICT. 2018. All-American Canal. Available from: <https://www.iid.com/water/water-transportation-system/colorado-river-facilities/all-american-canal>
- JENNINGS, M., AND M. FULLER. 2004. Origin and distribution of leopard frogs, *Rana pipiens complex*, in California. California Fish and Game 90:119-139.
- JENNINGS, M., AND M. HAYES. 1994. Decline of native ranid frogs in the desert Southwest. Pages 183-211 in P. R. Brown, and J. W. Wright, editors. Herpetology of the North American Deserts. Special Publication Number 5, Southwestern Herpetologists Society, Van Nuys, California, USA.
- KEENEY, S. 2012. Desert pupfish (*Cyprinodon macularius*). California Department of Fish and Wildlife. Available from: <https://www.wildlife.ca.gov/Regions/6/Desert-Fishes/Desert-Pupfish>
- KOCHER, T. D., AND R. D. SAGE. 1986. Further genetic analysis of a hybrid zone between leopard frogs (*Rana pipiens complex*) in central Texas. Evolution 40:21-33.
- KORSCHGEN, L. J., AND D. L. MOYLE. 1955. Food habits of the bullfrog in Central Missouri farm ponds. American Midland Naturalist 54:332-341.
- LOVICH, R., R. MASON, A. P. PESSIER, AND B. CLAYPOOL. 2008. Infection with the fungus *Batrachochytrium dendrobatidis* in a non-native *Lithobates berlandieri* below sea level in the Coachella Valley, California, USA. Herpetological Review 39:315-317.
- MARSH, P. C., AND D. W. SADA. 1993. Desert Pupfish Recovery Plan. Region 2, U.S. Fish and Wildlife Service, Albuquerque, New Mexico, USA.
- MCCOLLUM, A. 2000. The Salton Basin: An Historical Chronology. [web application]. 2000. The Salton Sea Authority. Available from: <http://home.att.net/~amcimages/saltonbasin.html>
- MILLER, R. R. 1946. The probable origin of the soft-shelled turtle in the Colorado River Basin. Copeia 1946:46.
- MUNSEY, L. D. 1972. Salinity tolerance of the African clawed frog, *Xenopus laevis*, Copeia 1972:584-586.
- PARKER, M. L., AND M. I. GOLDSTEIN. 2004. Diet of the Rio Grande leopard frog (*Rana berlandieri*) in Texas. Journal of Herpetology 38:127-130.
- PLATZ, J. E. 1972. Sympatric interaction between two forms of leopard frog (*Rana pipiens complex*) in Texas. Copeia 1972:232-240.

- PLATZ, J. E. 1981. Suture zone dynamics: Texas populations of *Rana berlandieri* and *Rana blairi*. *Copeia* 1981:733–734.
- PLATZ, J. E., R. W. CLARKSON, J. C. RORABAUGH, AND D. M. HILLIS. 1990. *Rana berlandieri*: recently introduced populations in Arizona and southeastern California. *Copeia* 1990:324–333.
- RORABAUGH, J. C. 2005. *Rana berlandieri* Baird, 1854(a), Rio Grande leopard frog. Pages 530–532 in M. J. Lannoo, editor. *Amphibian Declines: The Conservation Status of United States Species*. University of California Press, Berkeley, California, USA.
- RORABAUGH, J. C., AND J. SERVOSS. 2006. *Rana berlandieri* (Rio Grande leopard frog). Mexico: Sonora. *Herpetological Review* 37(1):102.
- RORABAUGH, J. C., M. J. SREDL, V. MIERA, AND C. A. DROST. 2002. Continued invasion by an introduced frog (*Rana berlandieri*): southwestern Arizona, southeastern California, and Rio Colorado, Mexico. *Southwestern Naturalist* 47:12–20.
- RUIBAL, R. 1959. The ecology of a brackish water population of *Rana pipiens*. *Copeia* 4:315–322.
- SAN DIEGO COUNTY WATER AUTHORITY. 2016. Canal Lining Projects. Available at: <https://www.sdcwa.org/canal-lining-projects>
- SPINKS, P. Q., G. B. PAULY, J. L. CRAYON, AND H. B. SHAFFER. 2003. Survival of the western pond turtle (*Emys marmorata*) in an urban California environment. *Biological Conservation* 113:257–267.
- SREDL, M. J. 2005. *Rana yavapaiensis* Platz and Frost, 1984, lowland leopard frog. Pages 596–599 in M. J. Lannoo, editor. *Amphibian Declines: The Conservation Status of United States Species*. University of California Press, Berkeley, California, USA.
- STEBBINS, R. C. 1966. *A Field Guide to Western Reptiles and Amphibians*. Houghton-Mifflin Co., Boston, Massachusetts, USA.
- STEBBINS, R. C. 1985. *A Field Guide to Western Reptiles and Amphibians*. Second Edition. Houghton-Mifflin Co., Boston, Massachusetts, USA.
- STEBBINS, R. C. 2003. *Western Reptiles and Amphibians*, Third Edition. Houghton Mifflin Company, Boston, Massachusetts and New York, New York, USA.
- STEWART, M. M., AND P. SANDISON. 1972. Comparative food habits of sympatric mink frogs, bullfrogs and green frogs. *Journal of Herpetology* 6:241–244.
- STORER, T. I. 1925. A synopsis of the amphibia of California. University of California Publications in Zoology 27:1–343.
- SULLIVAN, B. K. 2005. *Bufo woodhousii* Girard, 1854, Woodhouse's Toad. Pages 438–440 in M. J. Lannoo, editor. *Amphibian declines. The conservation status of United States species*. University of California Press, Berkeley, California, USA.
- THOMSON, R. C., A. N. WRIGHT, AND H. B. SHAFFER. 2016. California Amphibian and Reptile Species of Special Concern. California Department of Fish and Wildlife and University of California Press, Oakland, California, USA.
- USCD (U.S. CLIMATE DATA). 2018. Version 2.3. Available from: <http://www.usclimatedata.com>
- UNITED STATES FISH AND WILDLIFE SERVICE. 2017. African clawed frog (*Xenopus laevis*) Ecological Risk Screening Summary. Available from: <https://www.fws.gov/fisheries/ans/erss/highrisk/Xenopus-laevis-ERSS-FINAL-Sept-2017.pdf>
- VITT, L. J., AND R. D. OHMART. 1978. Herpetofauna of the Lower Colorado River: Davis Dam to the Mexican border. *Proceedings of the Western Foundation of Vertebrate Zoology* 2(2):35–72.

APPENDIX A. MUSEUM VOUCHER SPECIMENS

Anaxyrus boreas—LACM 160934. Roadkill. Varner Ave., 1.3 mi W of Monroe St., N side of I-10. Indio, Riverside Co., CA, USA. 33.743799°N, -116.256617°W. Coll. D. Woodward, 21 February 2005.

Lithobates berlandieri—LACM 178031. Hwy. 111 between Palm Island Drive and Cleveland St., Mecca, Riverside Co., CA, USA. 33.534206°N, -115.97975°W. Coll. D. Woodward, 06 September 2009. (site R7).

LACM 178032. 0.2 mi. east of Highway 86S on Avenue 81, Oasis, Riverside Co., CA, USA. 33.462534°N, -116.087603°W. Coll. D. Woodward, 07 March 2010. (site R23).

LACM 178033. Coachella Canal, from wildlife drinker, siphon 23, North Shore, Riverside Co., CA, USA. 33.470796°N, -115.750433°W. Coll. M. Wilcox, 05 April 2008. (site R4).

LACM PC 2409. Photo. Irrigation pond, 66th Ave., 2.2 km east of Mecca, Riverside Co., CA, USA. 33.568472°N, -116.053348°W. D. Woodward, 24 October 2007. (site R32).

LACM PC 2410. Photo. East end of irrigation drain, 84th Ave., 5.6 km southeast of Oasis, Riverside Co., CA, USA. 33.441859°N, -116.043466°W. D. Woodward, 27 September 2017. (site 27).

Thamnophis marcianus—LACM 178035. Roadkill, Lincoln Street, 1.7 mi. south of Mecca, Riverside Co., CA, USA. 33.547121°N, -116.079122°W. Coll. D. Woodward, 05 February 2009. (site C3).

APPENDIX B. SPECIFIC SITE LOCATIONS AND DATA

Sites with more than one species are listed under each species found there, i.e., some locations are listed more than once. Coordinates format is decimal degrees. Date format is month/day/year.

SITE	LATITUDE	LONGITUDE	DATE	DESCRIPTION
Rio Grande Leopard Frog				
R1	33.373441	-115.610177	10/07/2005	Tadpoles, one subadult frog in seepage pond, leakage from Coachella Canal, Imperial County, about 10 km southeast of county line.
R2	33.439248	-115.690848	04/05/2008	Five frogs, siphon 21 of Coachella Canal.
R3	33.453935	-115.713531	04/05/2008	Five frogs and egg mass, siphon 22 of Coachella Canal.
R4	33.470796	-115.750433	04/05/2008	One adult, siphon 23 of Coachella Canal. Voucher specimen.
R5	33.503712	-115.830013	several	Dos Palmas Preserve, see Table 1 for dates. RGLF and bullfrogs.
R6	33.534741	-115.97385	09/06/2009	One adult, Cleveland Street ditch, north of Highway 111.
R7	33.534206	-115.97975	09/06/2009	One adult, Highway 111 south of Palm Island Drive, rainy night. Voucher specimen.
R8	33.550376	-116.017809	03/07/2010	One juvenile, Wheeler Street, 500 m south of 68th Avenue, near irrigation pond. Rainy night.
R9	33.554403	-116.036027	03/07/2010	One adult, 68th Avenue at Colfax Street. Rainy night.
R10	33.554718	-116.046815	03/07/2010	One adult, 68th Avenue, 260 m west of Grant Street. Rainy night.
R11	33.561966	-116.009453	03/07/2010	One subadult in irrigation pond, 800 m north of 68th Avenue on Garfield Street.
R12	33.569087	-116.000624	04/12/2008	Several in irrigation pond near Coachella Canal, east end of 66th Avenue.
R13	33.725323	-116.163814	08/23/2012	About 20, mostly juveniles, a few adults. The Vineyards resort. In ponds and on lawns.
R14	33.726748	-116.164187	08/01/2009	Four adults, in grates on Coachella Canal, Dillon Road crossing. None in grates further west, up to Jackson Street.
R15	33.74539	-116.212003	08/29/2012	Several adults and subadults, Indio public golf course, in pond near entrance.
R16	33.747948	-116.212473	08/29/2012	Several adult RGLF and subadult bullfrogs, north edge of Indio public golf course, seep ponds with overflow from golf course plus recent rainfall.
R17	33.726388	-116.253049	08/29/2012	One RGLF calling, one bullfrog seen, leakage seep from Coachella Canal, 350 m southeast of Fred Waring Drive.
R18	33.723652	-116.251809	09/13/2011	Several frogs in La Hacienda plant nursery, Miles Street, near cattail-filled pond.

SITE	LATITUDE	LONGITUDE	DATE	DESCRIPTION
R19	33.722166	-116.254334	09/13/2011	Dozens of subadults and juveniles, exiting plant nursery on Miles Street, three on bank down to Whitewater channel, no frogs in channel puddles below bridge. Rainy night.
R20	33.525526	-116.177338	05/20/2009	Four subadults, west end of 72nd Avenue, in irrigation pond.
R21	33.462559	-116.100051	09/05/2009	One juvenile and one adult on 81st Avenue, 260 m west of Harrison Street, by fish farm. Rainy night.
R22	33.462803	-116.094784	07/10/2011	One subadult, 81st Avenue and Buchanan Street, on bank of irrigation pond.
R23	33.462503	-116.087363	03/07/2010	One adult, 350 m east of Highway 86S on 81st Avenue. Near date grove, rainy night. oucher specimen.
R24	33.455545	-116.088069	07/30/2009	One adult RGLF in irrigation pond, 82nd Avenue, just east of Highway 86S. Eight Woodhouse's Toads, some calling.
R25	33.448161	-116.061219	03/07/2010	Two adults, 83rd Avenue and Johnson Street. Rainy night.
R26	33.462629	-116.059949	09/29/2017	Four (2 adults, 2 subadults), east end of 81st Avenue, edge of drain, from end of pavement down to dense cattails.
R27	33.441859	-116.043466	09/29/2017	One large juvenile, end of 84th Avenue at lower end of cattails, just before the drain opens to the Salton Sea shore. Photo voucher.
R28	33.568757	-116.10771	09/29/2017	Three juveniles, Whitewater River, bank openings downstream from 66th Avenue bridge.
R29	33.629336	-116.095153	10/05/2017	Four juveniles, Buchanan Street, 190 m north of 58th Avenue, in irrigation pond.
R30	33.642229	-116.091074	10/05/2017	One juvenile, east end of Airport Boulevard, on bank of Coachella Canal.
R31	33.531736	-116.093205	07/18/2018	About 40 RGLF, all ages, hunt club, Mecca, 71st Avenue and Buchanan Street. A few bullfrogs also present.
R32	33.568472	-116.053348	Several, duration of study	Several, in irrigation pond 2.2 km east of Mecca, 66th Avenue at Euclid Street, several dates. RGLF photo voucher on 24 September 2007. Same site as G4, A3, W5.
American Bullfrog				
A1	33.423123	-115.682425	04/26/2003	One, Hot Mineral Spa Road in Imperial County, in small pond.
A2	33.503712	-115.830013	05/10/2005	Dos Palmas Preserve, see Table 1 for dates, bullfrogs and RGLF.
A3	33.568472	-116.053348	Several, duration of study	Several, in irrigation pond, 2.2 km east of Mecca, 66th Avenue at Euclid Street, several dates. Same as G4, R32, W5.
A4	33.711119	-116.197108	09/15/2012	A few bullfrogs calling, wildlife ponds adjacent to Indio Water Treatment Plant, no RGLF. Islands of bulrushes.

SITE	LATITUDE	LONGITUDE	DATE	DESCRIPTION
A5	33.747948	-116.212473	08/29/2012	Several, different ages, north edge of Indio public golf course in shallow overflow ponds.
A6	33.726388	-116.253049	08/29/2012	One bullfrog, one RGLF, leakage seep from Coachella Canal, 350 m southeast of Fred Waring Drive. Same location as R17.
A7	33.724954	-116.254269	08/29/2012	Two adults, Whitewater River, 480 m south of Fred Waring Drive, seep with Arrowweed and cattails.
A8	33.717504	-116.299602	09/14/2011	Four, Whitewater River seep, 420 m west of Washington Street. After summer rain, extensive marshy habitat.
A9	33.734501	-116.355949	09/15/2011	Three adults, Whitewater River channel, Cook Street, seep just below road crossing.
A10	33.735408	-116.360823	09/29/2017	Five adults, Whitewater River channel, seep upstream from Cook Street.
A11	33.736231	-116.365157	09/15/2011	One subadult, Whitewater River channel, Cook Street, uppermost seep.
A12	33.744513	-116.40779	09/14/2011	Five heard calling, Whitewater River channel, just below Bob Hope Drive.
A13	33.7463	-116.411553	09/14/2011	About 25 small bullfrog tadpoles, Whitewater River channel, seep above Bob Hope Drive.
A14	33.643563	-116.272286	07/20/2011	Several heard calling, 600 m north of Lake Cahuilla in cattail-lined pond.
A15	33.541551	-116.098351	05/12/2007	Sixty-five bullfrogs (no RGLF), fish farm along Highway 86S at 72nd Avenue.
A16	33.511668	-116.095572	03/07/2010	Thirteen juveniles on road at night, near hunt club pond on Buchanan Street, 150 m north of 74th Avenue.
A17	33.524658	-116.078981	05/02/2009	Multiple observations, Lincoln Street crossing, Whitewater River. Listed date is one of many.
A18	33.529445	-116.06129	08/09/2009	Bullfrogs encountered multiple times, Johnson Street ditch, west from Highway 111. Listed date is one of many.
A19	33.723761	-116.322089	11/05/2017	Twenty-three juveniles, Whitewater River channel, below Renaissance Esmeralda Resort, 450 m west of Miles Avenue. Cattails and open water.
A20	33.531736	-116.093205	07/18/2018	Four adult bullfrogs with many RGLF, hunt club, Mecca. 71st Avenue and Buchanan Street.
Great Plains Toad				
G1	33.491745	-116.11798	07/30/2009	Ten adults, 77th Avenue, 500 m west of Pierce Street, date grove under flood irrigation.
G2	33.499228	-116.129511	07/30/2009	Six adults (also 20 Woodhouse's Toads), Fillmore Street and 86th Avenue. Great Plains Toads in clumps of flooded grass in recently filled irrigation pond.
G3	33.525295	-116.082995	03/10/2008	Chorus heard west of Whitewater River at Lincoln Street, habitat unknown.

SITE	LATITUDE	LONGITUDE	DATE	DESCRIPTION
G4	33.568472	-116.053348	Several, duration of study	Several calling adults, irrigation pond 2.2 km east of Mecca, 66th Avenue at Euclid Street, Same as R32, A3, W5.
G5	33.568815	-116.185153	07/30/2009	Chorus of about twelve, 66th Avenue, 100 m west of Harrison Street, in date grove.
G6	33.569471	-116.204952	07/30/2009	Chorus of about 6, 66th Avenue 800 m east of Jackson Street, in flooded date grove.
G7	33.613025	-116.206984	07/30/2009	One adult, 60th Avenue and Calhoun Street, next to date groves.
G8	33.618961	-116.122224	05/05/1995	Chorus, Oasis Date Gardens, Highway 111, vicinity of 59th Avenue, Thermal, in flooded date grove and in nearby puddles.
G9	33.628319	-116.09446	08/01/2009	Adults and tadpoles, 58th Avenue and Buchanan Street, vineyard with flooded furrows. Citrus and field crops nearby.
G10	33.7463	-116.411553	09/14/2011	One adult, Whitewater River channel, 350 m upstream from Bob Hope Drive. Recent rains, grassy habitat.
Woodhouse's Toad				
W1	33.423123	-115.682425	04/26/2003	Hundreds of tadpoles and new toadlets, irrigation drain at end of Palm Island Drive, on wet sand, Salton Sea shore.
W2	33.503712	-115.830013	03/07/2010	One, South end of Palm Island Drive, rainy night.
W3	33.538519	-115.973864	03/30/2002	One adult, Cleveland Street ditch north of Highway 111. Three on 09/07/2002.
W4	33.537387	-116.017778	03/07/2010	One adult, Wheeler Street, 300 m south of 70th Avenue. Rainy night.
W5	33.568472	-116.053348	08/01/2009	Several adults, irrigation pond 2.2 km east of Mecca, 66th Avenue at Euclid Street. Same as G4, A3, R32. Several visits.
W6	33.591631	-116.061128	08/29/2012	One adult, Johnson Street 800 m south of 62rd Avenue. Rainy night.
W7	33.612887	-116.060622	03/07/2010	One adult, Johnson Street and 60th Avenue. Rainy night.
W8	33.61327	-116.084706	03/07/2010	One adult, 60th Avenue 640 m west of Lincoln Street. Rainy night.
W9	33.629336	-116.095153	08/01/2009	Twenty adults, Buchanan Street at 58th Avenue, irrigation pond, same as R29.
W10	33.656628	-116.104464	08/01/2009	One on road, east end of 54th Avenue, vineyards.
W11	33.734501	-116.355949	10/05/2017	One subadult Woodhouse's Toad, four adult bullfrogs, Cook Street seep, Whitewater River channel.
W12	33.736231	-116.365157	10/05/2017	One subadult, upper Cook Street seep.
W13	33.605441	-116.365157	02/21/2005	One, 160 m east of Monroe Street on 61st Avenue. Recent rains.

SITE	LATITUDE	LONGITUDE	DATE	DESCRIPTION
W14	33.598199	-116.245097	02/21/2005	One, 62nd Avenue, 100 m east of Madison Street. Recent rains.
W15	33.525526	-116.177338	05/20/2009	Woodhouse's Toads calling from irrigation pond west end of 72nd Avenue, Same as R20.
W16	33.510651	-116.145933	07/30/2009	Two on 74th Avenue, 130 m east of Polk Street.
W17	33.503476	-116.147456	03/07/2010	One adult, Polk Street, 750 m south of 74th Avenue, rainy night.
W18	33.503476	-116.129511	07/30/2009	Twenty Woodhouse's Toads and six Great Plains Toads at irrigation pond, Fillmore Street 500 m north of 76th Avenue. Same as G2.
W19	33.523156	-116.095564	05/02/2009	One adult on road, 3 calling, Buchanan Street and 72nd Avenue, hunt club ponds.
W20	33.53761	-116.061241	09/10/2004	Two, Johnson Street ditch, south of Highway 111, near cattails.
W21	33.554616	-116.094793	02/21/2005	Two, on Highway 86S at 68th Avenue. Recent rains.
W22	33.462517	-116.116573	03/07/2010	One immature, 81st Avenue 370 m west of Pierce Street.
W23	33.462598	-116.09151	07/30/2009	One adult on 81st Avenue at Highway 86S. Also 02/21/2005, one in front of Oasis Palms RV Park, 100 m to the west. No recent rain.
W24	33.45565	-116.088069	07/30/2009	Eight Woodhouse's Toads, some calling, in irrigation pond at west end of 82nd Avenue. One adult RGLF also.
W25	33.45565	-116.086927	07/30/2009	One adult calling in pond, 100 m east of site W24.
W26	33.454584	-116.07868	07/30/2009	One, Lincoln Street near 82nd Avenue.
W27	33.441151	-116.070173	07/30/2009	Two calling, irrigation pond, 84th Avenue 440 m east of Highway 86S.
W28	33.440901	-116.065095	07/30/2009	Three calling, irrigation pond, 84th Avenue 380 m west of Johnson Street.
W29	33.440978	-116.061148	09/29/2017	Two adults, 84th Avenue at Johnson Street.
W30	33.441859	-116.043466	09/29/2017	One large juvenile, east end of 84th Avenue, at end of drain where it opens onto the Salton Sea shore. An adult on barnacle sand nearby. Three adults calling here April 2016.
W31	33.717296	-116.299624	09/14/2011	Two subadult Woodhouse's Toads, four bullfrogs, Whitewater River channel above Washington Street crossing. After summer rain.
W32	33.665024	-116.281483	10/20/2017	One dead on golf pathway, Silver Rock Resort.
W33	33.82396	-116.480536	10/27/2017	One adult in yard, Cimarron Resort, Palm Springs.
W34	33.744674	-116.186492	08/24/2011	iNaturalist photographic record, Indio.
W35	33.778539	-116.247966	04/01/2016	iNaturalist photographic record, Indio Hills.
W36	33.683940	-116.404821	05/19/2014	iNaturalist photographic record, Palm Desert.
W37	33.746816	-116.414503	07/09/2018	iNaturalist photographic record, Rancho Mirage.

SITE	LATITUDE	LONGITUDE	DATE	DESCRIPTION
Spiny Softshell				
SO1	33.521505	-115.839148	12/09/2006	Three adults, siphons 28-29, draining unlined Coachella Canal.
SO2	33.566264	-115.97277	03/01/2009	Three on banks of Coachella Canal, just east of Cleveland Street crossing.
SO3	33.642721	-116.09121	07/07/2005	One on bank of Coachella Canal, Airport Boulevard crossing.
SO4	33.728637	-116.168843	03/04/2009	Three on bank of Coachella Canal, at Dillon Road crossing.
SO5	33.758582	-116.270777	03/04/2009	One on bank of Coachella Canal, east of Madison Street crossing.
SO6	33.694013	-116.247274	08/04/2009	One on bank of Coachella Canal, between 48th-49th Avenues.
SO7	33.682913	-116.251711	08/04/2009	One on bank of Coachella Canal, south of 50th Avenue crossing.
SO8	33.670263	-116.263788	08/02/2009	Two on bank of Coachella Canal, 52nd Avenue crossing.
SO9	33.651664	-116.277034	08/02/2009	One on bank of Coachella Canal, by golf course, southwest of 54th Avenue crossing.
SO10	33.639815	-116.274006	07/20/2011	One on bank of Coachella Canal, 160 m north of Lake Cahuilla.
SO11	33.437695	-116.043473	08/17/2009	Twenty-three adults and large juveniles, no small juveniles, end of 85th Avenue, in irrigation drain.
SO12	33.500318	-116.05452	09/05/2009	One adult, in Whitewater River at mouth.
SO13	33.526241	-116.081357	04/28/2007	Four adults, on sandy bank of Whitewater River above Lincoln Street crossing. Also 3 on 03/23/2008.
SO14	33.716759	-116.194167	09/14/2012	3 adults, Indio Water Treatment Plant outfall, Whitewater River.
Red-eared Slider				
SL1	33.736775	-116.192789	07/08/2011	One, Lago Vista Street and 43rd Avenue, golf course pond.
SL2	33.755844	-116.219285	09/08/2011	One adult sunning on bank of Coachella Canal, west of Jackson Street crossing.
SL3	33.735408	-116.360823	09/29/2017	One large juvenile, Upper Cook Street seep, Whitewater River channel.
SL4	33.730446	-116.380175	10/21/2017	Sixty-five adults and juveniles, Palm Desert Civic Center ponds.
SL5	33.665024	-116.281483	2016-17	Several, Silver Rock Resort, La Quinta. Reported by workers.
SL6	33.80337	-116.493672	10/24/2017	Thirty-one, mostly adults, Taquitz Creek Golf Resort, pond near Water Park.
SL7	33.794719	-116.483958	10/24/2017	Four, Taquitz Creek Golf Resort, small pond near Golf Club Drive and Cree Street.
SL8	33.813517	-116.515785	10/29/2017	Sixteen, all sizes, Compadre Road 265 m south of Ramon Road, Palm Springs. Golf course pond with duckweed.

SITE	LATITUDE	LONGITUDE	DATE	DESCRIPTION
SL9	33.760324	-116.405363	11/05/2017	Five, Eisenhower Medical Center ponds.
SL10	33.807802	-116.511959	12/07/2017	Two adults, pond at Bel Air Greens (abandoned), west of El Cielo Road, 300 m north of East Sonora Road.
SL11	33.982508	-116.532768	03/01/2018	Twenty-three adults and subadults, Mission Springs Golf Resort, Desert Hot Springs, golf course pond.
SL12	33.531736	-116.093205	07/18/2018	One small juvenile, 6 adults, one clutch of eggs, Hunt Club, Mecca, Buchanan Street and 71st Avenue.
SL13	33.823568	-116.480064	08/01/2018	Nine of various sizes, in golf course pond, Cimarron Golf Resort, west end of McCallum Way, Cathedral City.
SL14	33.736828	-116.360803	07/03/2018	Nine, First Tee Golf Course, Cook Street at north edge of Whitewater River channel, Palm Desert.
Checkered Gartersnake				
C1	33.533972	-115.973818	10/19/2002	One immature, Cleveland St. Ditch, north of Highway 111, cattails, other vegetation, shallow water.
C2	33.533126	-116.061128	05/25/2007	DOR, Johnson Street, 780 m south of 70th Avenue, John Green, photo.
C3	33.547121	-116.079122	05/02/2009	DOR, Lincoln Street, 860 m south of 68th Avenue. Voucher specimen.
C4	33.462648	-116.064923	05/17/2008	DOR, 81st Avenue, 330 m west of Johnson Street.
C5	33.462651	-116.077742	03/12/2008	DOR, 81st Avenue, 1.5 km west of Johnson Street. Chet McGaugh. photo.
C6	33.531932	-116.043748	Undated, after 2000	Grant Street drain, J. Crayon, California Department of Fish and Wildlife, personal communication.
C7	33.503712	-115.830013	Undated, 1990s	Dos Palmas Preserve, J. Cornett, Palm Springs Desert Museum, personal communication.

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