

Trough to trough

the Colorado River and the Salton Sea



The 2008 Desert Symposium Field Guide and Proceedings

Robert E. Reynolds, editor

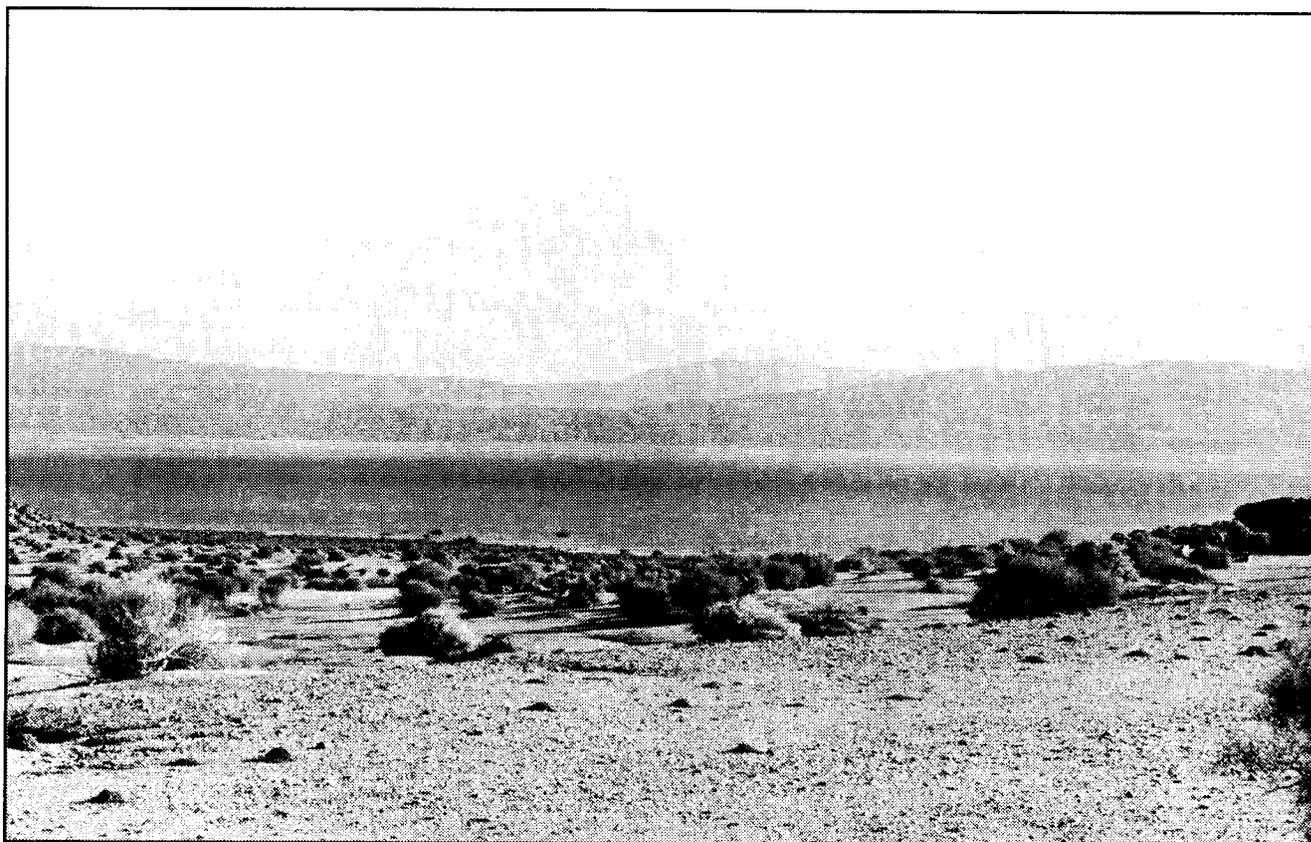
California State University, Desert Studies Consortium and LSA Associates, Inc.

April, 2008

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THE SALTON SEA, 1906

Trough to trough—the field trip guide

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Proceedings of the 2008 Desert Symposium

ROBERT E. REYNOLDS, *compiler*

California State University, Desert Studies Consortium and LSA Associates, Inc.

April 2008

Distribution of native turtles in the arid southwestern United States with comments on *Kinosternon sonoriense*: a species presumed to be lost from California's herpetofauna

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ABSTRACT. The United States has a rich diversity of 55 turtle species, rivaling that of virtually any country. Because of the aridity characterizing the Mojave Desert, Sonoran Desert, northern Baja California, and the Colorado Plateau regions of Arizona, California, and Mexico, only seven native species occur there. Three families are represented including the **Emydidae** or semi-aquatic pond and marsh turtles (Pacific Pond Turtle, *Actinemys marmorata*; Painted Turtle, *Chrysemys picta*; Ornate Box Turtle, *Terrapene ornata*), the **Kinosternidae** or mud turtles (Arizona Mud Turtle, *Kinosternon arizonense*; Yellow Mud Turtle, *K. flavescens*; Sonora Mud Turtle, *K. sonoriense*), and the **Testudinidae** or tortoises (Desert Tortoise, *Gopherus agassizii*). Over half of these species have broad ranges that just enter the area of interest but the Desert Tortoise, Arizona Mud Turtle, and Sonora Mud Turtle have ranges centered on the southwest. The Pacific Pond Turtle has a range focused along the Pacific versant, while the other species have ranges centered more in the humid central and eastern United States. The Sonora Mud Turtle disappeared from the fauna of California sometime after 1960, perhaps due to competition with the introduced Softshell Turtle (*Apalone spinifera*), predation by introduced fish, or because of changes in hydrology due to dam building in the Colorado River Basin. Turtles in the southwest include some of the best-studied species (e.g., Desert Tortoise and Painted Turtle), as well as some of the least-studied (especially the Arizona Mud Turtle).

Introduction

There are about 300 species of turtles in the world (Bickham et al., 2007). They occur on all continents and in all oceans except for in and around Antarctica. From oceans, rivers, and ponds to rugged mountains, humid jungles, and hot deserts, turtles have found a home in all but the coldest and most arid of climates (Hecnar, 1999).

The United States has one of the richest turtle faunas of any country with 55 native species (Ernst and Lovich, in press) and at least two well-established exotic species (Ernst et al., 1994). The greatest turtle diversity in the United States occurs in the Southeast (Buhlmann et al., 2008) with comparatively few species in the Southwest, especially in the Great Basin (Iverson, 1992a), a reflection of the aridity of the region. Despite the relatively low diversity and subsequent reduced research focus on turtles in the southwestern United States, several species are of interest and conservation concern. Our main purpose in this paper is to provide a brief review of the distribution of turtles in the Mojave and Sonoran Deserts in Arizona, California, and northern Mexico to increase awareness of a largely neglected element of biodiversity. We include turtle records from northern Baja California and the Colorado

Plateau due to the arid nature of those adjacent regions. We also discuss the apparent disappearance of the Sonora Mud Turtle (*Kinosternon sonoriense*) from California's fauna, the only turtle species extirpated from a range state in our focus area during historical times. We do not attempt to present and synthesize all of the available literature on southwestern turtles but provide a general overview of their current distributions in the region. The reader is referred to Ernst et al. (1994) and Ernst and Lovich (in press) for the most recent synopses of the ecology, conservation, and fossil records of turtles in the United States.

Materials and methods

We compiled the list of species in the region from distribution maps presented in Iverson (1992b). We compiled museum records using HerpNet (<http://www.herpNet.org>), an online resource with 53 participating natural history museums listing over 5.5 million specimens. Since the Ornate Box Turtle (*Terrapene ornata*), Sonoran Mud Turtle (*K. sonoriense*), and the Desert Tortoise (*Gopherus agassizii*) are well represented in collections, we include museum records for only the other, more poorly represented species. Exact locality data for museum specimens

are not included in this paper, and the following tables use the output as generated by HerpNet. We searched all museums currently listed under HerpNet and collection acronyms follow those posted on HerpNet: CAS—California Academy of Sciences; LACM—Natural History Museum of Los Angeles County; MPM—Milwaukee Public Museum; SDNHM—San Diego Natural History Museum; TCWC—Texas Cooperative Wildlife Collection, Texas A & M University; UAZ—Amphibian and Reptile Collection, University of Arizona; USNM—United States National Museum (Smithsonian). Taxonomy follows Crother (2000) and updates (Crother et al., 2003) as does common name usage.

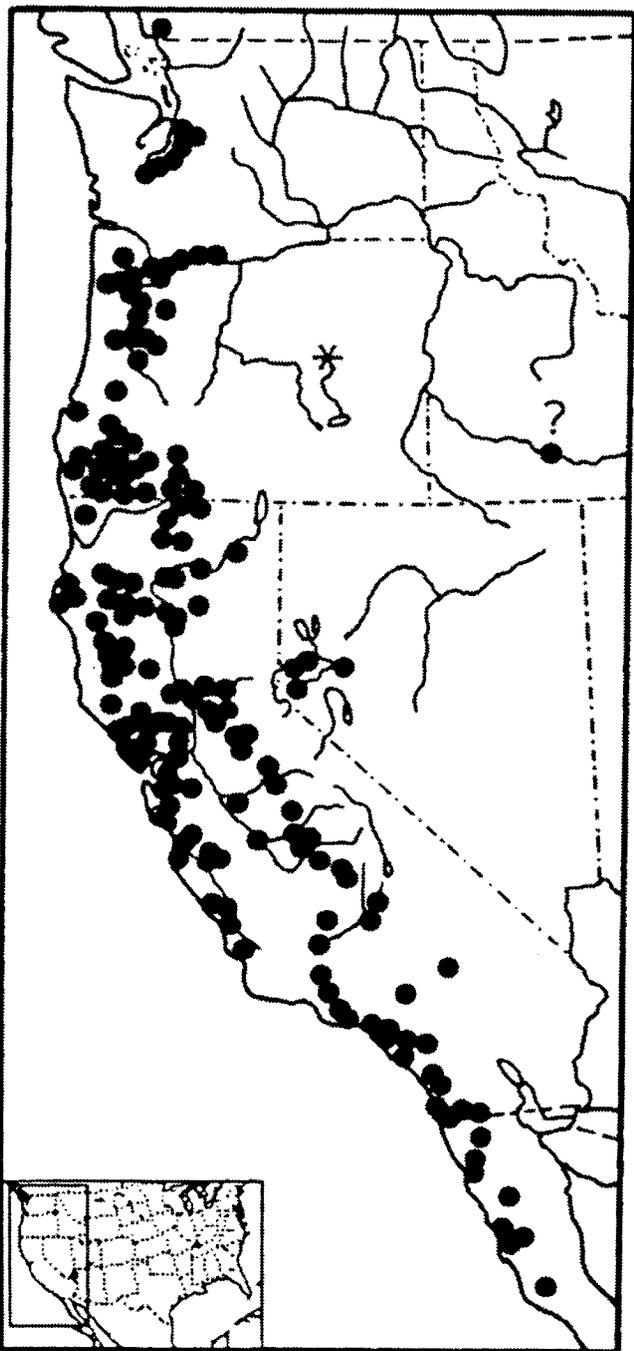


Figure 1. Modern distribution of the Pacific Pond Turtle.

Results

Seven species of turtles representing three families (Emyidae, Kinosternidae, and Testudinidae), and five genera are found in the region of treatment. One species, the Painted Turtle (*Chrysemys picta*), has a distribution in the United States that is primarily eastern with a narrow western extension. The Ornate Box Turtle (*Terrapene ornata*) and Yellow Mud Turtle (*Kinosternon flavescens*) are primarily midwestern species and the Pacific Pond Turtle (*Actinemys marmorata*) is primarily far western. The remainder, including the Desert Tortoise (*Gopherus agassizii*), Arizona Mud Turtle, (*Kinosternon arizonense*) and Sonora Mud Turtle (*K. sonoriense*) are primarily southwestern in their distribution.

FAMILY EMYDIDAE

Actinemys marmorata (Pacific Pond Turtle, formerly *Clemmys marmorata*)

The Pacific Pond Turtle has a long but narrow modern distribution in freshwater (and occasionally brackish) wetlands between the Pacific coastline and the Sierra-Cascade Crest, from northern Baja California, Mexico to Puget Sound, Washington and, formerly, southern British Columbia (Figure 1). Despite this largely Pacific versant distribution, the species ranges into the dry interior of the Great Basin and Mojave deserts in a few locations, including records in the Truckee, Carson, and possibly Humboldt rivers in Nevada, the Columbia Gorge of Washington, and the Mojave River in San Bernardino County, California (Ernst et al., 1994; Ernst and Lovich, in press). In Baja California, the species occurs as far south as Arroyo Grande (Grismer, 2002). The peripheral range of the species may reflect use and translocation by Native Americans due to the presence of pond turtle remains in archaeological sites (Schneider and Everson, 1989).

Fossil remains of *A. marmorata* have been identified from Pliocene (Blancan) and Pleistocene (Irvingtonian, Rancholabrean) deposits in California (Ernst et al., 1994), including the Mojave Desert for the latter (Jefferson, 1968).

Lovich and Meyer (2002) studied the ecology of Pacific Pond Turtles at Camp Cady and Afton Canyon along the Mojave River and reported that these populations exhibit few adaptations that differentiate them from populations occurring in more mesic coastal environments. A notable exception was the fact that terrestrial estivation and hibernation, commonly observed in coastal populations, were not observed in the desert, an obvious response to hyperaridity. A single specimen from Montezuma Well, Yavapai County, Arizona in 2007 (Lovich, unpublished) is likely a result of human introduction, as non-native Red-eared Slider Turtles (*Trachemys scripta elegans*) are also found at the site.

Table 1 contains a partial list of museum records for *A. marmorata* from the area of study. All of the California records are from the Mojave River downstream from Barstow.

Table 1. Selected museum records of *Actinemys marmorata* from the Mojave Desert of California and Baja California.

Institution	Catalog number	Country	State/Province	County	Year collected
LACM	7997	USA	California	San Bernardino	1937
SDNHM	17135	USA	California	San Bernardino	1937
SDNHM	17136	USA	California	San Bernardino	1937
SDNHM	19222	Mexico	Baja California Norte		1957
SDNHM	43635	Mexico	Baja California Norte		1958
SDNHM	46798	Mexico	Baja California Norte		1966
LACM	105322	Mexico	Baja California		
LACM	105323	Mexico	Baja California		1960
UAZ	UAZ 22057	Mexico	Baja California Norte		1952

Chrysemys picta (Painted Turtle)

The Painted Turtle is the only native species of turtle in the United States whose natural distribution is transcontinental, extending from the Atlantic to the Pacific coasts. Their range extends west of the northern Rocky Mountains through Montana, Idaho and into Washington, Oregon and southern British Columbia. Farther south, relict populations and records are reported from restricted portions of southern Utah, Arizona, New Mexico, and Colorado (Figure 2), all of which are represented by the Western Painted Turtle, *C. p. bellii*. The southernmost distribution of the taxon is in northern Chihuahua in the lower portion of the internally draining Rio Santa Maria (Smith and Smith, 1979), and possibly the Rio Grande (Smith and Smith, 1979; Iverson, 1992b).

Brennan and Holycross (2006) state: "Populations in Apache County [Arizona] near St. Johns and Concho might be native" without providing additional details. As recently as 2007, Charles Drost (USGS, pers. comm.) found the shells of two individuals near Lyman Lake, Apache County, Arizona. Given the existence of other populations at various locations throughout the arid western United States and Mexico, it is likely that Painted Turtles are native to Arizona. Early records of *Kinosternon* from southern Utah that were likely Painted Turtles (Iverson, 1978) support this hypothesis. Individuals occurring in and around Phoenix and Tucson, Arizona (including the photographic record from the Tucson area in Table 2—UAZ 55305) are considered released pets. The presence of native Painted Turtles in the San Juan River Basin

of northwestern New Mexico (Degenhardt et al., 1996) and southeastern Utah (Iverson, 1978) may explain the occasional reports of this species on the Colorado Plateau in the Lake Powell region. Drost et al. (in press) summarized literature records (primarily from Woodbury, 1959) for the Lake Powell region including Labyrinth, Face, and Rock Creek canyons. The former two canyons straddle the Arizona/Utah state line with their mouths only 1–2 miles north of Arizona. The latter is contained fully in Utah. Drost et al. concluded that painted turtles occurred in the

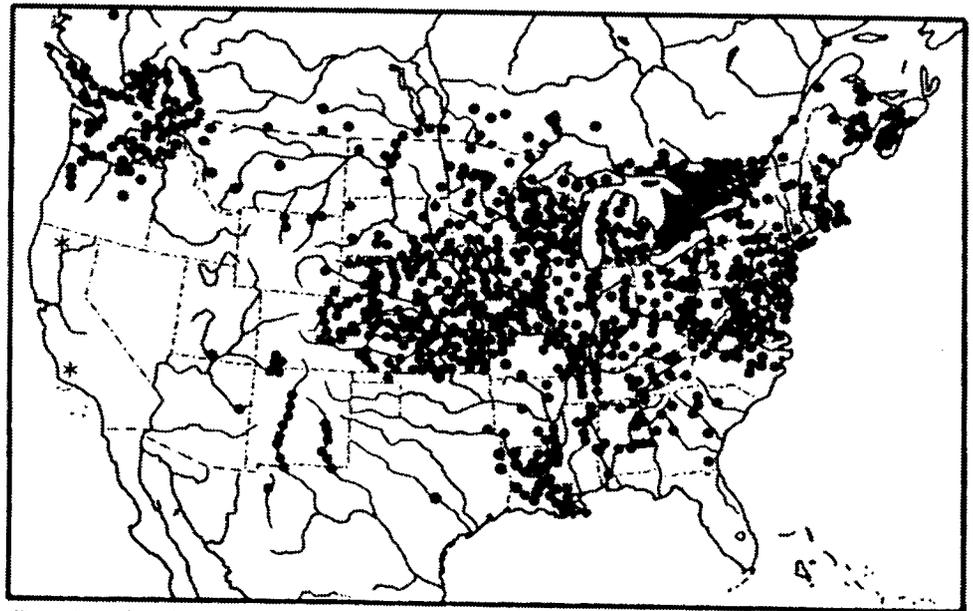


Figure 2. Modern distribution of the Painted Turtle.

Colorado River in Glen Canyon prior to the construction of Glen Canyon Dam (the dam that impounds Lake Powell) with none documented since completion of the dam in 1963. Table 2 lists museum records for Arizona.

Nothing is known of the ecology of this species in Arizona where it occurs primarily in the vicinity of the White

Table 2. Selected museum records of *Chrysemys picta* from Arizona.

Institution	Catalog number	Country	State/Province	County	Year collected
UAZ	UAZ 55305-PSV	USA	Arizona	Pima	2002
CAS	188541	USA	Arizona	Apache	1988
CAS	188542	USA	Arizona	Apache	1988

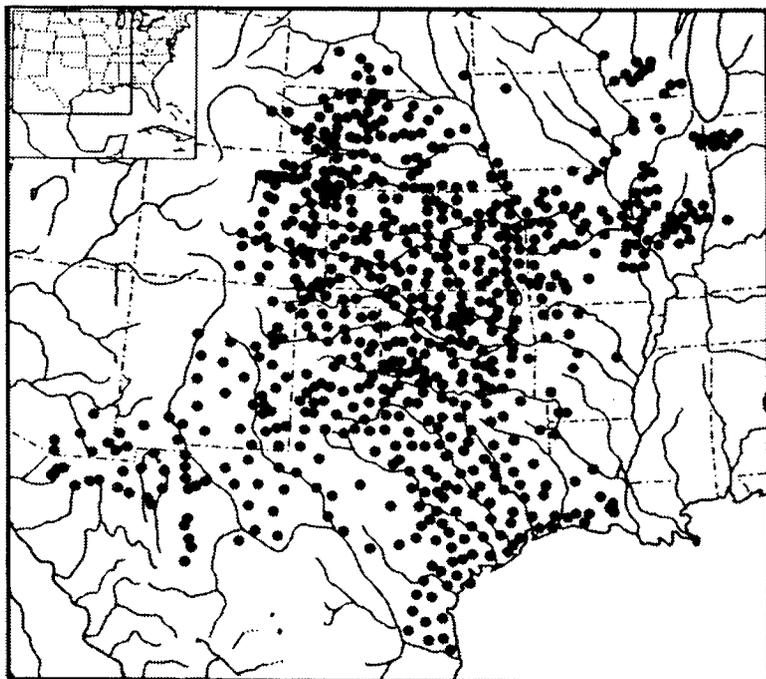


Figure 3. Modern distribution of the Ornate Box Turtle.

Mountains at the periphery of the arid region covered in our paper (except for the Lake Powell records). Although represented by fossil material throughout the eastern United States, we know of no records closer to the Southwest than Texas (Ernst et al., 1994).

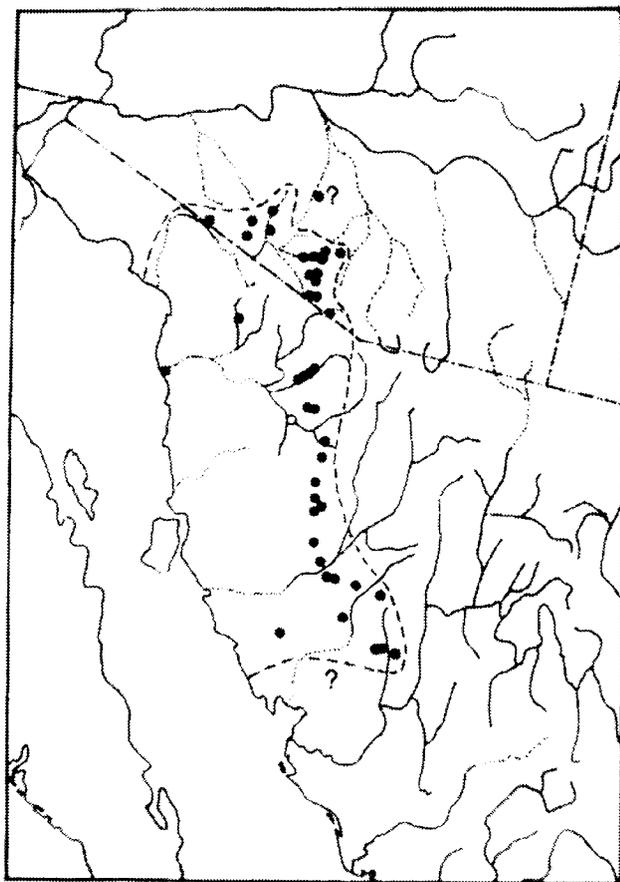


Figure 4. Modern distribution of the Arizona Mud Turtle.

Terrapene ornata (Ornate Box Turtle)

Desert Box Turtles (*T. ornata luteola*) reach their westernmost distribution in southeastern Arizona and northern Mexico (Figure 3), mostly in semidesert grasslands, Chihuahuan desertscrub, lower Madrean evergreen woodland, and rarely in sky island mountain ranges (Brennan and Holycross, 2006) to about 2,200 m elevation (Brennan and Feldner, 2003). Arizona records exist for Cochise, Gila, Pima, Pinal, Santa Cruz, and Graham counties. The records from Navajo County (Petrified Forest) and Maricopa County probably represent released captives.

Pleistocene fossil material and recent archaeological material is known from Arizona (Ernst et al., 1994). The Ornate Box Turtle is well studied and several recent publications document the ecology and behavior of this species in Arizona (Plummer, 2003, 2004; Plummer et al., 2003).

FAMILY KINOSTERNIDAE

Kinosternon arizonense (Arizona Mud Turtle)

The majority of the range of the Arizona Mud Turtle is in Mexico with the northern limit barely extending into southern Arizona (Figure 4). It occurs from Pima County southward into Sonora, where it is confined to the watersheds of the Rio Sonoyta, Rio Magdalena, Rio Sonora, and northern portions of the Rio Matape and Rio Yaqui (Houseal et al., 1982; Iverson, 1978, 1989). *K. arizonense* occurs mostly at elevations of 200–800 m, but occasionally ranges to 1,050 m in Pima County, Arizona. Formerly considered to be a subspecies of the more wide-ranging Yellow Mud Turtle (*Kinosternon flavescens stejnegeri* and later *K. f. arizonense*), Iverson (1989) demonstrated that *K. arizonense* was a distinct species first described from fossils (see below). Subsequent analysis of mtDNA control region sequences provided additional support for the recognition of *K. arizonense* as a distinct species (Serb et al., 2001).

Kinosternon arizonense was originally described from Pliocene (Blancan) fossils found in Cochise County, Arizona (Gilmore, 1922). This distinction makes it the only living turtle species in the United States that was known from fossil material and type specimens first, a coelocanth among turtles! A Pleistocene (Rancholabrean) record of *K. arizonense* was also reported from Sonora, Mexico (Van Devender et al., 1985).

Based on a paucity of published papers, this is the most poorly known turtle species in the United States (Ernst and Lovich, in press). Table 3 presents a compilation of museum records (the record from Maricopa County is likely a *K. sonoriense*). Prior to 1981, *K. arizonense* was known from only seven localities in southern Arizona and 14 localities in Sonora, Mexico. Forty-four new localities are listed by Iverson (1989).

Table 3. Selected museum records of *Kinosternon arizonense* from Arizona.

Institution	Catalog number	Country	State/Province	County	Year collected
UAZ	UAZ 27949	USA	Arizona	Pima	1961
UAZ	UAZ 27950	USA	Arizona	Pima	1959
UAZ	UAZ 27954	USA	Arizona	Pima	1958
UAZ	UAZ 27955	USA	Arizona	Pima	1960
UAZ	UAZ 27964	USA	Arizona	Pima	
UAZ	UAZ 31739	Mexico	Sonora		1969
UAZ	UAZ 31740	Mexico	Sonora		1969
UAZ	UAZ 33581	USA	Arizona	Pima	1965
UAZ	UAZ 35394	USA	Arizona	Pima	1961
UAZ	UAZ 35395	USA	Arizona	Pima	1961
UAZ	UAZ 43037	Mexico	Sonora		1979
UAZ	UAZ 44250	USA	Arizona	Pima	1980
UAZ	UAZ 49433	USA	Arizona	Pima	1992
UAZ	UAZ 51809	USA	Arizona	Pima	1997
UAZ	UAZ 56581-PSV	USA	Arizona	Maricopa	2006

Kinosternon flavescens (Yellow Mud Turtle)

The Yellow Mud Turtle exhibits a more southerly mid-western distribution in the United States, from Nebraska southward, and then extending eastward in relict populations within the Prairie Peninsula. South of Texas it extends into northeastern Mexico (Figure 5). Within this range, it has been reported to elevations of about 1,500 m. This species' range barely extends into the southeastern corner of Arizona. Brennan and Holycross (2006) depicted the distribution in Arizona to include Cochise and Graham Counties where the turtle lives in ponds and slow moving water in Chihuahuan desertscrub and semidesert grasslands. It

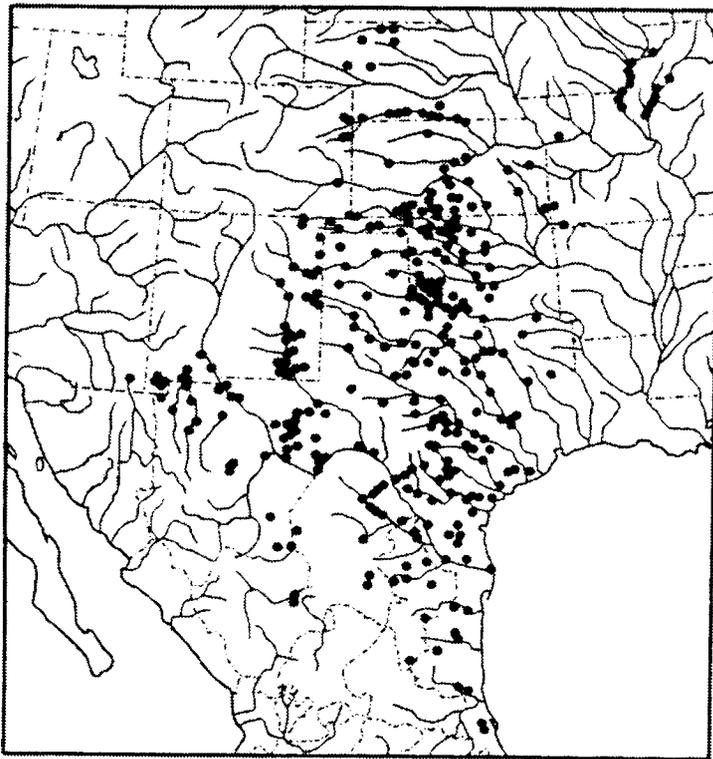


Figure 5. Modern distribution of the yellow mud turtle.

Table 4. Selected museum records of *Kinosternon flavescens* from the Arizona. Only records from Cochise and Graham Counties are included. Other county records in museums likely represent *K. sonoriense* or *K. arizonense*.

Institution	Catalog number	Country	State/Province	County	Year collected
UAZ	UAZ 27953	USA	Arizona	Cochise	1952
UAZ	UAZ 50637	USA	Arizona	Cochise	1994
UAZ	UAZ 50638	USA	Arizona	Cochise	1994
UAZ	UAZ 50639	USA	Arizona	Cochise	
TCWC	72419	USA	Arizona		1992
USNM	55627	United States	Arizona	Graham	1898
USNM	55628	United States	Arizona	Graham	1898

is not found in either the Colorado or Gila River Basins of Arizona (Iverson, 1978) despite misidentifications (usually of *K. sonoriense*) in the literature suggesting so (e.g., Vitt and Ohmart, 1978). Because *K. arizonense* was formerly recognized as a subspecies of the wide-ranging *K. flavescens*, differentiating the

two species in the literature in Arizona is difficult without examining specimens or obtaining exact locality data.

Within the area of treatment, Pleistocene (Rancho-labrean) fossil material is known from Sonora, Mexico (Van Devender et al., 1985). This species is well studied in the Midwest (but not in the Southwest) and the reader is referred to Ernst et al. (1994) for further details on their biology.

Kinosternon sonoriense (Sonora Mud Turtle)

The Sonora Mud Turtle (Figure 6) occurs primarily in the Sonoran Desert, as its name suggests. The range of this

turtle is shared almost equally by Arizona and Sonora, Mexico (Figure 7), with a slight extension into western Chihuahua. In the United States, records are known or reported from Arizona, extreme southeastern California, extreme southern Nevada, and New Mexico. The *K. flavescens* record mentioned by La Rivers (1942) from along the Colorado River in Clark County, Nevada is probably based on a specimen of *K. sonoriense* (Iverson, 1978). We are not aware of any later records of any species of *Kinosternon* from Nevada.

The Sonora Mud Turtle occupies a variety of habitat types in rocky streams, rivers, cattle tanks, and ponds from Lower Colorado River desertscrub to Petran montane conifer forest (Brennan and Holycross, 2006), especially along the Mogollon Rim of Arizona. The reported elevational range is 43–2,040 m (Jennings and Hayes, 1994). Ongoing research at Montezuma Well in Yavapai County, Arizona demonstrates that *K. sonoriense* populations have the ability to thrive even in chemically challenging environments incapable of sustaining fish (Lovich, Drost, Casper, and Monatesti, unpublished). Springs arising out of limestone formations at this locality are heavily charged with calcium carbonate,

producing water high in dissolved CO₂. An impoverished aquatic invertebrate fauna, with several

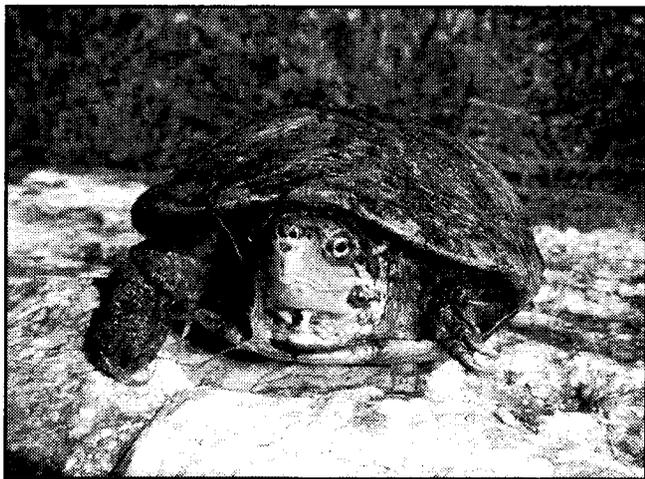


Figure 6. Sonora Mud Turtle.

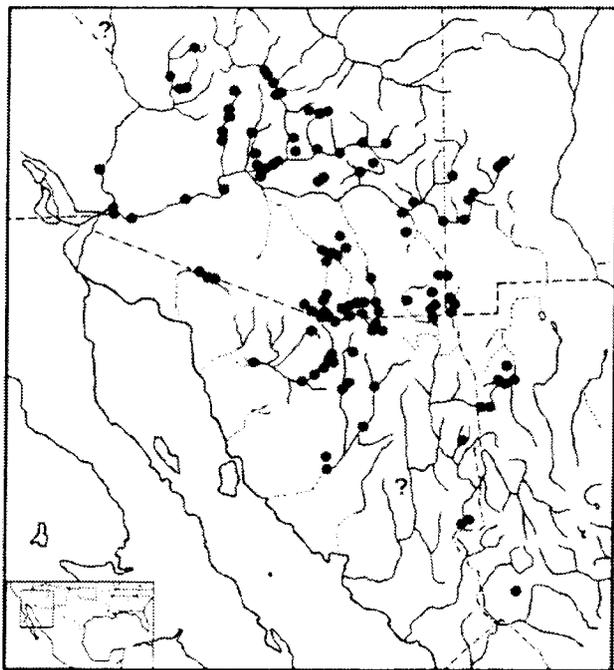


Figure 7. Modern distribution of the Sonora Mud Turtle.

endemic species, presents an unusual array of food items and diet studies are currently in progress at the site.

The available evidence suggests that Sonora mud turtles were never widespread in California. Sporadic records exist along the length of the Colorado River, mostly in Imperial County. Historical documentation of this species in California is summarized by Jennings and Hayes (1994). Records for *K. sonoriense* in California appeared in various publications from 1870 to the early 1900s. The earliest museum records we located were for two specimens collected in 1912 in Imperial County. Another was collected at Palo Verde in 1917. Subsequently, specimens were collected at Bard (1941) and Calexico (1942) according to data from museum specimens. According to Jennings and Hayes, the last two were collected along irrigation canals, implicating humans in the role of temporarily extending the range of this turtle away from the marshes and oxbows that likely

constituted their natural habitat along the Colorado River. One of the last published records for this species in the extreme lower Colorado River was based on an observation 1.6 km southwest of Laguna Dam in a canal on the Arizona side of the river on 31 March, 1962 (Funk, 1974), as summarized by Jennings and Hayes (1994). This appears to be the same specimen reported by Vitt and Ohmart (1978) with locality data listed as "N Gila E main canal, 1.0 mile SW Laguna Dam" since it was in the collection of Richard S. Funk.

The Sonora Mud Turtle may be extirpated in California (Palermo, 1988). Efforts to sample this species with fyke nets during April and May, 1991 were unsuccessful, resulting in the capture of non-native Texas Spiny Soft-shell Turtles (*Apalone spinifera emoryi*) only, according to information summarized in Jennings and Hayes (1994). The authors concluded that the species was endangered. The exact reasons for the disappearance of *K. sonoriense* from California are unknown. Certainly, California occurs at the margin of this species' wide distribution, but habitats along the Colorado River prior to human modification likely provided good conditions for this species based on our knowledge of their requirements. Introduction of exotic species, especially predatory fish (Mueller and Marsh, 2002) and possibly softshell turtles (Jennings and Hayes, 1994), may have been a factor. Jennings and Hayes suggest that widespread riparian habitat changes along the Colorado River were responsible. Certainly, the Colorado River is considered to be one of the most regulated rivers in the world (Blinn and Poff, 2005; Gloss et al., 2005; Mueller and Marsh, 2002), and completion of Hoover Dam in 1936 and Glen Canyon Dam in 1963 resulted in major changes to hydrology and subsequently riparian habitat, possibly to the detriment of this species (Iverson, 1978).

Pleistocene (Rancholabrean) fossils are known from Arizona and Sonora, Mexico (Moodie and Van Devender, 1974; Van Devender et al., 1985). Although several excellent studies have been published for this species (Hulse 1974; 1976a, b; 1982), it remains poorly studied and more research is needed both the United States and Mexico.

Since this species is represented by hundreds of museum specimens, a complete list is beyond the scope of our paper.

FAMILY TESTUDINIDAE

Gopherus agassizii (Desert Tortoise)

This is the quintessential turtle of the southwestern United States. The Desert Tortoise is widely distributed throughout most of the Mojave and Sonoran Deserts of California, Arizona, and northern Mexico, ranging northward into southern Nevada and southwestern Utah (Figure 8). In California, the Desert Tortoise typically occurs in valleys and on bajadas, while those in Arizona tend to occupy rocky hill slopes in Sonoran upland habitat. Populations on either side of the Colorado River usually exhibit significant behavioral, ecological, morphological and genetic differences (but see McLuckie et al., 1999 for an exception in the Black

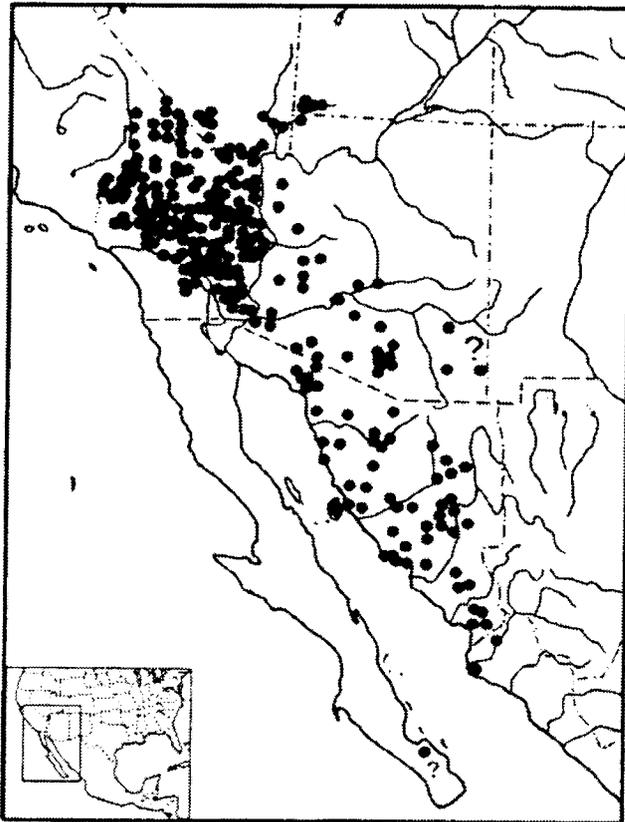


Figure 8. Modern distribution of the Desert Tortoise.

Mountains of Arizona). Throughout their broad latitudinal distribution (about 1,000 km from north to south—fully half of the latitudes occupied by turtles in North America: Hecnar, 1999), Desert Tortoises occupy an extensive array of habitats including tropical deciduous forest, thornscrub, desertscrub, and occasionally desert grasslands. They rarely occur above elevations of 1,600 m. Populations west and north of the Colorado River are protected as Threatened under the Endangered Species Act.

Pliocene (Blancan) and Pleistocene (Irvingtonian and Rancholabrean) remains have been recovered in California and Arizona along with more recent remains at archaeological sites (Ernst et al., 1994; Schneider and Everson, 1989). McCord (2002) provides a review of fossil history and evolution of *G. agassizii*.

This is the second best-studied turtle in the United States, as measured by the number of scientific publications, and the reader is referred to Ernst et al. (1994) and Ernst and Lovich (in press) for a review of their voluminous literature. This turtle is well represented in museum collections (but not necessarily from the lower Colorado River region according to Vitt and Ohmart, 1978) and for that reason, a list of specimens is not provided. Details on the range and habitats of the desert tortoise are provided by Germano et al. (1994).

Discussion

The depauperate turtle fauna of the desert southwestern United States is not unexpected due to the aridity of the

region. Semi-aquatic and aquatic organisms are obviously limited by the availability of wetlands and this is mirrored by similarly reduced fish and amphibian biodiversity in the Southwest, relative to the humid east. In an analysis of global correlates of species richness in turtles involving 12 environmental variables (including latitude, temperatures and basin area and discharge), only annual rainfall was highly significant (Iverson, 1992c).

Although rivers and other wetlands in the region have been altered, depleted, or eliminated by human activities, others have been created through construction of impoundments from the scale of cattle tanks to huge impoundments like Lakes Mead and Powell. Anthropogenic water sources do not appear to have contributed to an increase in the range or population size of native turtles in the Southwest with the possible exception noted above for Sonora Mud Turtles utilizing irrigation canals and possibly cattle tanks. In contrast, several non-native species appear to flourish in anthropogenic waters, especially the Red-Eared Slider now found in most artificial wetlands in the Phoenix and Tucson metropolitan areas (Lovich, pers. obs.), and the Texas Spiny Softshell Turtle, introduced into the Gila River of Arizona or New Mexico in the early 1900s (Linsdale and Gressitt, 1937), probably before 1904 (Miller, 1946).

We still have much to learn regarding some of the turtle species in the Southwest. A recent review of the literature of turtles in the United States and Canada (Ernst and Lovich, in press) provides an assessment of our knowledge of the 55 species currently recognized. The number of references in one of the authors' bibliographic database (Lovich, unpublished) provides a rough metric for assessing the status of our knowledge based on the number of citations for each species (shown in brackets). Accordingly, *Gopherus agassizii* [373] and *Chrysemys picta* [363] are the second- and third- best-studied turtles in the United States (first place goes to *Trachemys scripta* [418]). *Kinosternon arizonense* [3] is the least-studied, followed by *K. sonoriense* [25], and the other turtles in our area of treatment (*Actinemys marmorata* [89], *K. flavescens* [54], and *Terrapene ornata* [82]) are moderately to well-studied. The southwestern United States and northern Mexico still hold numerous opportunities for researchers and graduate students interested in turtle ecology and systematics.

Acknowledgements

Special thanks to Carol Spencer, acting curator of herpetology at the Museum of Vertebrate Zoology, University of California, Berkeley and HerpNet coordinator, for assistance with the HerpNet searches. Rick Feeney of the Natural History Museum, Los Angeles County also assisted with museum record retrieval. Earlier versions of the manuscript benefitted from the insightful reviews of Charles Drost, Mark Sogge, and Whit Gibbons.

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