

Amphibians & Reptiles

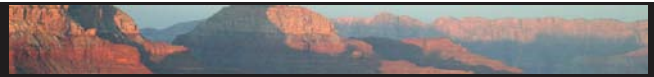
The American Southwest is well known for its abundance and diversity of reptiles. Some well-known inhabitants of the area include the Gila monster, one of only two venomous lizards in the world, the desert tortoise, whiptail lizards (with some species reproducing asexually), the coachwhip (a wide-ranging species, variable in color), and various aquatic species such as the narrow-headed gartersnake. The Southwest is less well known for its amphibian populations, but they are abundant in some habitats. There are some very unique amphibians in the region, such as the barking frog, casque-headed frog, Arizona toad, Sonoran desert toad, and Sonoran tiger salamander. Amphibians and reptiles are important components of aquatic and terrestrial ecosystems. Amphibians constitute an important part of the food web; they consume insects and other invertebrates, and they are prey for a long list of fish, reptile, bird, and mammal species, and even some predatory aquatic insects. Reptiles too serve as both predators and prey for many animals, such as small mammals, birds, and other reptiles. The occurrence of amphibians is associated with healthy wetland habitats. Amphibians serve as indicators of ecosystem health, because their permeable skin and complex life histories make them particularly sensitive to environmental disturbance and change.

Amphibians and Reptiles are, together, referred to as herpetofauna or “herps.” Most herpetofauna lay eggs, although some give birth to live young. Amphibians and reptiles are ectotherms, meaning they are unable to regulate heat within their own bodies and warm up or cool off through behavioral means (e.g., basking or seeking shade). Although this places limits on their distribution and times of activity, it allows them



Green toad

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OVERVIEW



PHOTO: ROBERT SHANTZ

Gila monster

to live on less energy than mammals or birds of similar size. Amphibian and reptile species may occupy similar habitats and are similarly vulnerable to habitat degradation and other threats. Herpetofauna populations may exhibit dramatic, natural fluctuations in site occupancy, distribution, abundance, and species richness.

Distribution and Life History

There are about 460 species of amphibians and reptiles in the continental U.S. (Marks 2006), with a substantial number occurring in the American Southwest. The Sonoran Desert supports some 100 reptile and at least 20 amphibian species. The northern region of the Chihuahuan Desert supports more than 170 herpetofauna species. At least 18 species are endemic to the Chihuahuan Desert (e.g., the bolson tortoise [*Gopherus flavomarginatus*] and Chihuahuan fringe-toed lizard [*Uma exsul*]), some of which occur in the U.S. Also, the ranges of several lizards are centered in the Chihuahuan Desert (e.g., the Texas banded gecko (*Coleonyx brevis*) and several species of spiny lizards (*Sceloporus* spp.)). There is at least one endemic amphibian in the Southern Colorado Plateau Network (SCPN)—the Jemez Mountains salamander (*Plethodon neomexicanus*), which occurs in Bandalier NM. The parks within the SCPN support at least 58 herpetofauna species—two salamanders, 11 anurans, 22 lizards, one turtle, and 22 snakes (Persons and Nowak 2006).

An individual park noteworthy because of its large number of herpetofauna species is the Saguaro National Park (SAGU) in the Sonoran Desert Network (SODN). This park is home



to 56 native reptile and amphibian species— eight frogs and toads, one salamander, three turtles (including the desert tortoise), and 48 lizards and snakes (including the Gila monster) (Flesch et al. 2006, 2007). This wealth of species is attributed to landscape diversity and the overlap of several major biogeographic provinces, particularly the Sonoran Desert and Madrean mountains of northern Mexico.

Not only are there a large number of herpetofauna species in the Southwest, there are a large number of resources that describe their distribution and life history. Thus, rather than duplicating such material here, we refer readers to some of the many alternative sources (see the last section of the overview, “Sources of Distribution and Life History Information.”) It is not our intent to endorse any particular source.

Additionally, herpetofauna surveys have been conducted at many parks in the Southwest. For results of recent inventory projects, see the available Resource Briefs and Project Summaries for herpetofauna in the Amphibian and Reptile section of the Learning Center website (<http://www.southwestlearning.org/>). Also see further discussion of inventories in the “Management and Monitoring Activities” section of the overview. Lists of federally threatened and endangered species at individual parks can be obtained online at the NPS ESA Database (<http://www.nature.nps.gov/biology/endangeredspecies/database/search.cfm>).

Although distribution and life history information for individual species is not presented here, a brief discussion of the life histories of amphibians and reptiles is provided. The Greek word “amphibios” means having two lives; the amphibians have a larval stage and an adult stage that are often quite different from one another (e.g., a tadpole and adult frog) (Tyning 1990). However, some amphibians keep many of their larval characteristics, such as external gills, throughout their adult lives. Amphibians take in oxygen and other gases through their glandular skin and the linings of their mouth and throat (they may also have lungs or gills). Like reptiles, amphibians maintain their body temperature by resting in warm or cold places. Two of the three groups of amphibians, frogs and salamanders, inhabit the U.S. Most frogs fertilize their eggs externally (with males and females releasing sperm and eggs, respectively, into the water). Salamanders generally show internal fertilization.

The reptiles that inhabit the American Southwest are the snakes, lizards, and turtles. In the Class Reptilia, there are three subclasses. The turtles and tortoises fall within one subclass (in the Order Testudines). The alligators and crocodiles, no members of which occur in the American Southwest, fall within the second subclass (in the Order Crocodylia). The third subclass contains two orders; one (Order Squamata) includes

the snakes, lizards, and Amphisbaenians (found in Mexico), and the other (Order Sphenodontia) contains the tuatara (endemic to New Zealand) (Brennan 2008). Reptiles have scales and at least one lung (Tyning 1990). They are ectothermic vertebrates. They have amniotic eggs, which enable them to lay eggs on land. All reptiles reproduce by internal fertilization. Females either lay eggs, keep the eggs within their bodies until they hatch, or give birth to live young, with some form of placentation. Reptiles hatch as miniature versions of the adults.

Ecology

Amphibians and reptiles may occupy similar habitats and can be found in most habitat types. Some species use different habitats at different times of the year. Some turtles, for example, spend most of their time in the water, but must move to land to lay eggs. Many salamanders inhabit upland habitats for most of the year, but require temporary or permanent wetlands or aquatic sites to breed and lay eggs. Additionally, many herpetofauna species become less active during periods of extreme cold or heat, and at such times they seek out protected sites.

Depending on the species and location, amphibians may need sites for burrowing in moist soil or wet areas to keep their skin moist (Marks 2006). Near wetlands and riparian areas, amphibians use a variety of upland microhabitats, including leaf litter, woody material, small mammal burrows, and boulders and cracks in rocks. Reptiles require sites that contain shelters from the heat and basking areas in the sun. Microhabitats used during times of extreme cold or heat include rock piles or outcroppings, animal burrows, woody material, and brush piles. Many snakes and lizards would also find these suitable areas for nesting.

A description of adaptations of amphibians and reptiles for living in desert environments is found in Van Devender



Ornate box turtle

COURTESY: COLORADO DIV OF WILDLIFE

(2000). These adaptations include the ability to excavate deep burrows where the animal may stay for substantial periods of time (e.g., Couch's spadefoot [*Scaphiopus couchi*], northern casque-headed frog [*Pternohyala fodiens*]). These species are aided in digging with spades on their hind feet. Further, the casque-headed frog sheds outer layers of skin while in its burrow to form a cellophane-like "cocoon" that prevents water loss. Reptiles such as the chuckwalla (*Sauromalus obesus*) and Gila monster (*Heloderma suspectum*) store water in the fatty tissues of their tails. Adaptations also exist for living in loose, windblown sand. For example, the fringe-toed lizard (*Uma* spp.) gains traction while running across dunes with the fringe-like scales on the elongated toes of its back feet.

Amphibians and reptiles are both important members of aquatic and terrestrial ecosystems. Both groups serve as both predators and prey, and species that inhabit both ecosystems serve to transfer energy between the two systems. A discussion of the roles that snakes play as ectothermic predators can be found in Nowak et al. (2008). One of the authors' conclusions was that the potential for the viperids (true vipers and pit vipers) to regulate prey populations would be greatest when prey populations are low.

Amphibians are viewed as indicators of wetland ecosystem health. They are sensitive to a variety of threats and, thus, can serve as early indicators of ecosystem change when monitored over long time scales. Changes in amphibian populations can often be linked to one of the following causes, all of which suggest a decrease in overall ecosystem health: pollution, introduced species, drought, habitat destruction, disease, and ultraviolet radiation. Amphibian populations may exhibit measurable changes in site occupancy, distribution, abundance, species richness, and increases in both disease occurrence and malformations. These changes have cascading effects on other aspects of the ecosystem, such as predator, prey, and competitor populations, energy flow, and nutrient cycling (Stebbins and Cohen 1995).

Activity and behaviour of both amphibians and reptiles are affected by local weather conditions during the year. For example, lower rainfall and higher temperatures can significantly affect microhabitat in an area, and reduce the likelihood of observing amphibians, and to a lesser extent reptiles, for some period of time. This may result in lower recorded population levels during subsequent seasons and years. Similarly, daily activity of reptiles may be affected by rain and/or cold weather. These effects of local weather conditions can hamper short-term studies of herpetofauna, especially in the dry Southwest (Johnson and Lowe 1979, Lowe and Holm 1991). Effects of drought on herpetofauna are discussed further in the following section, under "Drought."



Couch's spadefoot

COURTESY: COLORADO DIV OF WILDLIFE

Threats and Concerns

Declines in amphibian and reptile populations have been and are being observed. Herpetofauna across the globe face threats from both known and unknown sources (Gibbons et al. 2000). Disease may now be as great a cause of amphibian decline as habitat destruction. Potential causes of herpetofauna decline in the Southwest include habitat loss and degradation, direct persecution, disease, invasive species, chemical contamination, ultraviolet radiation, drought, and illegal collecting.

Habitat Loss and Degradation

Habitat loss and degradation is one of the greatest threats to amphibian and reptile populations. Habitat loss/degradation occurs from a variety of sources, including urban/suburban development, aquatic habitat alteration from water withdrawals and stream diversions, water pollution, and off-road vehicle use in terrestrial habitats. Declines in both population levels and species diversity have been attributed to habitat loss and degradation. Development can negatively affect habitat by destroying sites or degrading their quality, and by creating barriers or hazardous zones (e.g., a road) between important habitat features. Loss and degradation of habitat can disrupt population connectivity, diminishing the rate of dispersal and recolonization, such that local populations are unable to persist through natural catastrophes or population fluctuations.

For amphibians and aquatic reptiles (e.g., Mexican and narrow-headed gartersnakes [*Thamnophis rufipunctatus*]), the destruction of wetlands removes breeding sites and fragments populations, making these species more vulnerable to regional extirpation. For semi-aquatic and terrestrial reptiles, similar declines may occur. For example, individual desert tortoises occasionally move long distances between populations (Edwards et al. 2004). Historically, populations exchanged in-

dividuals at a rate > 1 migrant/generation. Such movements today are increasingly difficult for tortoises due to fragmentation of their habitat from landscape changes such as roads, housing developments, canals, and fences. Also, the loss of native bunchgrasses, from cattle grazing, in the Chiricahua mountains in southeastern Arizona was considered to be the main cause of a decline in the bunchgrass lizard (*Sceloporus scalaris*) (Ballinger and Congdon 1996). This lizard requires bunchgrasses for cover and protection from predators and harsh winter conditions.

Many studies have reported high rates of amphibian and reptile mortality on roads. Amphibian populations are most susceptible to high rates of road-kill when migrating en masse between habitat patches. Reduced anuran density and population abundance, lower probabilities of occurrence, and adverse population genetic effects have been attributed to roads. Reptiles, such as snakes, sometimes prefer sunning on warm, smooth surfaces such as roads. A year-long study in a Texas wildlife management area found road traffic affected reptiles extensively in the fall and spring and amphibians in the spring and summer. In the spring, 83% of amphibians observed were found dead on the road (Coleman et al. 2008). Road mortality in Arizona is also high during the summer rain (monsoon) period, when amphibians are drawn to breeding sites and some snake breeding movements are also high.

Urban development also increases conflicts between venomous species and humans (Sullivan et al. 2004, Nowak et al. 2002). Every year in the Tucson and Phoenix, Arizona, areas, hundreds of rattlesnakes and dozens of Gila monsters are removed from residential/human-inhabited areas and translocated to nearby desert habitats. Research, however, has shown that some translocations may not be effective in removing the animal from the original area and/or may subject translocated animals to increased risks (e.g., from predation).

Wildfires may also lead to long-term or permanent loss of habitat for amphibians and reptiles. Such loss includes the filling-in or sedimentation of stream pools. In SAGU, many tinajas (bedrock pools) that are home to the lowland leopard frog have been buried by eroded material resulting from stand-replacing wildlives occurring at higher elevations (Parker 2006).

Diseases

Chytridiomycosis

The disease chytridiomycosis is caused by a recently identified species of parasitic fungus (*Batrachochytrium dendrobatidis*), known as the amphibian chytrid fungus. Chytridiomycosis is considered a major threat to amphibians worldwide, causing population declines and species extinctions. The disease is thought to have originated in Africa, spreading rapidly since



Tiger salamander

COURTESY : COLORADO DIV OF WILDLIFE

the 1970s (Australia Department Environment and Heritage 2006), although this is debated and much is still unknown about the disease.

Amphibian chytrid fungus attacks keratin in the skin of amphibians. The water-dependent fungus spreads via free-swimming zoospores, which colonize amphibian skin and develop into zoosporangia. The fungus is believed to be able to persist in aquatic environments without amphibians. Amphibian larvae are not lethally affected, but they can carry the fungus in mouthparts and toe tips during later stages of development. Some amphibian species can carry the fungus without being killed by it, and they may serve as vectors of the pathogen to more susceptible species.

The responses of amphibian populations infected with the fungus range from no perceptible impact, to mass mortality events, to severe decline without recovery. In the western U.S., chytridiomycosis is thought responsible for the decline of the boreal toad in the southern Rocky Mountains, and for the recent, catastrophic decline of this species in Rocky Mountain National Park. Reports of the disease in the Southwest include infections in lowland leopard frogs (*Rana yavapaiensis*), Chiricahua leopard frogs (*Rana chiricahuensis*), and canyon tree frogs (*Hyla arenicolor*) in eastern, central, and southern Arizona (Bradley et al. 2002). The disease may persist in healthy amphibian populations once an epidemic wave has passed.

Ranavirus

The genus *Ranavirus* (family Iridoviridae), only recently discovered, causes disease in amphibians, reptiles, and fish. Amphibian ranaviruses are considered a global threat to amphibian populations due to their high virulence and rapid expansion to areas with previously unexposed populations. Ranavirus is associated with mass mortalities in amphibians, particularly larvae and recently metamorphosed juveniles, with death rates reaching 100%. Death is thought to result from organ failure

due to tissue necrosis and possibly from secondary bacterial infections. Ranavirus can be spread in various ways, including through infected food, water, human handling, introduction of fish and amphibians (e.g., released bait and pets), and boats and fishing gear. The disease is thought to be particularly associated with disturbed or degraded habitats and high amphibian densities. Susceptibility to disease may be influenced by many factors, including chemical exposure and temperature. Ranavirus has not been shown to cause local or species extinctions, but because ranavirus outbreaks sometimes kill all or most of an entire year class in a population, the persistence of local amphibian populations could be threatened by episodic die-offs. A virus thought to be an iridovirus was found to be the primary cause of periodic population crashes in the Sonora tiger salamander (*Ambystoma tigrinum stebbinsi*) in southern Arizona (Jancovich et al. 1997).

Upper Respiratory Tract Disease

Another disease of concern for reptiles is a widespread upper respiratory tract disease (URTD) caused by the bacterium *Mycoplasma agassizii* (Gibbons et al. 2000). This contagious disease may be part of the cause of population declines in desert tortoises (*Gopherus agassizii*) in the Mohave Desert (Ivanyi et al. 2000); in Arizona, most populations of the tortoise do not seem to be impacted by this disease. In addition to desert tortoises in the Mohave Desert, *M. agassizii* has been identified in Florida gopher tortoises and box turtles (Pappas 2003). Symptoms of the disease are a runny or wet nose and eyes. The disease is spread by direct contact and probably by an infected animal sneezing and leaving drops of mucus. Captive tortoises should not be released into the wild, because, among other reasons, they could spread *M. agassizii* or other diseases.

Invasive species

Non-native invasive species are another threat to amphibian and reptile populations. Non-native invasive species may act as predators of or competitors with native species. Bullfrogs (*Rana catesbeiana*), for example, were introduced in the 1800s west of the Rocky Mountains, where they are efficient predators of amphibians and some reptiles (Marks 2006). For example, the bullfrog is thought to be a primary cause of declines of leopard frogs (including the federally-threatened Chiricahua leopard frog, *Rana chiricahuensis*) and gartersnakes in Cochise County, southern Arizona (Rosen and Schwalbe 2002). Few young Mexican gartersnakes (*Thamnophis eques*), a highly aquatic species, were found to survive in the presence of bullfrogs, but the snakes may survive well once they outgrow the sizes susceptible to bullfrog predation.

Non-native fish are also a major problem for native aquatic amphibians and reptiles. Non-native fish compete with or eat



Coachwhip preying on bird eggs in saguaro

NPS (SAGUARO NP) PHOTO

native fish that are needed by the herpetofauna species, such as narrow-headed (*Thamnophis rufipunctatus*) and Mexican gartersnakes. For example, research by the U.S. Geological Survey found that the distribution pattern of narrow-headed garter snakes in Oak Creek, Arizona, was similar to the availability of smooth-bodied fish with soft fins (a major food source) (Nowak 2006a). The snakes may be declining in the lower reaches of the creek, which are dominated by unedible, non-native fish with stiff, spiny fins. Non-native fish may also prey upon native amphibians and reptiles.

Non-native crayfish in the Southwest have caused the decline of some amphibian and aquatic reptile species (Marks 2006). Crayfish, such as the Northern or virile crayfish (*Oreconectes virilis*), intentionally introduced for bait and vegetation control, eat insects, fish, frogs, small snakes, and young turtles (Arizona Invasive Species Advisory Council 2008). Crayfish populations increase dramatically while the native herpetofauna and other prey decrease; crayfish then consume the aquatic plants present, altering the aquatic communities where they are found. Victims of the non-native crayfish include the narrow-headed gartersnake (Nowak 2006a), whose young and prey are eaten by the crayfish.



Bullfrog

PHOTO : KELLY MCALLISTER

The introduction of non-native plant species threatens some reptiles. Alteration of habitat (e.g., changes in habitat structure and native plant community composition) has negatively affected the desert tortoise (*Gopherus agassizii*) (Gibbons et al. 2000, Ivanyi et al. 2000). In Arizona, exotic annuals such as red brome (*Bromus rubens*) and buffelgrass (*Pennisetum ciliare*) have increased, and native perennial grasses, shrubs, and annuals have decreased. These changes are detrimental because the tortoise and other species require the native vegetation, and because the proliferation of the exotics has led to increased fire frequencies in areas where many of the plants are not well-adapted to fire (Esque 2003). Tortoises are also directly killed by fire.

Chemical Contamination

Chemical contaminants come from many sources and include locally applied herbicides, pesticides, and fertilizers, wastewater, and unintended releases of sewage, fuels, solvents, and other chemicals used for maintenance or construction. Such pollutants can have direct and indirect effects on both amphibians and reptiles (Gibbons et al. 2000). Amphibians may be exposed to chemical hazards through direct uptake from water or by ingestion of contaminants in soils, sediments, and food items. They may be unusually susceptible to toxins due to their permeable skin and protracted development in the aquatic environment. Many aquatic snakes, such as the narrow-headed gartersnake, and other aquatic/semi-aquatic reptiles may also be susceptible to contaminants. Knowledge about the effects of contaminants on amphibians is scarce, and reptiles have been studied even less (Gibbons et al. 2000). Effects of contaminants on reptiles are known primarily from observations on turtles and crocodilians.

The variety and severity of sublethal effects indicated by controlled studies suggests the potential for contaminants to affect amphibian populations. Chemical stressors, even at levels well below toxic concentrations, influence the ability of

amphibians to handle environmental stress. The interaction of physical and chemical stress is an important area of research for amphibian population declines.

Ultraviolet (UV-B) Radiation

Because pollutants have reduced the thickness of the protective ozone layer in the atmosphere, increasing amounts of UV-B are reaching the earth's surface. UV-B levels have increased an estimated 5-10% per decade since 1979, especially at higher latitudes and in early spring. Amphibians may be more vulnerable to harmful effects of UV radiation than other kinds of animals due to their "naked" skin and shell-less eggs. [An increase in UV-B radiation levels is unlikely to threaten reptile eggs at this time, because they are infrequently exposed to UV-B radiation (Gibbons et al. 2000)].

Adverse effects of UV-B include interference with intracellular functions, impaired transcription of DNA, and interactions with chemicals that make them more toxic. Field and laboratory studies have demonstrated increased mortality, deformities, and susceptibility to fungal disease. There is debate over whether or not UV-B is a main factor in currently observed amphibian declines, but researchers share concern about ozone depletion and the consequences of increasing levels of UV-B. Of particular concern is the potential for UV-B to interact in complex ways with contaminants, climate (e.g., drought), and disease.

Drought

Amphibian and reptile populations are sensitive to fluctuations in the amount and timing of precipitation. Drought has been implicated as the cause of drastic declines in frog populations. In addition to direct effects on survival and reproduction, drought can adversely affect amphibians by interacting with other factors, such as disease, UV-B radiation, and exposure to contaminants. Although drought is a natural phenomenon, climate changes including drought could be occurring faster than organisms can adjust. Climate change is cited consistently as one of the main potential causes of amphibian population declines. Temperatures have increased 0.8 degrees Celsius in the West since the 1950s, and they are predicted to rise 2-5 degrees in the next century (Hansen et al. 2001). Drought frequency is predicted to increase by 66-90% (Gitlin et al. 2006).

Drought adversely affects amphibians because of their dependence on pooled surface water for reproduction. When a breeding pond dries up prior to the onset of metamorphosis, the entire reproductive effort for the year is lost. At ponds reduced in size because of drought, an increase of larval density can negatively influence larval survival by slowing development. In addition, pond drying can result in early metamorpho-



PHOTO: ROBERT SHANTZ

Texas horned lizard

sis, which is linked to small body size and decreased survival rates in juvenile frogs. Post-metamorphic amphibians which use terrestrial habitats for non-breeding activities can also be adversely affected by drought. The loss of body water through evaporation must be offset through absorption of water from wet or moist substrates. Amphibians must rehydrate frequently; death results from desiccation. Amphibians crowded into limited habitat also may be more subject to disease or parasite epidemics.

Drought impacts desert reptiles because there is less free water for them and their prey. Prey numbers typically decline during drought, and many reptiles rely on their diets to obtain water if they cannot drink free water; they may die from desiccation if they cannot eat enough. A behaviour of some reptiles, which may be especially important for survival in the desert where rainwater may not accumulate (Repp and Schuett 2008), is that of harvesting and drinking water from their own bodies (e.g., from a pool of water within a snake's coils). Repp and Schuett (2008) reported on western diamond-backed rattlesnakes (*Crotalus atrox*) harvesting and drinking rainwater in the Sonoran Desert during an extended drought.

Other Potential Threats

Increased temperatures resulting from climate change could affect some reptiles and amphibians. Evidence for effects on freshwater turtles includes increased juvenile growth rates, earlier ages at maturity, and changes in sex ratios (Frazer et al. 1993). Crocodilians and some turtles may be affected the most, because of their temperature-dependent sex determination. Altered sex ratios could affect population demographics and persistence. Reptiles and amphibians could also be affected by climate change if changes occur in hibernation periods. The absence of a long hibernation period could result in starvation over the winter or changes in gonadal development. An increase in summer temperatures could render burrows unusable and result in desiccation.

Illegal collecting of herpetofauna in the Southwest may also affect some populations. For example, illegal collecting for the pet trade may be the biggest threat to twin-spotted rattlesnake (*Crotalus pricei*) populations in the U.S. at the present time (Prival et al. 2002); this species occurs in the U.S. only in four disjunct mountain ranges in southeastern Arizona. Reptile collecting may also lead to the destruction of habitat, which can further adversely affect populations (Goode et al. 2002). To expose reptiles in their shelters, collectors break apart and overturn rocks; this usually leads to permanent damage of cracks and crevices that serve as shelters in the rock outcrops.



PHOTO: ROBERT SHANTZ

Sonoran whipsnake

In addition to the threats from non-native, invasive species discussed in the last section, domestic animals, such as dogs, may also threaten some reptile species. The impacts of free-roaming domestic dogs on the desert tortoise have been studied at SAGU and found to be an issue (Zylstra 2008). Also, in a small (<30) tortoise population in Tucson that is surrounded by urban development, many of the individuals show shell trauma from domestic or feral dogs (Edwards et al. 2004).

Management and Monitoring Activities

Recent surveys for amphibian and reptile species have been conducted in most parks in the American Southwest. In some cases, these inventories focused on amphibian and reptile species, and in other cases these groups were surveyed as part of vertebrate surveys. For results of recent inventory projects, see the available Project Summaries and inventory reports for herpetofauna or vertebrates in the Amphibian and Reptile section of the Learning Center website (<http://www.southwestlearning.org/>). Recent inventories have been conducted in: the SCPN for nearly all parks (report dated 2006); the SODN for all parks (reports dated 2005-2008); the CHDN for all parks (reports dated 2005); and in nearly all SOPN parks (reports dated 2002-2004).

Amphibians and/or reptiles have not been identified as a vital sign in any of the Southwest's four I&M networks. Therefore, there is no network-wide or larger area-wide, uniform monitoring of these animals. Many parks, however, have conducted research or monitoring for individual species or groups of herpetofauna, in addition to the inventory projects mentioned above. Some of these research/monitoring projects include:

- Impacts of urbanization on the desert tortoise in SAGU (Averill-Murray and Swann 2002), and other studies (Zylstra and Swann 2009).
- Movement patterns, range requirements, dietary habits, and use of developed areas by Gila monsters at Tonto NM (Nowak 2006b).
- Rattlesnake-human interactions in Arizona national parks

(Nowak 2006c, Nowak 2006d).

- Lizard monitoring in Organ Pipe Cactus NM (ORPI) (Conner and Holm 2006).
- Sonoyta mud turtle research and management in ORPI (Rosen et al. 2006).
- Management strategy for the lowland leopard frog in SAGU (Swann and Wallace 2008).
- Long-term research on tree lizards at SAGU (e.g., M'Closkey and Baia 1990).

Sources of Distribution and Life History Information

Field Guides and Species References

Field guides for herpetofauna range from general guides to those specializing in particular geographic areas or taxonomic groups. Here are a few field guides or books with species accounts covering parts or all of the American Southwest:

A Field Guide to Western Reptiles and Amphibians. 2003. The Peterson Field Guide Series. Third Edition. Text and Illustrations by R. Stebbins. Houghton Mifflin Company.

A Field Guide to Amphibians and Reptiles in Arizona. 2006. By T.C. Brennan and A.T. Holycross. Arizona Game and Fish Department, Phoenix, Arizona.

Amphibians and Reptiles of New Mexico. 1996. By W. Degenhardt, C. Painter, and A. Price. University of New Mexico Press. Albuquerque, New Mexico.

Amphibians and Reptiles in Colorado, a Colorado Field Guide. 2000. By G.A. Hammerson. Second Edition. University Press of Colorado.

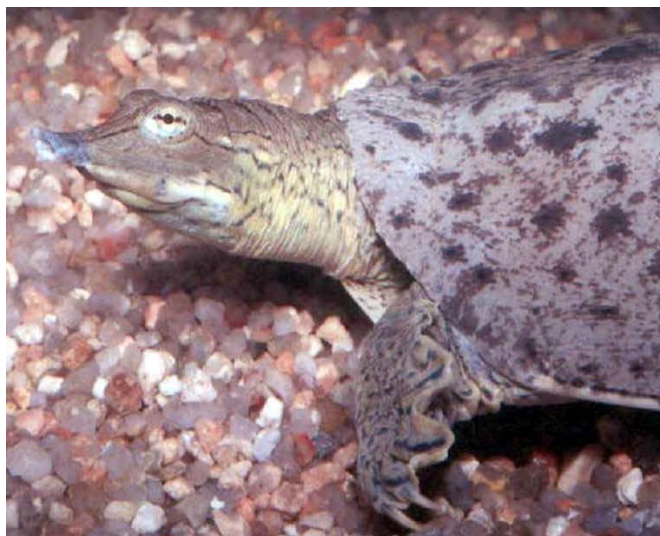
Amphibians and Reptiles of Texas. 2000. By J.R. Dixon. Texas A&M University Press.

Lizards of the American Southwest, a photographic field guide. 2009. Edited by L.C. Jones and R.E. Lovich. Rio Nuevo Publishers, Tucson, Arizona.

A Natural History of the Sonoran Desert. 2000. Edited by S.J. Phillips and P.W. Comus. Arizona-Sonora Desert Museum. Arizona-Sonora Desert Museum Press, Tucson, and University of California Press, Berkeley and Los Angeles. Pages 533-585, by C. Ivanyi, J. Perry, T.R. Van Devender, and H. Lawler, provide amphibian and reptile species accounts.

Electronic Resources

A sampling of resources available on the internet include:



Spiny softshell turtle

COURTESY : COLORADO DIV OF WILDLIFE

eNature – URL: <http://www.enature.com/fieldguides/>

eNature's core content consists of wildlife information about almost 6,000 individual species and is the same data set used to create the printed Audubon Field Guides.

PARC Links – URL: http://www.parcplace.org/other_links.html

PARC (Partners in Amphibian and Reptile Conservation) is a partnership for the conservation of herpetofauna and their habitats. The PARC website page listed above contains numerous links, including those for herpetological journals, research labs, atlases, and regional resources. A few links of particular interest are noted here.

AmphibiaWeb (<http://www.amphibiaweb.org>) provides information on the conservation, natural history, and taxonomy of amphibians. Searches can be conducted by state, and photos of species are available for viewing.

The National Amphibian Atlas (www.pwrc.usgs.gov/naa) website, maintained by the Patuxent Wildlife Research Center of the U.S. Geological Survey, provides species distribution maps.

Southwest PARC (<http://chelydra.unm.edu/swparc/index.html>) is a working group focused on implementing the PARC mission in the Southwest.

Online Field Guide to the Reptiles and Amphibians of Arizona – URL: <http://www.reptilesfaz.org/>

Created by T.C. Brennan in 2008, this site contains information on amphibians, snakes, lizards, turtles, and habitat, and it includes species accounts, information on relevant books, and links to organizations.

Arizona-Sonora Desert Museum – URL: http://www.desert-museum.org/books/nhsd_reptile.php

The Arizona-Sonora Desert Museum site provides more than 30 Amphibian and Reptile Accounts by C. Ivanyi, J. Perry, T.R. Van Devender, and H. Lawler. This is the same information that appears in the book “Natural History of the Sonoran Desert” (2000), listed above.

Centennial Museum, University of Texas at El Paso – URL: <http://museum.utep.edu/chih/NHCD/herps.htm>

This website contains information on the Chihuahuan Desert and its amphibians and reptiles. Available information includes photographs, distribution data and maps, species lists, and some natural history information.

Tucson Herpetological Society – URL: <http://tucsonherpsociety.org/>

Focused on the herpetofauna of Arizona and Mexico, this website contains checklists of species within a 100-mile radius of Tucson and provides internet links to other information sources. The Society publishes a monthly newsletter and informational brochures.

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