The Bolson Tortoise (*Gopherus flavomarginatus*): King of the (*Re-*) Wild Frontier

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Figure 1. Bolson Tortoise (*Gopherus flavomarginatus*). Photo by Cecil R. Schwalbe.

While most of us in the Sonoran desert are familiar with the Desert Tortoise (*Gopherus agassizii*), relatively few of us may know much about its close relative in Mexico, the Bolson Tortoise (*Gopherus flavomarginatus*). The current range of the Bolson Tortoise is restricted to a small area in Mexico at the junction of Chihuahua, Coahuila, and Durango. However, a few Bolson Tortoises have been living in Arizona and more recently New Mexico since the mid-1970's. Thanks to Ariel Appleton and others at the Research Ranch in Elgin, a small reproducing population of tortoises has been studied for more than three decades in large enclosures on the ranch.

Recently, amidst discussion of new and radical conservation strategies, tortoises from the Research Ranch in Elgin were moved to large-scale enclosures on ranches owned by Ted Turner in New Mexico. While some may view the translocated tortoises simply as captive breeding populations, others have viewed this as a small step towards a long-term goal of reintoducing Bolson Tortoises into areas occupied by the species more than 13,000 years ago. The concept of "Pleistocene rewilding" has become a popular topic of discussion, but few people are proponents of actually enacting these proposals, especially when the reintroduced species are top-level predators that have been absent in North America for thousands of years. However, large tortoises present fewer potential threats and impacts to human populations, and for this reason we may eventually see Bolson Tortoises released in New Mexico or parts of Texas.

Background

The Bolson Tortoise was first described as a distinct species by Legler (1959) and later modified by Legler and Webb (1961). However, the most detailed species account was completed more than two decades later by Morafka (1982). The species name *G. flavomarginatus* was given because of the yellow coloration on the lateral marginals and plastron observed in many of the specimens (Legler and Webb, 1961).

The Bolson Tortoise is the heaviest terrestrial reptile in North America. It is common for individuals to attain carapace lengths of more than 340 mm, which is considerably greater than other extant Gopherus species

(Morafka, 1982). Maximum length or weight is unknown; however, both Legler and Webb (1961) and Morafka (1982) noted that local Mexicans spoke of tortoises reaching substantially larger sizes than the specimens they observed. Locals estimated tortoises reaching lengths of one meter and weights of 35 to 50 kg (75-110 lbs.; Legler and Webb, 1961). While anecdotal evidence is inherently less dependable then scientific observations, these accounts are to some extent supported by fossil records, which provide evidence that Gopherus flavomarginatus predecessors might have been twice the length and up to eight times the mass of the extant Bolson Tortoise (Morafka, 1988).

Natural History

Relatively little is known about life history traits of the Bolson Tortoise, primarily due to its late description (Germano and Bury, 1994). Most of the estimates that will follow are based on small sample sizes and captive individuals. Obviously, there is a need for additional research.

First reproduction in females typically occurs at a minimum of 14 years of age or a minimum carapace length of 285 mm (11.2 in; Germano, 1994). Females have 0 – 3 clutches per year, with a mean of 1.4 clutches per year. Observed clutches contained 3 – 9 eggs, with an average of approximately 6 eggs per clutch (Germano, 1994; Aguirre et al., 1997). Scientists estimate hatchling and juvenile survival in the wild to be low; however, field studies have been limited and detection of young animals during surveys is known to be very difficult (Germano, 1994; Aguirre et al., 1997). Currently, there are no estimates of adult survival rates or longevity, but it is generally assumed that these estimates are similar to other extant *Gopherus* species, with adult survival relatively high (greater than 75%) and maximum age greater than 50 years (Germano, 1994).

Habitat

Bolson Tortoises have rather restricted habitat requirements, most of which were described by Dr. David Morafka in his 1982 report of field studies conducted in the Bolson de Mapimi region of Mexico in the 1970's. Climate in this region is highly seasonal, characterized by dry winters with no appreciable precipitation, and hot summers with significant monsoon rainfall. Greatest tortoise densities occur between 1,000 m and 3,000 m (3280-9842 ft.) elevations, along slopes (1 – 3%) lining closed-drainage basins often referred to as bolsons. Soil in these areas is generally alkaline and compacted, with high sand content. Bolson Tortoise populations are associated with high densities of their major foods such as creosote bush (*Larrea tridentata*) and tobosa grass (*Hilaria mutica*).

Burrows

Bolson Tortoises dig extensive burrows that may reach lengths greater than seven meters (75 ft.) and depths greater than two meters (6.6 ft; Morafka, 1982). Active burrows usually have a mound of soil at the entrance, which may serve as a perch for basking and also may prevent flooding of the burrow. While most burrows are located on slopes that naturally prevent severe flooding, some occupied burrows are found in the bottom of bolsons and occasionally flood without apparent detriment to the occupant (Morafka, 1982). Burrows are thought to serve two purposes. Extensive burrows provide a refuge from predators and also provide a mechanism for the tortoise to regulate its body temperature. Surface temperatures may vary more than 15º C (59º F) from temperatures deep inside a burrow, providing cooler temperatures in the summer and warmer temperatures during cool winter months (Morafka, 1982).

Activity

Similar to *Gopherus agassizii* in the Sonoran Desert, Bolson Tortoises are usually dormant during the cool, dry winters, from approximately November through April (Morafka, 1982). If the area receives significant spring rains, tortoises may emerge to take advantage of available food supplies in May and June. However, most surface activity takes place during the summer months, July through September, when food is plentiful and mates can be found (Morafka, 1982). During the summer, tortoises generally exhibit a bimodal activity pattern, retreating into the burrow at midday for several hours when surface temperatures are highest. Mating and egg deposition usually occur in May, June, or early summer, while hatchlings frequently emerge later in the summer (Morafka, 1982)

Historical Distribution

Fossil records indicate that the genus *Gopherus* reached its maximum distribution during the Pliocene (5.3 to 1.8 million years ago; Morafka, 1988). At that time, *Gopherus* ranged from Aguascalientes, Mexico, to Kansas, and from Arizona in the west to Florida in the east. However, as the climate cooled, regional uplifts occurred, and glaciopluvial lakes formed in the early Pleistocene (1.8 million years to 10,000 years ago), the range of gopher tortoises was reduced and fragmented. Paleontologists believe that during the Pleistocene, *Gopherus flavomarginatus* was restricted to the Trans-Pecos and Mapimi subprovinces of the Chihuahuan Desert (Morafka, 1988), areas characterized by bolsons. It is thought that during this time, most of the bolsons contained major lakes (Van Devender, 1978), which separated and isolated small tortoise populations along shorelines.

Similar to many species of North America megafauna, the Bolson Tortoise underwent a severe and rapid extirpation from most of its range (80 – 90%) late in the Pleistocene (Morafka, 1988). In Dr. Morafka's 1988 synopsis of the historical biogeography

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Figure 2. Habitat of the Bolson Tortoise, Bolson de Malpimi, Mexico. Photo by Cecil R. Schwalbe.

of the Bolson Tortoise, he asserts that "human induced extinction" is the most credible explanation for tortoise population crashes at the end of the Pleistocene, based on chronological, geographical, and ecological arguments. Morafka's conclusions support the "overkill hypothesis," earlier proposed by Martin (1967).

The range of the Bolson Tortoise continued to diminish in post-Columbian times, with increases in human populations, agricultural development, urbanization, and livestock grazing (Morafka, 1988). Human predation, primarily for food, has had a devastating effect on Bolson Tortoise populations, as demonstrated by the complete extirpation of tortoises within 10 km (6.2 mi) of paved roads and railroads (Morafka, 1982). Such discriminate extirpation has further fragmented and isolated remaining populations into small colonies that may or may not be viable (Aguirre et al., 1997).

Current Distribution and Status

It is difficult to delineate the current range of the Bolson Tortoise, due to the fragmented nature of the distribution; however, it is generally centered in the Bolson de Mapimi (Morafka, 1982). This area consists of interconnected closed drainage basins in southeastern Chihuahua, northeastern Durango, and western Coahuila, Mexico. Bury et al. (1988) divided the range of the Bolson Tortoise into six districts, estimating the total area of tortoise occurrence within the districts to be just over 6000 km^2 (2316 mi^2) Bury and his colleagues also conducted multiple field surveys of Bolson Tortoise habitat in the 1970's and estimated the area actually occupied by tortoises to be approximately 700 km^2 (270 mi^2) which could support a maximum of 10,000 adults (Bury et al., 1988).

Little is known about the current status of the Bolson Tortoise. There is substantial evidence that few isolated populations or colonies of tortoises contain sufficient numbers of individuals to allow long-term persistence (Bury et al., 1988). If humans continue to have a deleterious effect on tortoise populations, either directly through collection or indirectly through habitat degradation, the only remaining bolson tortoise populations will reside in protected areas such as the Mapimi Biosphere Reserve and Rancho Sombreretillo (Bury et al., 1988; Trevino et al., 1997).

Protection of the Species

In 1979, the Bolson Tortoise was listed as endangered under the United States Endangered Species Act (USFWS, 2006). Despite the fact that it was listed more than twenty-five years ago, the Fish and Wildlife Service has neither published critical habitat nor formed a recovery team to initiate the writing of a recovery plan and establish recovery criteria. Given that the Bolson Tortoise was listed as endangered only within Mexico, it is not surprising that few benefits from the USFWS, other than publicizing its plight, have come to the species as a result of its listing.

The Bolson Tortoise is additionally protected under Mexican wildlife laws issued by the Ministry of Social Development (Secretaría de Desarrollo Social [SEDESOL]) and listed in Appendix I of the Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES). In all probability, the best form of local protection for the tortoise was the

establishment of the Mapimi Biosphere Reserve in Durango, Mexico in 1977 (Aguirre et al., 1997). Despite limited resources to enforce protections granted the tortoise, the reserve has successfully initiated many essential research projects encompassing many aspects of Bolson Tortoise ecology (Morafka, 1982; Aguirre et al., 1997).

Employed Conservation Efforts

As part of the many-faceted conservation program at Mapimi Biosphere Reserve, scientists successfully established a captive-breeding program and reintroduced juvenile tortoises into wild populations. In association with the captive-breeding program, scientists studied the survival and behavior of hatching and juvenile tortoises (Aguirre et al., 1997).

In an effort to diversify their conservation strategy, tortoise ecologists moved 16 adult tortoises from the Mapimi Biosphere Reserve to an enclosure on the Appleton Research Ranch in Elgin, Arizona between 1971 and 1976 (Appleton, 1978). The tortoises were monitored to assess how well they adapted to the area that was a part of their range thousands of years ago. The translocation was deemed successful when the tortoises utilized the supplied artificial burrows but did not require supplemental food, as they were able to subsist on the native grasses and forbs in the enclosures (Truett et al., 2006). Since the translocation, a captive-breeding program and several research projects have been initiated.

Figure 3. Juvenile Bolson Tortoise. Photo by Cecil R. Schwalbe.

Several years ago, ecologists and others with a vested interest in the Appleton Research Ranch tortoises discussed the idea of moving some of the tortoises to additional sites where captive breeding programs could be established (Truett et al., 2006). They believed it would be beneficial to have more than one captive-breeding population under different political jurisdictions. In September 2006, 37 tortoises (30 adults and 7 hatchlings) were moved from the Appleton Research Ranch to 3 locations in New Mexico (Traphagen et al., 2007). Four adult tortoises that had tested positive or suspect for exposure to *Mycoplasma* sp. were moved from Elgin to the Living Desert Zoo and Gardens State Park in Carlsbad. Twenty-six adult tortoises that tested negative for exposure to *Mycoplasma* sp. were translocated to the Armendaris Ranch, near Truth or Consequences. Additionally, seven hatching Bolson Tortoises were moved to a large indoor terrarium at the Ladder Ranch, southwest of Truth or Consequences.

Proposed Conservation Efforts

In 1991, two Bolson Tortoise biologists submitted a proposal to Big Bend National Park (BBNP) to reintroduce the tortoise (Donlan et al., 2006). Surveys conducted in BBNP indicated that the habitat requirements of the Bolson Tortoise, in terms of climate, substrate, and vegetation, could be met in the park despite the fact that tortoises last inhabited the area during the late Pleistocene (Aguirre et al., 1997). However, BBNP rejected the proposal, stating that Gopherus flavomarginatus was an alien species (Houston and Schreiner, 1995). This decision by the National Park Service is particularly interesting when it is noted that in 1996, Grand Canyon National Park reintroduced the California condor (*Gymnogyps californianus*) in spite of the fact that it last occupied the Grand Canyon 10,000 years ago (Donlan et al., 2006). Obviously, there are inconsistencies in the National Park Service's policy regarding reintroductions and the nature of native or non-native species. Given that the existence and range of many North American species were dramatically altered at the end of the Pleistocene, it will probably become necessary for the National Park Service to delineate on which temporal scale their definitions of native or alien species will be based.

Arguments pertaining to the reintroduction of Bolson Tortoises into the southwestern United States have recently resurfaced as a result of a controversial proposal calling for conservation in the form of "Pleistocene rewilding" (Donlan et al., 2005). According to Drs. Harry Greene and Paul Martin, two of rewilding's strongest proponents, it is more appropriate to consider the moment when humans first arrived in North America (approximately 13,000 years ago) than 1492 as the benchmark for ecological restoration. The loss of North America's megafauna has had a profound impact on most ecosystems, and the reintroduction of these species (or their proxies) would facilitate the restoration of these

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ecosystems (Donlan et al., 2006). Donlan and his colleagues suggest that the reintroduction of the Bolson Tortoise should be one of the first steps in rewilding because the associated costs would be low, while potential conservation and economic benefits could be significant. Although current political climates prevent any such reintroduction in the near future, it certainly does provide some food for thought.

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