SONORAN DESERT TORTOISE POPULATION MONITORING

Jeffrey M. Howland
Amphibians and Reptiles Program Manager
Nongame Branch, Wildlife Management Division

Technical Report 38
Nongame and Endangered Wildlife Program
Program Chief: Terry B. Johnson
Arizona Game and Fish Department
2221 West Greenway Road
Phoenix, Arizona 85023-4312

June 1994

Recommended citation: Howland, J.M. 1994. Sonoran desert tortoise population monitoring. Nongame and Endangered Wildlife Program Technical Report 38. Arizona Game and Fish Department, Arizona.

Funding for this project was provided by: the Arizona Game and Fish Department's Heritage Fund; Arizona's Nongame Wildlife Checkoff; Project E5, Job 21, under Title VI of the Endangered Species Act; and various contracts with the Bureau of Land Management.

Sonoran Desert Tortoise Population Monitoring

Jeffrey M. Howland

Introduction

When the desert tortoise (*Gopherus agassizii*) was emergency listed as an endangered species in 1989, it became necessary to gather information on population trends throughout the range of the species in the United States. One result was initiation of this population monitoring project for the Sonoran desert tortoise in Arizona, through Fish and Wildlife Service (FWS) funding under Section 6 of the Endangered Species Act. Section 6 funding covered one or two plots per year over the four year duration of the project (1990-1993). The Nongame Checkoff Fund, Nongame Donations Fund, Arizona Game and Fish Department (AGFD) Heritage Fund, and the U.S. Bureau of Land Management (BLM) have provided funding for an additional two to five plots per year.

Primary objectives of the project were determination of population trends (status, including population size and age-structure) of Sonoran desert tortoises and an evaluation of the various threats and impacts to these populations. Because disease, especially Upper Respiratory Tract Disease (URTD) and "shell disease," was an important stimulus for listing the Mojave population of the desert tortoise, careful examination and photodocumentation of disease symptoms were a major emphasis. Information from early stages of this project formed the primary basis of a FWS decision not to list the Sonoran population of the desert tortoise.

Although Section 6 funding was discontinued for federal FY95, we are continuing our monitoring program through Heritage and Checkoff funds, a task order from BLM, and a new Partnerships for Wildlife project. Information from subsequent years will be used in ongoing evaluation of protection and management needs for the Sonoran population of the desert tortoise.

History

In 1990, AGFD began active involvement in population monitoring for the Sonoran population of the desert tortoise. That year, we performed standard 60-day surveys at four sites (Shields et al. 1990). Two of these, the Eagletail Mountains and Maricopa Mountains, had been surveyed previously under similar protocols (Shields and Woodman 1988; Wirt 1988). The other two, Little Shipp Wash and Granite Hills, had been study sites for tortoise projects that involved marking, but survey protocols were dissimilar (Schneider 1981; Schwartzmann 1983). These plots were selected partly based on the fact that they had been studied previously, and partly because they cover substantial portions of the geographic and habitat ranges of Sonoran desert tortoises in Arizona. Little Shipp Wash is in transitional habitat between Sonoran Upland and Interior Chaparral, while the Eagletail Mountains and Granite Hills are somewhat transitional between Sonoran Upland and Lower Colorado Desert (with the Granite Hills leaning toward the former vegetation type and the Eagletails toward the latter). The Granite Hills receive summer rains more reliably than the Eagletail Mountains. The Maricopa Mountains site was selected largely because a die-off was identified during the initial survey (Wirt 1988).

In 1991, we resurveyed three of these plots (Hart et al. 1992). We chose not to continue monitoring at the Maricopa Mountains site because the severe population decline in the mid to late 1980s had reduced tortoise numbers to the point where the standard survey protocol was not a cost effective means of information gathering. Instead, we carried out a preliminary and cursory search for evidence of mortality at four sites off of the plot (but still within the Maricopa Mountains) and on the plot itself in order to determine the geographic extent of the die-off (Hart et al. 1992). Study of the Maricopa Mountains population has continued under a Heritage grant from the Department to an independent researcher.

Because suitable habitat at the Eagletail Mountains site is limited and tortoise numbers are relatively small, we chose to reduce survey time to approximately 35 person days. We ran standard 60-day surveys at Little Shipp Wash and Granite Hills. In addition, BLM funded initial standard surveys at four new sites: West Silverbell Mountains, San Pedro Valley, Hualapai Foothills, and Wickenburg Mountains (Hart et al. 1992).

In 1992, we surveyed the three AGFD plots and, through a task order from BLM, established new plots at Bonanza and Mineral Mountain (Tortilla Mountains) (Woodman et al. 1993). We decided tentatively that after 1992, enough monitoring plots were established around the state, and began long-term rotation to cover each plot on a periodic basis (period of rotation has not been decided and may be more dependent upon available funding than upon biology or sampling design).

In 1993, we surveyed the three AGFD plots for the fourth consecutive year (this will be extended to five years in 1994). We performed the second coverage of the Harcuvar Mountains plot, originally established in 1988 (Woodman and Shields 1988), and the East Bajada plot (Black Mountains), initially surveyed in 1990 (SWCA 1990).

Site descriptions (including topography, vegetation, human impacts, and climate) and methodology for population surveys under this project are thoroughly documented by Shields et al. (1990), Hart et al. (1992), and Woodman et al. (1993, 1994). These references also provide information on sex ratios, size structure, morphological anomalies, growth, reproduction, spatial distribution, and behavior.

Summary of Results

Population Size and Mortality

On the three 1 mi^2 AGFD plots, we have fairly reliable estimates of population size of subadult and adult tortoises. Population density ranges from moderate (for Arizona) in the Eagletail Mountains (about 31 adults and subadults) to high in the Granite Hills (about 90 subadults and adults in 1993) and Little Shipp Wash (about 107 adults and subadults). A total of 146 tortoises have been marked at both Granite Hills and Little Shipp Wash, but size structure between the two plots differs markedly. Marked adults and subadults total 104 at Little Shipp, but only 77 at Granite Hills. Granite Hills tortoises also reach smaller body sizes (no tortoises exceeded 270 mm MCL in 1993) than Little Shipp tortoises (32 tortoises 270 mm or more in 1993). At the Eagletail Mountains, 62 tortoises have been marked. Like Little Shipp, most (39 individuals) were adults or subadults and body size is frequently greater than 270 mm MCL (11 individuals in 1993).

We have been able to estimate time since death for all carcasses found within four years of death on the plots from 1990 to 1993. We therefore have carcasses that died between 1986 and 1993 for each of the plots. At Little Shipp Wash, we know of 13 adult mortalities over this period. Most were probable, or at least possible, mountain lion kills (based on bone breakage, claw marks, etc.), including seven of the eight carcasses found in 1993. Mountain lion predation appears to be common at Little Shipp, and possibly is increasing, though 1993 may have been an aberrant year. At the Eagletail Mountains, no adults are known to have died from 1986 to 1993, though carcasses of several younger tortoises were found. At Granite Hills, six adult mortalities were recorded from 1986 to 1993 (all prior to 1991). Other than the dramatic number of recent lion kills at Little Shipp Wash, there seems to be little cause for concern at these sites.

At the Maricopa Mountains, 17 live tortoises were located in 1990, while 119 carcasses were removed from the plot in 1988 and 1990 combined. There is also some evidence for elevated mortality off-plot (Hart et al. 1992). This is by far the most significant decline documented in Sonoran tortoises to date. While we have no definitive explanation, some possible causes have been suggested (see below).

In 1988 and 1993 combined, 73 tortoises have been marked at the Harcuvar Mountains. Eight carcasses were found in 1988 (0 adults ≤4 years) and five in 1993 (4 adults ≤4 years). At East Bajada, for 1990 and 1993 surveys combined, 67 tortoises were marked and 14 carcasses were found. Only 1 adult ≤4 years was observed, but 10 tortoises, mostly immatures, are thought to have died in 1992 and 1993. Trauma on carcasses suggests that dogs may be responsible. No live tortoises <160 mm MCL were encountered in 1993.

The numbers of tortoises marked and known mortality on other plots surveyed during the four years of this project varied considerably. West Silverbell Mountains: 64 tortoises marked, 11 carcasses (only 3 adults ≤4 years); San Pedro Valley: 43 tortoises marked, 11 carcasses (7 adults, all ≤4 years); Hualapai Foothills: 37 tortoises marked, nine carcasses (5 adults ≤4 years); Wickenburg Mountains: 15 tortoises marked, three carcasses (2 adults ≤4 years); Bonanza: 17 tortoises marked, 13 carcasses (10 adults ≤4 years; dogs possibly responsible); Mineral Mountain (Tortilla Mountains): 52 tortoises marked, 12 carcasses (5 adults ≤4 years).

The New Water, Arrastra (Poachie), and Harquahala mountains plots had small numbers of tortoises (Shields and Woodman 1988b; Wirt 1988; Holm 1989, respectively). A large number of carcasses were found on the Arrastra plot in 1987 (Wirt 1988). Additional plots have been established at the Mohave and Santan mountains, with no tortoises marked at the former and a few at the latter (SWCA 1990). At least two plots have been surveyed on military land (the Goldwater Range) in the Sand Tank Mountains. Other surveys in the Sand Tanks have located fairly large numbers of tortoise carcasses (P. Woodman, pers. comm.). A high density population on U.S.

Forest Service land near Sugarloaf, west of the Mazatzal Mountains, is under study by a graduate student at the University of Arizona. There has been no report of high mortality at this site. Other graduate student projects on tortoises, involving marking of large numbers of animals, have occurred at the Picacho Mountains (Barrett 1990) and Tucson Mountains (B. Martin, pers. comm.). Work at Saguaro National Monument (Goldsmith and Shaw 1990) identified URTD symptoms (A. Goldsmith, pers. comm.), while studies at Organ Pipe Cactus National Monument located fairly high numbers of carcasses (Wirt, pers. comm.).

Disease Symptoms

Disease symptoms were observed on most plots. In the Sonoran population of the desert tortoise in Arizona, overt clinical symptoms of URTD are rare. However, we have limited information, based on ELISA analysis of blood samples from tortoises at various localities around Arizona, to suggest that *Mycoplasma agassizii*, the causative agent for URTD, is present in the Sonoran population and may be widespread (e.g. Dickinson 1994). It is still unclear why URTD in Sonoran tortoises has not resulted in levels of mortality similar to those observed in the Mojave population. Perhaps *M. agassizii* has been present throughout much of the recent evolutionary history of the Sonoran population and absent, until recently, from the Mojave population. This might explain disease resistance among Sonoran tortoises contrasted with vulnerability among Mojave tortoises.

Incidence of breathing anomalies (raspy or congested breathing, nasal discharge, etc.) was as high as 30% of all tortoises at East Bajada (3 tortoises, 7%, with discharge); 4-9% at Granite Hills, declining steadily over the four year period from 32% in 1990 to 4% in 1993; 11% at Harcuvars in 1993; 12-25% at Little Shipp Wash; 12% at Maricopa Mountains; 2% at West Silverbells; 5% at San Pedro Valley; 5% at Hualapai Foothills; 7% at Wickenburg Mountains; 6% at Bonanza; and 4% at Mineral Mountain (Tortilla Mountains).

The second major "disease" currently under scrutiny is commonly referred to as shell disease. Lesions of this disease appear as flaky, whitish areas, usually along scute margins and typically more pronounced on the plastron than on the carapace. The cause(s) and significance of shell disease are still unknown. There is some circumstantial evidence to suggest that high mortality may be associated with the presence of shell disease, yet some apparently healthy populations (populations demonstrating no declining trend) have a high incidence of shell lesions. Among Arizona plots, shell disease is particularly prevalent at East Bajada, with 67% of all tortoises sampled in 1993 showing shell lesions. Symptoms are also common at Bonanza, with 41% of tortoises affected, and Little Shipp Wash, with 21-39% showing lesions, depending on the year. At the Granite Hills, shell lesions occurred in only 2-11% of all tortoises. At the Eagletail Mountains, lesions were present in 0-4% of tortoises sampled. For other plots, incidence of lesions has been low: 10-15% at Harcuvar Mountains; 6% at Maricopa Mountains; 0% at West Silverbell Mountains; 0% at San Pedro Valley; 3% at Hualapai Foothills; 0% at Wickenburg Mountains; and 12% at Mineral Mountain (Tortilla Mountains).

Population Trends

Lincoln-Peterson estimates of population size for most plots surveyed more than once indicate at least some degree of population stability. For the Granite Hills, estimates of population size, both total and adult/subadult, increased over the four year period (Woodman et al. 1994, Table 4). At Little Shipp Wash, population estimates have increased over the same period, especially for total number of tortoises (tortoises of all sizes included). To a lesser extent, estimates of numbers of adults and subadults have also increased (Woodman et al. 1994, Table 23). Eagletail Mountains population estimates have increased slightly for all tortoises, while subadult/adult estimates have remained nearly identical over the four years (Woodman et al. 1994, Table 47). Reliable estimates of population size are not available for more than one year at any of the other monitoring sites, so it is not possible to speculate on population trends, except that some plots (e.g. Maricopa Mountains and Bonanza) had such high mortality rates that population decline can be reasonably inferred (see below).

Conclusions and Recommendations

At present, we lack sufficient data to describe population trends on a statewide basis in Arizona. We have, however, established a solid foundation for gathering such data over the next several years. We have estimates of population size from more than two years at only three sites. Fortunately, these three sites represent a large portion of the geographic and habitat range of Sonoran desert tortoises in Arizona. At these sites, populations appear to be stable or even growing. However, we cannot safely extrapolate from apparent stability at three sites to conclude stability for the Sonoran population as a whole. Potential threats to population stability vary in nature, severity, and extent, but have been identified in several areas around the state.

Urban and agricultural development have resulted in loss of some populations and fragmentation or isolation of others. Naturally occurring populations of tortoises have essentially disappeared from mountain preserves in the Phoenix Valley and development along the outskirts of metropolitan Phoenix and Tucson continues to encroach upon tortoise habitat. Though agriculture, canals, and highways often do not directly impact Sonoran tortoises or their habitat, they may preclude or reduce natural migration between mountain populations, amplifying isolation in an already fragmented landscape. Evidence for genetic isolation may be provided by the high frequency of morphological anomalies (mostly consisting of unusual numbers or shapes of scutes) observed in Sonoran desert tortoises.

High levels of mortality have been documented or are suspected at several sites. Causation remains unknown and even our suspicions differ from one site to another. Decline in the Maricopa Mountains is well established. Several workers suspect highly localized, long-term drought at the plot, and it is hypothesized that drought-related stress has resulted in increased mortality. Proximate causes of mortality are unknown, but may include starvation, stress-induced disease, or even consumption of toxic plants in the absence of more palatable foods. These hypotheses remain untested.

Our 1992 spot surveys indicate high mortality may have been widespread within the Maricopas, but recent work indicates that a healthy population occurs within three miles of the monitoring plot at a ridge known as Espanto (B. Wirt, pers. comm.). We recommend a study of growth rings in perennial plants at the plot and a nearby weather station (where long-term precipitation is known) to determine whether a local drought actually occurred (and is perhaps ongoing) at the monitoring site. If not, it may be difficult or impossible to determine the cause of decline. Even if there has been a drought, it may not be possible to unequivocally attribute the die-off to drought-related stress.

At Bonanza, it has been suggested that high mortality in recent years may be attributable to predation by dogs from a small community near the plot (Woodman et al. 1993). A similar hypothesis has been made to explain high mortality (especially for smaller tortoises) in 1992 and 1993 at East Bajada. At both sites, domestic/feral dogs were seen on the plot. Both live and dead tortoises at these sites showed trauma that differs from that typically observed on plots where dogs are not present (i.e. where any predation is due to native predators such as coyotes, mountain lions, etc.). Trauma was similar to that caused by a dog in an attack that was observed by a field worker at Bonanza (Woodman et al. 1993). In both cases, nearby human settlements, which are not present near most plots, serve as a source for dogs.

At San Pedro Valley and Hualapai Foothills, numbers of carcasses, recency of death, and size class of dead tortoises are suggestive of declines, but sample sizes and short time frame (no trend information) make it difficult to be certain. High mountain lion predation at Little Shipp Wash seems unlikely to be damaging to the population in the long-term, though we will continue to monitor the situation there.

Although populations seem healthy at several sites (e.g. Little Shipp Wash, Granite Hills, Mineral Mountain, West Silverbell Mountains), evidence of high levels of mortality at other sites (e.g. Maricopa Mountains, Bonanza, Sand Tank Mountains) and the high frequency and widespread occurrence of disease symptoms are cause for concern.

There are now nine established plots that are appropriate for inclusion in a rotating long-term monitoring program: Little Shipp Wash, Granite Hills, Eagletail Mountains, West Silverbell Mountains, San Pedro Valley, Mineral Mountain, Hualapai Foothills, East Bajada, Harcuvar Mountains. Plots that should not be considered for further monitoring on a regular basis, because population densities are too low, are: New Water Mountains, Wickenburg Mountains, Santan Mountains, and Mohave Mountains. In spite of small population size, Bonanza, Arrastra Mountains, and Maricopa Mountains should be surveyed periodically in order to track continued mortality or recovery. The second survey of the Harquahala Mountains plot is in progress, and further evaluation of future work on this site will depend upon this year's results. It might be desirable to have as many as 12-16 plots in the rotation, so we should consider using some of those already established by other workers (e.g. Sugarloaf, Sand Tank Mountains, national monument sites) after incompatible research uses (such as telemetry, x-rays, etc.) are completed. Alternatively, there is still some potential to establish new sites near these areas or in other areas that are known to support reasonably large tortoise populations.

We must investigate mortality and its causes and continue monitoring of populations at numerous sites around the state in order to allow development of sound approaches for management of Sonoran desert tortoises in Arizona. Although several local populations seem stable, we can not conclude that the Sonoran desert tortoise population as a whole is secure. High mortality at some sites and a lack of certainty as to its causes (which probably differ among sites) leave us unable to make confident predictions on future trends or to develop conservation strategies that specifically address threats. Assuring the vitality of a robust monitoring program will entail commitment by state and federal land and resource management agencies to continue funding from existing resources and aggressively pursue supplemental support.

Literature Cited

Barrett, S.L. 1990. Home range and habitat of the desert tortoise (*Xerobates agassizii*) in Picacho Mountains of Arizona. Herpetologica 46:202-206.

Dickinson, V.M. 1994. Health studies of Sonoran desert tortoises, 1993 annual report. Arizona Game and Fish Department, Phoenix.

Goldsmith, A. and W.W. Shaw. 1990. Report on desert tortoise telemetry studies in Saguaro National Monument 1989. University of Arizona, Tucson.

Hart, S., P. Woodman, S. Bailey, S. Boland, P. Frank, G. Goodlett, D. Silverman, D. Taylor, M. Walker and P. Wood. 1992. Desert tortoise population studies at seven sites and a mortality survey at one site in the Sonoran Desert, Arizona. Arizona Game and Fish Department, Phoenix.

Holm, P.A. 1989. Desert tortoise monitoring baseline study: Harquahala Mountains. Bureau of Land Management, Phoenix District, Arizona.

Schneider, P.B. 1981. A population analysis of the desert tortoise (*Gopherus agassizii*) in Arizona. Bureau of Land Management, Phoenix District, Arizona.

Schwartzmann, J. 1983. Desert tortoise in the Picacho Mountains. Draft M.S. thesis, Arizona State University, Tempe.

Shields, T., S. Hart, J. Howland, T. Johnson, N. Ladehoff, K. Kime, D. Noel, B. Palmer, D. Roddy and C. Staab. 1990. Desert tortoise population studies at four plots in the Sonoran Desert, Arizona. Arizona Game and Fish Department, Phoenix.

Shields, T. and A.P. Woodman. 1988a. A study of the desert tortoise in the Eagletail Mountains, Maricopa County, Arizona. Bureau of Land Management, Phoenix District, Arizona.

Shields, T. and A.P. Woodman. 1988b. Some aspects of the ecology of the desert tortoise at the New Water study plot, Arizona. Bureau of Land Management, Phoenix District, Arizona.

SWCA. 1990. Final report for 1990 East Bajada desert tortoise study plot, Mohave County, Arizona. Bureau of Land Management, Kingman Resource Area, Arizona.

Wirt, E.B. 1988. Two desert tortoise populations in Arizona. Bureau of Land Management, Phoenix District, Arizona.

Woodman, A.P. and T. Shields. 1988. Some aspects of the ecology of the desert tortoise in the Harcuvar study plot, Arizona. Bureau of Land Management, Phoenix District, Arizona.

Woodman, A., S. Boland, P. Frank, G. Goodlett, S. Hart, D. Silverman, T. Shields, and P. Wood. 1993. Desert tortoise population surveys at five sites in the Sonoran Desert, Arizona. Arizona Game and Fish Department, Phoenix.

Woodman, P., S. Hart, S. Boland, P. Frank, D. Silverman, G. Goodlett, P. Gould, D. Taylor, M. Vaughn, and P. Wood. 1994. Desert tortoise population surveys at five sites in the Sonoran Desert of Arizona, 1993. Arizona Game and Fish Department, Phoenix.