# Have desert tortoises undergone a long-term decline in abundance?

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**The desert tortoise reportedly had widespread, high-density populations (>1,000/km$^2$) in the Mojave Desert that declined during 1900–1970 into isolated fragments with greatly reduced densities. These authors question this scenario...**

The desert tortoise (*Gopherus agassizii*) is a large herbivorous reptile occurring in most parts of the Mojave and Sonoran deserts in the southwestern United States and the Sinaloan shrub region in northwestern Mexico. This turtle requires 13–18 years to reach sexual maturity, and adults may live ≥30 years (Turner et al. 1987; Germano 1992, 1994). These demographic traits suggest that populations of tortoises are slow to recover from declines and that mortality of adult animals is a threat to survival of populations (U.S. Fish and Wild. Serv. [USFWS] 1993*a*). Since the mid-1980's, large decreases in numbers of adult tortoises have been reported in the western Mojave Desert, apparently due to the outbreak of an upper respiratory disease, loss of habitat, and other perturbations (Spang et. al. 1988, Berry 1989, Jacobson et al. 1991, USFWS 1993*a*). These recent losses and threats to populations led to listing of *G. agassizii* as threatened in the Mojave Desert of Arizona, California, Nevada, and Utah (USFWS 1990).

Besides the recent losses, the distribution and abundance of tortoises reportedly have undergone large declines during the past century resulting from human encroachment of the desert. For example, "Historical information show [sic] that the tortoise populations in the Mojave Desert have lost 60% of their range and 90% of their numbers in the last 100 years" (Bur. Land Manage., rep. to U.S. House of Representatives, Comm. Int. and Insular Affairs and U.S. Senate Comm. Energy and Nat. Resour., 1990:3). This scenario was a major factor in the initial petition in 1984 by several non-governmental organizations to list the tortoise as threatened (Campbell 1988, Johnson et al. 1989) and the Fish and Wildlife Service's determination that listing was warranted but precluded (USFWS 1985, 1987).

However, data supporting a long-term decline in abundance and distribution of tortoises have never been published, and the scenario of a large decline from 1900–1970 needs scrutiny. The conservation community and many scientists have accepted as fact that tortoises have undergone a long-term decline in abundance and distribution, and this belief has promoted management actions potentially harmful to tortoises. In this essay, we examine unpublished information and published evidence on the presumed historic losses of tortoise populations in the Mojave Desert, evaluate recommendations for tortoise management that were based on the scenario of a long-term decline, and discuss the importance of peer review in wildlife conservation.

## Hypothesized long-term declines

Most evidence for a long-term decline of *G. agassizii* was presented in one chapter (Berry 1984:118–153) of a major report (Berry 1984) submitted to USFWS by the Desert Tortoise Council in

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support of the initial petition to list the tortoise. Although it is not customary to critique unpublished reports, we feel it is justified here for several reasons. The chapter contains the only data and analysis supporting a long-term decline. The full report has been a major resource in USFWS decisions concerning listing, and it has been cited frequently in non-refereed literature (e.g., Dodd 1986, Anonymous 1989, Bostick 1990) as well as refereed literature (e.g., Berry 1986, Berry and Turner 1986, Nagy and Medica 1986, Turner et al. 1987, Germano and Joyner 1988, Schneider and Everson 1989). Because the analysis of long-term declines (Berry 1984:118–153) is not readily available, we briefly summarize its data and conclusions.

Berry (1984:118–153) reviewed technical literature and cited 12 references for historical abundance of tortoises in California. Four published accounts included anecdotes of tortoise declines, but none of the published accounts provided density estimates. Berry (1984:118–153) also queried people who were long-term residents of the desert, requesting information about past and current observations of the desert tortoise in California. The analysis of published information and responses to questionnaires was partitioned into three geographic regions in southern California: the western Mojave Desert (areas near Barstow, Victorville, Mojave, Twentynine Palms, and Joshua Tree National Monument), the eastern Mojave Desert (near Goffs, Ivanpah, and valleys near or adjacent to the Nevada border), and the Colorado Desert (south and east of Palm Springs).

Most responses to questionnaires (23 of 28 persons) were from the western Mojave Desert and they reported seeing fewer tortoises currently (late 1970's?) than in the past. Berry (1984:138) stated that the densities of tortoises in the western Mojave Desert before extensive human disturbance, "...were probably in excess of the highest levels (≈250/sq. mile) found in the late 1970's when formal censuses were taken. Densities may have ranged from 500 to over 1,000 tortoises/sq. mile in some areas." However, no description of the method used to estimate this historical abundance was provided.

The survey respondents reported a variety of human activities as causing declines of tortoises, including collection for pets and food, vandalism, mortality on roads, military training activities, off-road vehicles, urbanization, livestock grazing, and conversion of desert to crop lands. Berry (1984:118–153) concluded that these factors were the most convincing explanation for the declines in the western Mojave Desert.

Desert tortoise in the Mojave Desert, Clark County, Nevada (Photo by P. S. Corn)

Few data exist for estimating historical abundance of tortoises in the eastern Mojave and Colorado Deserts in California. Berry (1984:141) stated that, "The distribution and abundance in this region may not have changed noticeably."

Berry (1984:118–153) dealt only with *G. agassizii* in California. Subsequently, Berry (1989:5) stated that, "Until a few decades ago, the desert tortoise was widespread at lower elevations throughout the Mojave and Sonoran deserts of the U.S.A. In the northern and western parts of the geographic range, large and relatively homogeneous populations with densities exceeding 1,000/sq km extended throughout parts of California, and probably into Nevada and Utah... In most areas, numbers have declined dramatically and the extent of populations has been reduced. Most populations are now isolated and low in numbers."

The scenario of formerly dense populations and a long-term decline of *G. agassizii* is now routinely accepted as fact in conservation and news articles. For example, "In the United States it now exists in only a handful of scattered populations in the Mohave Desert of California, Nevada, Arizona, and southwestern Utah and in the Sonoran Desert of Arizona" (Johnson 1982:9); "According to biologists, the tortoise population has been reduced by 90 percent in certain prime habitats and altogether in others. In fact, the reptile's entire range...has been fragmented to such an extent that the tortoise is now confined to a scattering of ever-diminishing islands" (Holing 1986:28); and "It suffered a 60-percent reduction in range and a 90-percent reduction in numbers over little more than a century... There are no historical data for desert tortoise densities in Nevada before the 1970s, but...they must have been distributed much more continuously and at considerably higher densities over approximately the current range" (Campbell 1988:570).

## Published evidence

We found several early observations and accounts in the technical literature on *G. agassizii*, including some explicit statements of relative abundance. We present relevant excerpts from these accounts in chronological order.

Frémont (1845) traveled from California through the Mojave Desert to Utah in April and May, 1844. His account of the expedition did not mention tortoises, although he described the inhabitants of the Virgin River area east of Las Vegas as roasting lizards for food. The first account of desert tortoise abundance we found was in the diary of Balduin Möllhausen, an artist and naturalist accompanying Lieutenant. A. M. Whipple's expedition exploring the 35th parallel for a railroad route. This expedition traversed the Mojave Desert from the Colorado River at the present-day site of Needles, California, westward across the Providence Mountains to the end of the Mohave River, then up the river to Cajon Pass. When the expedition reached Piute Spring east of Lanfair Valley (eastern California) on 3-4 March 1854, Möllhausen (1858:287) wrote, "...the number of turtle-shells lying about showed this to be a favourite food of the natives of the country... Wherever we found water we found also the remains of turtle, but we did not succeed in obtaining a single living one; a proof of how eagerly they are pursued by the Indians." On 7 March at Soda Lake, the terminus of the Mohave River, Möllhausen (1858:294) wrote, "It struck us all that, after leaving the Colorado, we had met with no living creature but some horned lizards." Möllhausen did not mention tortoises during the remainder of the trip through the western Mojave Desert.

The U.S. Biological Survey's Death Valley expedition in 1891 collected desert reptiles from the eastern Mojave Desert in Nevada, Arizona, and Utah in the spring and summer of 1891, but only 2 tortoises were collected from the Pahrump Valley, Nevada, west of the Spring Mountains. The field notes of C. Hart Merriam stated of the tortoise, "...it is so sought after by Pah-Ute Indians and coyotes that it is rather scarce" (Stejneger 1893:162). In the western Mojave Desert in California, Merriam wrote, "...[the tortoise] is tolerably common in the Mohave Desert, California, where 1 was caught between Daggett and Pilot Knob, April 24, and another at Leach Point Valley April 25" (Stejneger 1893).

Camp (1916) observed 10 desert tortoises during 19 field days in the Turtle Mountains in eastern San Bernardino County, California, in June 1914. He listed them as fairly common in Joshua tree (*Yucca brevifolia*) habitats and rare in rocky hillside and canyon bed habitats. In a discussion of desert tortoises in California, Camp (1916:513) stated, "Tortoises, though widely distributed, appear to be common at few places in the desert."

Klauber (1932) recorded no localities for tortoises on 2 trips through southern Nevada in April 1931 and April 1932. In California, Miller (1932:196) stated that, "Five days rambling by a party of six people on the hills north of Barstow in most favorable season and territory yielded only four or five animals. The season was April, and green food was abundant both in the broken hills and on the bajadas. Fresh tracks, feces, and deserted winter burrows were more common than on any other field trip, yet the animals were not often encountered." Miller (1932) summarized 20 years of observations in the deserts of southern California by stating, "In none of these areas is the reptile at all common."

Commenting on the area near Hodge, California, west of Barstow, Grant (1936) reported that, "By driving to likely places, making a hurried reconnaissance and hunting only where tracks abounded the writer was able to collect ten specimens in about six hours..." Linsdale (1940:255) listed 5 localities for *G. agassizii* in Nevada, and stated, "Tortoises are found widely scattered over the desert on flat sandy or gravelly ground."

Johnson et al. (1948) reported on 367 days of collecting vertebrates by 18 persons from 1917-1945 in and around the Providence Mountains in eastern California. They described desert tortoises as occurring in "a wide variety of situations" and observed 4 tortoises in a radius of 100 yards near Kelso. However, they listed only 5 localities where tortoises were observed, despite collecting in at least 13 localities in creosote bush (*Larrea tridentata*) and *Yucca* habitats where tortoises might occur. Miller and Stebbins (1964) listed 9 localities for desert tortoises in Joshua Tree National Monument, California and described its occurrence as "widely distributed."

## Alternative interpretations

Reports of a long-term decline in abundance and distribution of *G. agassizii* are mainly based on circumstantial and anecdotal evidence. Even the primary advocate for this scenario stated, "The major problem in determining distribution and abundance of desert tortoises in California prior to the 1970's is the lack of data" (Berry 1984:144). Despite this lack of data, she argued that there were formerly dense, widespread populations of the tortoise in the western Mojave Desert of California. Since then, the esti-

mated maximum historical density of tortoises has increased without explanation and the extent of high-density populations has expanded to all of the Mojave Desert (Table 1). However, the oft-cited figures of a 90% decline in numbers and a 60% decline in geographic distribution for the species as a whole (Holing 1986, Campbell 1988) were given by Berry (1984:118–153) as applying just to 15,550 km$^2$ of the western Mojave Desert in California. There are no published or unpublished data that support the expansion of conclusions about tortoise declines in western California to the entire Mojave Desert.

It is not possible to estimate densities of *G. agassizii* before 1900, and we question whether anecdotal accounts of large populations that have declined in the last few decades should be accepted at face value. Population sizes based on personal interviews can be easily biased toward reporting large populations or rare events, because people recollect outstanding events (e.g., observing many tortoises on one drive through the desert). The respondents to Berry's (1984:118–153) survey also represent a biased sample because most lived in the western Mojave Desert. Distribution and abundance of desert tortoises has declined considerably in the western-most part of its range because of habitat destruction and degradation from agriculture, urbanization, highways, and off-road vehicle activity (Bury and Marlow 1973, Bury et al. 1977, Luckenbach 1982, Berry 1984).

Several naturalists and field biologists provided statements on the occurrence and relative abundance of tortoises between 1850 and 1940. Some published accounts are more detailed (e.g., Stejneger 1893, Camp 1916, Miller 1932) than others (Frémont 1845, Klauber 1932), and therefore, are more useful for inferring historical abundance of tortoises. But none of the published accounts support extraordinarily high abundance of tortoises. Only Grant's (1936) collection of 10 tortoises in 6 hours suggests high abundance, but this was not a systematic survey. Rather, it was "high-grading," a technique favored by herpetologists attempting to quickly catch as many animals as possible. Similar observations of abundance can still be made. For example, P. A. Medica (Natl. Biol. Serv., Las Vegas, Nev.) observed 40 tortoises while driving along a 6.6-km section of dirt road in the Ivanpah Valley, California, during a rainstorm on 28 April 1980.

We believe that greater weight should be given to published statements than to interviews (recollections of events 30 or 40 years earlier), but even the published accounts of tortoise abundance are relative and anecdotal because none represent repeatable or even casual attempts to estimate population size. We conclude that long-term data on tortoise populations are nonexistent.

So, do the available data support the scenario of a dense distribution that has shrunk to a few scattered, declining fragments or, alternatively, was the tortoise distributed in the past much like it is today? *Gopherus agassizii* currently is widely distributed in the Mojave Desert (Bury et al. 1994) with occasional populations reaching high (>77/km$^2$ [200/mile$^2$]) density. A long-term decline in abundance and distribution is radically different from the current situation. Therefore, a heavy burden of proof must be met to support this hypothesis. Published accounts are generally neutral or support the alternative hypothesis of little change, and the anecdotal recollections of desert residents are insufficient evidence to accept the hypothesis of a long-term decline.

Additional evidence, not discussed previously, involves human exploitation of tortoises before European settlement. Archaeological sites with remains of desert tortoises occur frequently within the current range of the species (Schneider and Everson 1989). At least 14 tribes of the native peoples of the Mojave and Sonoran deserts ate tortoises, and Schneider and Everson (1989) considered that the economic importance of tortoises to native cultures has been underestimated. The comments by Möllhausen (1858) and Merriam (Stejneger 1893) indicated that consumption of tortoises by the Piute Indians in the eastern Mojave was common.

Although the overall effect of human predation on *G. agassizii* is currently unknown, aboriginal peoples probably targeted large adult tortoises. We hypothesize that human predation could have precluded dense populations, because increased mortality of adult tortoises (long-lived iteroparous animals) is a severe threat to population viability (Congdon and

Table 1. Estimates of historical density of desert tortoise in the Mojave Desert.

| Density[a] (number/mi$^2$) | Geographic extent | Source |
|---|---|---|
| >250 | Western Mojave Desert in California | Berry (1984:118–153) |
| 200–2,000 | 4 population centers in California (western Mojave and three areas of the eastern Mojave and Colorado deserts) | Berry (1984:502–516) |
| >2,590 | Most of Mojave Desert (California, Nevada, Utah) | Berry (1989) |

[a] Density reported in unit of measure stated in literature cited.

Gibbons 1990, USFWS 1993*a*). Similarly, Morafka (1988) concluded that hunting by Paleo-Indians was largely responsible for a major prehistoric decline in the distribution of the Bolson tortoise (*G. flavomarginatus*) in Mexico. Continued human subsistence hunting and habitat destruction are responsible for present-day declines and listing of *G. flavomarginatus* as endangered (Bury et al. 1988, Morafka 1988).

An additional consequence of the scenario of a long-term decline was that Campbell (1988) and Berry (1989) published similar range maps showing tortoises to be restricted to a few fragmented areas. The apparent rationale for the distribution shown on these maps is that areas with low densities of desert tortoises were considered to be demographic sinks, sustained only by immigration from nearby areas with high densities. For example, Berry (1984:508) stated that populations with densities below 19/km$^2$ (50/mi$^2$) are not viable. We know of no evidence that supports these conclusions. Bury et al. (1994) reported over 1,700 observations of desert tortoise sign (burrows, scats, shells) and live tortoises in Nevada, Utah, and northwestern Arizona, and most observations were made after 1975. Therefore, *G. agassizii* apparently occurs on virtually all undeveloped, suitable habitat in the eastern Mojave Desert. We suggest that analyses of population viability should be viewed as speculative, because knowledge of the life history and biology of desert tortoises is still incomplete (Germano 1992) and maps purporting to show the current distribution of the tortoise should include all areas where tortoises now occur and not just those areas thought to support viable populations.

## Management implications

Before the tortoise was listed as threatened, the scenario of declining, fragmented populations provided the rationale for management decisions that may not have been beneficial to tortoises. For example, areas of low tortoise density received little management and minimal mitigation of activities harmful to tortoises (Spang et al. 1988). This policy could have promoted the fragmentation of the distribution of the tortoise. Tortoises now have a high level of protection, and the proposed large management areas defined as critical habitat (USFWS 1993*b*), if implemented, should be adequate for continued survival of the species. Also, Bostick (1990) accepted the scenario of formerly dense populations of tortoises and argued that the long-term decline in abundance coincided with significant reductions in grazing pressure in the Mojave Desert. He concluded that livestock grazing must be beneficial to tortoises. We consider Bostick's conclusions about how tortoises and livestock might have coexisted at high densities of both to be conjecture. But the coincidence of grazing and dense populations of tortoises poses a difficult problem for the hypothesis of a long-term decline. This problem doesn't exist if tortoises have not undergone a long-term decline.

Finally, we think it is unfortunate that the scenario of a long-term decline of tortoises has become widely accepted in the popular literature and by many wildlife managers when the data supporting this hypothesis have not been critically examined. Non-refereed, unpublished reports (gray literature) are now most of the documentation for important decisions on desert tortoise management, a situation true of wildlife conservation generally (Knopf 1987). The draft recovery plan for *G. agassizii* (USFWS 1993*a*) includes 251 citations, of which 98 are from peer-reviewed journals or books. Many of the latter relate generally to conservation biology, not specifically to *G. agassizii*. However, peer review remains, "the principal means of quality control in scientific publication" (Baskett 1985:190). Further, as Philip Handler (in Harper 1990:47) advised, "The necessity for scientific rigor is even greater when scientific evidence is being offered as the basis for formulation of public policy than when it is simply expected to find its way in the marketplace of accepted scientific understanding." This is essentially the same advice given for assessing population trends of sea turtles, "Future reviews should focus on the need for publication in peer-reviewed journals with clear presentation of techniques, assumptions, and results which follow from the data. Accepting estimates of population size, mortality, and trends, are not justified until these conditions are met" (Dodd and Byles 1991:31).

The importance of peer review is paramount in today's political climate, which has a vocal environmental backlash (Taubes 1993). Perhaps mindful of this backlash, some reviewers of this essay have suggested it not be published because it might be used by opponents of tortoise conservation. However, we believe that rigor is best achieved by publication of biological information in reviewed outlets and that open exchange of scientific evidence is the desired means to develop sound management practices. Management recommendations and actions are often challenged for economic or political reasons. If the underlying data and analyses are flawed, however, then the contributions of scientists and wildlife managers suffer a loss of credibility. Needed conservation efforts may be hampered. If we lose too much credibility, the more important goals of retaining natural ecosystems and professional manage-

ment of natural resources will themselves be threatened or lost. The best way to avoid this bind is to subject our analyses and interpretations to peer review before management plans are developed.

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## Literature cited

Anonymous. 1989. Emergency action taken to protect the desert tortoise. Endangered Species Tech. Bull. 14(9-10):1, 5-6.

Baskett, T. S. 1985. Quality control in wildlife science. Wildl. Soc. Bull. 13:189-196.

Berry, K. H., editor. 1984. The status of the desert tortoise (*Gopherus agassizii*) in the United States. Report to the U.S. Fish and Wildl. Serv., Order 11310-0083-81. 858pp.

Berry, K. H. 1986. Incidence of gunshot deaths in desert tortoise populations in California. Wildl. Soc. Bull. 14:127-132.

Berry, K. H., 1989. *Gopherus agassizi*. Desert tortoise. Occ. Papers, IUCN-The World Conservation Union Species Survival Comm. 5:5-7

Berry, K. H., and F. B. Turner. 1986. Spring activities and habits of juvenile desert tortoises (*Gopherus agassizii*) in California. Copeia 1986:1,010-1,012.

Bostick, V. 1990. The desert tortoise in relation to cattle grazing. Rangelands 12:149-151.

Bury, R. B., T. C. Esque, L. A. DeFalco, and P. A. Medica. 1994. Distribution, habitat use and protection of the desert tortoise in the eastern Mojave Desert. Pages 57-72 *in* R. B. Bury and D. J. Germano, eds. Biology of North American tortoises. Nat. Biol. Survey Fish and Wildl. Research Rep.13.

Bury, R. B., R. A. Luckenbach, and S. D. Busack. 1977. Effects of offroad vehicles on vertebrates in the California desert. U.S. Fish and Wildl. Serv. Wildl. Res. Rep. 8:1-23.

Bury, R. B., and R. W. Marlow. 1973. The desert tortoise—will it survive? Natl. Parks and Conserv. Mag. 47(6):9-12.

Bury, R. B., D. J. Morafka, and C. J. McCoy. 1988. Distribution, abundance, and status of the Bolson tortoise. Ann. Carnegie Mus. 57:5-30

Camp, C. L. 1916. Notes on the local distribution and habits of the amphibians and reptiles of southeastern California in the vicinity of the Turtle Mountains. Univ. Calif. Publ. Zool. 12:503-544.

Campbell, F. T. 1988. The desert tortoise. Pages 567-581 *in* W. J. Chandler, ed. Audubon Wildl. Rep. 1988/1989. Academic Press, San Diego, Calif.

Congdon, J. D., and J. W. Gibbons. 1990. The evolution of turtle life histories. Pages 45-54 *in* J. W. Gibbons, ed. Life history and ecology of the slider turtle. Smithsonian Inst. Press, Washington, D.C.

Dodd, C. K., Jr. 1986. Desert and gopher tortoises: perspectives on conservation approaches. Pages 54-72 *in* D. R. Jackson, and R. J. Bryant, eds. The gopher tortoise and its community. Proc. Fifth Annual Meet., Gopher Tortoise Counc.

Dodd, C. K., Jr., and R. Byles. 1991. The status of loggerhead, *Caretta caretta*; Kemp's ridley, *Lepidochelys kempi*; and green, *Chelonia mydas*, sea turtles in U.S. waters: a reconsideration. Mar. Fish. Rev. 53:30-31.

Frémont, J. C. 1845. Report of the exploring expedition to the Rocky Mountains in the year 1842 and to Oregon and North California in the years 1843-'44. Twenty eighth Congress, Second Session, House Executive Doc. 166. 319pp.

Germano, D. J. 1992. Longevity and age-size relationships of desert tortoises. Copeia 1992:367-374.

Germano, D. J. 1994. Comparative life histories of North American tortoises. Pages 175-185 *in* R. B. Bury and D. J. Germano, eds. Biology of North American tortoises. Nat. Biol. Survey Fish and Wildl. Research Rep. 13.

Germano, D. J., and M. A. Joyner. 1988. Changes in a desert tortoise (*Gopherus agassizii*) population after a period of high mortality. Pages 190-198 *in* R. C. Szaro, K. E. Severson, and D. R. Patton, tech. coords. Management of amphibians, reptiles, and small mammals in North America. U.S. For. Serv. Gen. Tech. Rep. RM-166.

Grant, C. 1936. The southwestern desert tortoise, *Gopherus agassizi*. Zoologica 21:225-229.

Harper, A. E. 1990. Critical evaluation—the only reliable road to knowledge. Bioscience 40:46-47.

Holing, D. 1986. Losing ground. Fast times for the desert tortoise. Amicus J. 1986(Winter):28-33.

Jacobson, E. R., J. M. Gaskin, M. B. Brown, R. K. Harris, C. H. Gardiner, J. L. LaPointe, H. P. Adams, and C. Reggiardo. 1991. Chronic upper respiratory tract disease of free-ranging desert tortoises (*Xerobates agassizii*). J. Wildl. Dis. 27:296-316.

Johnson, A. S. 1982. Twilight for the desert tortoise? Defenders 57(6):9-11.

Johnson, A. S., M. L. Stout, and R. Spotts. 1989. The petition for Federal listing and the future of the desert tortoise. Proc. Desert Tortoise Counc. 1985:102-105.

Johnson, D. H., M. D. Bryant, and A. H. Miller. 1948. Vertebrate animals of the Providence Mountains area of California. Univ. Calif. Publ. Zool. 48:221-376.

Klauber, L. M. 1932. Amphibians and reptiles observed enroute to Hoover Dam. Copeia 1932:118-128.

Knopf, F. L. 1987. "On publishing symposia" revisited: when are proceedings no longer timely? Wildl. Soc. Bull. 15:603-605.

Linsdale, J. M. 1940. Amphibians and reptiles in Nevada. Proc. Am. Acad. Arts and Sci. 73:197-257.

Luckenbach, R. A. 1982. Ecology and management of the desert tortoise (*Gopherus agassizii*) in California. Pages 1-37 *in* R. B. Bury, ed. Ecology and conservation of North American tortoises. U.S. Fish and Wild. Serv. Wildl. Research Rep. 12.

Miller, A. H., and R. C. Stebbins. 1964. The lives of desert animals in Joshua Tree National Monument. Univ. Calif. Press, Berkeley. 452pp.

Miller, L. 1932. Notes on the desert tortoise (*Testudo agassizii*). Trans. San Diego Soc. Nat. Hist. 7:187-208.

Möllhausen, B. 1858. Diary of a journey from the Mississippi to the coasts of the Pacific with a United States government expedition. Vol. 2. Longman, Brown, Green, Longmans, and Roberts, London, U.K. 389pp.

Morafka, D. J. 1988. Historical biogeography of the Bolson tortoise. Ann. Carnegie Mus. 57:47-72.

Nagy, K. A., and P. A. Medica. 1986. Physiological ecology of desert tortoises in southern Nevada. Herpetologica 42:73-92.

Schneider, J. S., and G. D. Everson. 1989. The desert tortoise (*Xerobates agassizii*) in the prehistory of the southwestern

Great Basin and adjacent areas. J. Calif. Great Basin Anthropology 11:175–202.

SPANG, E. F., G. W. LAMB, F. ROWLEY, W. H. RADTKEY, R. R. OLENDORFF, E. A. DAHLEM, AND S. SLONE. 1988. Desert tortoise habitat management on the public lands: a rangewide plan. U.S. Bur. of Land Manage., Washington, D.C. 23pp.

STEJNEGER, L. 1893. Annotated list of reptiles and Batrachians collected by the Death Valley Expedition in 1891, with descriptions of new species. North Am. Fauna 7:159–163.

TAUBES, G. 1993. The ozone backlash. Science 260:1,580–1,583.

TURNER, F. B., P. A. MEDICA, AND R. B. BURY. 1987. Age-size relationship of desert tortoises (*Gopherus agassizi*) in southern Nevada. Copeia 1987:974–979.

U.S. FISH AND WILDLIFE SERVICE. 1985. Endangered and threatened wildlife and plants; finding on desert tortoise petition. Fed. Register 50:49,868–49,870.

U.S. FISH AND WILDLIFE SERVICE. 1987. Endangered and threatened wildlife and plants; notice of findings on petitions and initiation of status review. Fed. Register 52:24,485–24,488.

U.S. FISH AND WILDLIFE SERVICE. 1990. Endangered and threatened wildlife and plants; determination of threatened status for the Mojave population of the desert tortoise. Fed. Register 55:12,178–12,190.

U.S. FISH AND WILDLIFE SERVICE. 1993*a*. Draft recovery plan for the desert tortoise (Mojave population). U.S. Fish and Wildl. Serv., Portland, Oreg. 170pp.

U.S. FISH AND WILDLIFE SERVICE. 1993*b*. Endangered and threatened wildlife and plants; proposed determination of critical habitat for the Mojave population of the desert tortoise; proposed rule. Fed. Register 58:45,748–45,768.

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