

THE DESERT TORTOISE IN THE MOJAVE DESERT PARKS

A preliminary research update



By MICHAEL BOYLES AND JERRY FREILICH

FEW REPTILES OF THE DESERT Southwest garner as much attention as the desert tortoise (*Gopherus agassizii*). Unfortunately, one reason for this attention is the dramatic decline of tortoise populations throughout a large portion of the species' range (U.S. Fish and Wildlife Service 1994). Reductions of up to 20% per year have been reported (U.S. Fish and Wildlife Service 1994), causing alarm within the biological community. Reasons for the decline are not completely understood, but urban development, off-road vehicle use, livestock grazing, poaching, increased predation by common ravens (*Corvus corax*), and a recently discovered upper respiratory disease are likely contributing factors (U.S. Fish and Wildlife Service 1994). In 1990, the U.S. Fish and Wildlife Service listed as threatened the entire Mojave Desert population (fig. 1), defined as all individuals north and west of the Colorado River. The Sonoran population, south and east of the river, remains a candidate for listing as a threatened species.

RESEARCH BY PARKS

Within national parks, the desert tortoise is protected from many of the human influences that may be causing its decline. Parks serve as a control framework with which to evaluate declines elsewhere in the species' range. For example, if the tortoise is declining due to direct human fac-

tors, these declines are less likely to be seen in parks. If declines are observed in parks, the causes may be attributable to influences not limited by park boundaries, such as atmospheric or global effects. Tortoise research in parks may help elucidate other, as yet unknown, factors that contribute to the decline of tortoise populations.

The role of the National Park Service in managing the desert tortoise regionally expanded in 1994 with the initiation of a three-year research project funded by the Natural Resources Protection Program (NRPP). One of the main objectives

was to implement several of the recommendations in the 1994 Desert Tortoise Recovery Plan to protect the tortoise and its habitat and ensure future viable populations throughout the southwestern deserts. These recommendations include surveys to determine the location and density of tortoises; establishing long-term monitoring plots; improvement, restoration, and protection of habitat; and strengthening public awareness and environmental education.

Five parks are participating in the research: Lake Mead National Recreation Area, Nevada and Arizona; Joshua Tree and Death Valley National Parks, California; and Organ Pipe Cactus National Monument and Saguaro National Park, Arizona. Staff from each of these parks assisted in the design and establishment of the study. However, because the extent of information and research on the tortoise varied considerably among the parks at the onset of the study, each park developed its own study design.

LIFE HISTORY OF THE DESERT TORTOISE

Research and monitoring of the desert tortoise is difficult because of the species' unusual life history. The reptile is adapted to living in a harsh and variable environment. It retreats into burrows and reduces its metabolism during periods of adverse environmental conditions. Thus, it spends much of its life underground, hibernating during the winter and escaping from the hot temperatures of summer (Woodbury and Hardy 1948). Its active period is largely confined to the mild spring and fall, and even at these times, it may reduce its activity if the season is unusually extreme as during the recent drought in the Mojave Desert. Thus, biologists must concentrate their efforts into a few months for any research that requires seeing the animals above ground.

The longevity and reproductive strategy of the tortoise also complicate monitoring. With a potential life span of many decades, the desert tortoise can compensate for variable reproductive success by breeding many times throughout its life,



Figure 1. The threatened Mojave population of the desert tortoise occurs north and west of the Colorado River, while the Sonoran population lies south and east. Interestingly, the boundary between the two populations bisects Lake Mead National Recreation Area.

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and one year of reproductive success may offset several years of failure. In order to get a realistic idea of population trends, biologists must not only make an accurate determination of population size (a difficult task in itself), but also follow population recruitment for many years (Doak et al. 1994). One year of successful reproduction is no more indicative of population recovery than several years of reproductive failure is of extinction.

TRANSECTS AND PLOTS ESTABLISHED AT LAKE MEAD

At Lake Mead National Recreation Area, we have established 14 1-km² (247-acre) study plots over three years to begin population monitoring. In addition to the plots, we have also established over 400 1.5-mile triangular transects in which biologists identify tortoise habitat and map tortoise distribution (fig. 2). Transects and plots are separate techniques that provide us with different types of information. Transects involve a single visit to a site in which biologists look for live tortoises, burrows, scat, and shell remains. The findings give us a preliminary idea of relative tortoise population density, and by spreading the transects across the park's 1.3 million terrestrial acres, a once patchy notion of tortoise distribution has become more complete. Plots, on the other hand, provide a way to monitor a localized group of tortoises for a long period of time. By making repeated visits to a plot and conducting intensive searches for tortoises and other sign, we can collect valuable ecological and life history data on the animals. Over the long term, this information may allow us to determine population trends, if only at a very localized scale.

Our transect work was highly successful in helping us determine which areas of the park contain desert tortoises. The 400 transects surveyed translate into roughly 960 km (600 mi) of surveyed ground. While most of Lake Mead's terrestrial acreage could be considered po-

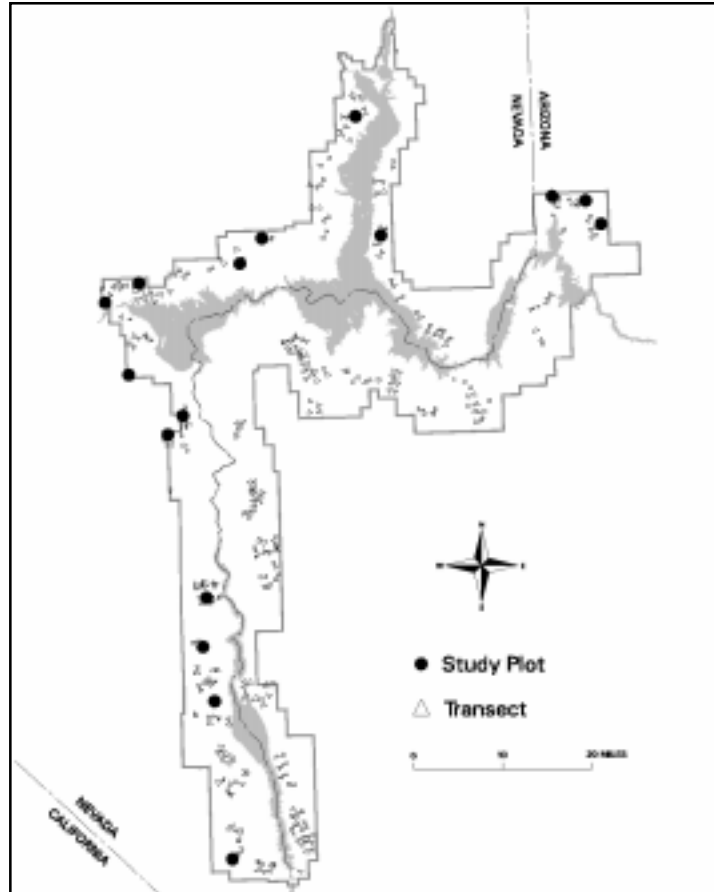


Figure 2. Biologists have established 16 permanent study plots and over 400 1.5-mile triangular transects in Lake Mead National Recreation Area to learn about tortoise distribution.

tential tortoise habitat, distribution of the animals is quite patchy. A few "hot spots" of high tortoise density have been found, as have several medium-density areas. Still other areas of the park show little or no evidence of tortoise occupation, even in what appears to be suitable habitat.

From our work on plots, we have established a baseline data set that we can follow for years. All tortoises found on the plots have been permanently marked. Thus, future sightings of these individuals will provide data on survival and movement patterns. Even as the NRPP project draws to a close, we have plans to extend our work and continue adding to our rapidly growing database.

LIMITATIONS ARISE

Where the transect monitoring method has provided new information about tortoise distribution, plot monitoring has posed at least as many questions as answers. One problem is the relatively short amount of time spent monitoring each plot. Our method consists of inventorying the plots within a series of parallel, 10-m (33 ft) wide transects (fig. 3). Because of such a short window of tortoise activity in the spring, we must concentrate our work into a 10-week period. During this time, biologists make two four-day passes over each plot for a total of eight days of sampling per plot. Do these days adequately represent the spring activity season? If not, the number of tortoises observed may differ greatly between the two passes, which makes population estimates based on this particular mark-recapture technique extremely difficult.

All plot-based methods suffer from the problem of limited inference. While intensive effort on a plot may lead to robust density estimates and can possibly identify certain population trends, the results of such efforts are site-specific and do not necessarily indicate what is happening regionally. As with any threatened species, the critical need is for information on the temporal and spatial trends of population abundance over the entire range of the species' habitat. Plot monitoring is time consuming, requires repeated visits, and is not likely to provide this information.

MONITORING METHODS PIONEERED AT JOSHUA TREE

At Joshua Tree National Park, we also dealt with some of these issues and found that years of data proved invaluable in helping determine the preferable method of studying tortoises. Beginning in 1991, before the NRPP study, we spent four years monitoring tortoises in a known hot spot (the Barrow site) and 12 other plots.



Figure 3. Biologists use GPS (global positioning systems) units to record tortoise locations within the study plots.

For the first few years, we found many new tortoises during each survey, suggesting that tortoises are easily missed by biologists. Initially, we were not sure if this was due to tortoises hiding underground or moving in and out of the study area. However, after six years, two of which coincided with the NRPP study, we learned that tortoises exhibit extreme site fidelity, with 72% of tortoises not seen for one year or more ultimately being recaptured within 300 m of their original capture point, and 22% within 100 m of that point. The ease with which tortoises can escape observation is an important reason why we sought new methods.

At Joshua Tree we pioneered the use of distance sampling for tortoise surveys. In distance sampling, straight-line transects of precisely calculated length are surveyed by teams of observers. We measure the perpendicular distance to the transect line of any tortoises found. This method, championed by Dr. Ken Burnham and Dr. David Anderson of Colorado State University, has been successfully used on dozens of other animals including whales at sea, but only recently

for tortoises. The method gives an accurate population estimate even if 70-80% of the animals present are missed.

During the present NRPP study, we abandoned all the plots except the Barrow site, using instead, these 4-km long distance sampling transects in the shape of a square to survey nearly the entire eastern half of the park. Most NRPP funds were expended on a work leader and a team of five Student Conservation Association (SCA) resource assistants each spring. The SCAs, in turn, supervised teams of two to eight volunteers recruited through newspaper and radio ads. These teams, usually two teams of 10 people each, walked the transects. In 1995, approximately 90 transects were surveyed and nearly as many in 1996. The only problem was that 1995 was a "good" year with plenty of rain, whereas 1996 was a drought year with less than 100 mm (3.9 in) of rain recorded at Twentynine Palms.

By using both plots and transects as corroborative methods, we gained many insights into tortoise surveying and monitoring. One of the most important findings was the significance of variability in rainfall and its effect on our ability to find tortoises. During years of high rainfall (and subsequent high forage production), tortoises will spend much of the spring above ground. During droughts, tortoises may remain underground to conserve water and energy. This can have a profound influence on the number of tortoises seen during the season. In 1995, a relatively wet year, our team walked 300 km (186 mi) of transects and found 203 tortoises. In 1996, an extremely dry year, we surveyed a similar number of transects and found only 30 tortoises with the same expenditure of effort. This discrepancy was also evident on the plots, and demonstrates the need to consider environmental parameters when conducting tortoise surveys, regardless of the survey method used.

Our findings indicate that a single year of surveys may yield questionable results, especially if weather conditions have been unfavorable for tortoises. Indeed, research suggests that surveys performed in drought years may not be valid. This problem could be overcome by developing a set of decision rules that would determine whether surveys should be conducted in any given year. For example,

a certain minimum amount of rainfall or annual biomass production would need to be reached before a season is deemed acceptable for tortoise inventory and monitoring.

During the spring of 1997, Joshua Tree continued distance sampling, but also made a large effort to equip tortoises with radio transmitters in order to improve the sampling technique. Since tortoises often remain underground, depending on a variety of factors such as time of day, time of year, and temperature, many tortoises will not be observed during surveys. Radio-telemetry data can be used to estimate the proportion of tortoises underground at any given time; this information can then be used to adjust and improve future density estimates derived from distance sampling. This is the combination of methods presently recommended by the U.S. Fish and Wildlife Service for tortoise surveys.

DEATH VALLEY

Very little was known about the desert tortoise in Death Valley National Park, California, before the NRPP project. However, since 1994, 248 transects have been surveyed to determine the presence of the tortoise and to gather general density data. Tortoise sign was found along 60 transects, and sign counts indicate that population levels may be in the range of 20 to 50 animals per square mile in the Greenwater Valley area of the park. Elsewhere in the park, densities are much lower, and for the park as a whole, tortoise densities appear to be low when compared to other areas of the Mojave Desert.

THE FUTURE

The work being conducted by the five parks is already contributing to the knowledge of the desert tortoise regionally. The methods pioneered at Joshua Tree, in conjunction with radio-transmitter studies, have been adopted by the U.S. Fish and Wildlife Service for tortoise sampling. At Lake Mead, we are continuing to expand our knowledge of the distribution of tortoises and their habitat using transect methods. Death Valley, Organ Pipe Cactus, and Saguaro will continue with survey and monitoring to develop a regional

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database. Continued research is of paramount importance for the future, and a reliable data set is needed to guide future research objectives. This will help us improve our ability to monitor populations of the desert tortoise and play a more effective role in securing its future.

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