NEVADA TEST SITE TORTOISE POPULATION MONITORING STUDY

Final Report

by

James Michael Mueller and Katherine Kristen Zander

December 1994

Reviewed by

W. K. Ostler, Director
Environmental Sciences Division

This report is unclassified

C. K. Mitchell
Classification Officer

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This work was performed by EG&G/EM for the U.S. Department of Energy under
Contract Number DE-AC08-93NV11265.

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Abstract

A Tortoise Population Monitoring Study was initiated to determine and monitor the density of desert tortoises (*Gopherus agassizii*) on the Nevada Test Site. Quadrat sampling was conducted following methodology described in the Draft Desert Tortoise Recovery Plan (FWS, 1993). So few tortoises were found that densities could not be calculated. Based on estimates of capture probabilities and densities from other studies, it was determined that 1-km² (0.4 mi²) plots did not contain enough tortoises for estimating densities with the Recovery Plan methods. It was recommended that additional surveys on the Nevada Test Site using those methods not be conducted. Any future efforts to monitor desert tortoise densities should start by identifying other possible methods, determining their relative power to detect changes, and estimating their cost.

Acknowledgements

The following EG&G/EM personnel conducted searches for tortoises: D. Allen, G. Brown, T. Burke, C. Callison, W. Fariss, R. Goodwin, K. Herndon, E. Holt, A. Hughes, L. Lewis, G. Lyon, J. Medrano, D. Rakestraw, K. Rautenstrauch, S. Schultz, G. Sharp, K. Sharp, C. Sowell, M. Walo, and T. Walrath. T. O'Farrell, K. Rautenstrauch, and C. Wills provided editorial comments. B. Hardenbrook provided helpful insight regarding his Trout Canyon study and current studies on tortoise census techniques.

Permission to handle desert tortoises was granted by the U.S. Fish and Wildlife Service through permits PRT-683011 and PRT-781234 and by the Nevada Division of Wildlife through permit S 9060.

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Introduction

The Endangered Species Act directs all federal agencies to "carry out programs for the conservation of endangered species and threatened species . . ." The desert tortoise is the only species listed as threatened or endangered that occurs on the Nevada Test Site (NTS). No information exists to determine if tortoise populations on NTS are stable. A Tortoise Population Monitoring Study was initiated by EG&G Energy Measurements for the Basic Environmental and Compliance Program (BECAMP) of the U.S. Department of Energy/Nevada Operations Office in FY93 to determine and monitor the density of desert tortoises on NTS.

Literature Review

Past studies of desert tortoises on NTS have addressed the growth (Medica et al., 1975; Turner et al., 1987; Germano, 1988), diet (Nagy and Medica, 1986), and physiology (Nagy and Medica, 1986) of tortoises in large enclosures in Rock Valley. In addition, transect studies were conducted throughout the southern one-third of NTS to determine the range and distribution of tortoises (EG&G/EM, 1991). These studies showed that desert tortoises occur at low to very low densities on NTS relative to the rest of their range. Results from the transect studies cannot be used reliably to analyze trends in population densities because they are based on quantity of tortoise sign, not numbers of tortoises. Amounts of tortoise sign may vary over time due to factors unrelated to tortoise density.

Studies at Yucca Mountain, on the western edge of NTS, are designed to monitor impacts of the Yucca Mountain Site Characterization Project on tortoises and to learn more about the biology of the species (Rautenstrauch et al., 1991). A pilot study was conducted in 1990 at Yucca Mountain to determine the feasibility of conducting annual counts of tortoises for monitoring their relative abundance (Rautenstrauch et al., 1991). Results from the study showed that conducting counts using a 100% coverage survey was very expensive. Because of this it was decided to monitor survival and reproduction of tortoises instead of relative abundance to evaluate impacts.

The two most widely used methods for estimating desert tortoise abundance are line transects and quadrat sampling (Berry, 1984). Line transect sampling is seldom used to estimate tortoise abundance anymore because of the questionable accuracy of the technique (Bury and Luckenbach, 1977; Turner et al., 1982). A method of quadrat sampling was proposed by the U.S. Fish and Wildlife Service (FWS) (1993) for monitoring densities of desert tortoises throughout the Mojave population (those tortoises north and west of the Colorado River). These surveys would be conducted on Desert Wildlife Management Areas in California, Nevada, and Utah and used to assess the recovery of the Mojave population. This method was selected for the BECAMP Tortoise Population Monitoring Study so that results from NTS could be compared with results obtained in other portions of the tortoise's range.

Methods

A map of NTS was sectioned into a grid of 1 km $\times$ 1 km (0.6 mi $\times$ 0.6 mi) plots. Areas with low potential for tortoises were eliminated from consideration as study plots. They included plots with an average elevation $>1,281$ m (4,200 ft) or <915 m (3,000 ft), playas, areas with $>5\%$ human disturbance, and plots with paved roads transecting them. Every three years, a sample of plots was to be randomly selected and surveyed for tortoises. The sample would have consisted of 5% (33) of the 668 remaining plots. FWS (1993) stated that surveys were to be conducted from February through May, since this is a known period of high tortoise activity. Studies of tortoises at Yucca Mountain have shown peaks in tortoise activity in the fall (August-October) as well as the spring (April-May) (EG&G/EM, unpublished data). A subsample of plots was surveyed in September 1993 and was to be re-sampled in Spring 1994 to determine if results were similar.

Boundaries of five plots were marked in the field using lath stakes and flagging. Each plot was then sectioned into quarters using flagging. Three plots were searched for a minimum of three and a maximum of seven days. A crew of four biologists searched an entire plot each day, with one biologist searching each 25-ha (61.9 ac) quadrant. To reduce search bias, quadrant assignments were rotated so that the same biologist did not search the same quadrant on consecutive days. Every tortoise found was marked with a paint pen. All tortoise sign was recorded. To prevent duplicate counts of sign, scat were destroyed, carcasses were flagged, and burrows were tagged but not flagged. Searches were suspended after the third day and prior to seven days if no unmarked tortoises >140 mm (5.5 in.) in mid-carapace length (MCL) were found for two consecutive days. Searches were suspended after the first day if no tortoise sign was found on a plot.

The Zippin method of removal (Zippin, 1956, 1958) was to be used to calculate population densities. This estimator uses the number of new captures each day to estimate population size. Tortoises were "removed" from the population by marking. The assumptions and limitations of this method are discussed by FWS (1993). Because small tortoises probably have a lower capture probability than large tortoises, only tortoises >140 mm (5.5 in.) in MCL were to be used in the calculations.

Results

Survey results are shown in Table 1. Because so few tortoises were found, densities could not be calculated.

Discussion

Tortoises occur at relatively low densities on NTS. For this reason, methods used in other areas of the desert tortoise's range may not be appropriate on NTS. Results from this study suggest that larger plots and higher capture probabilities would be required to monitor tortoise densities on NTS using mark-recapture estimators.

Table 1. Results from September 1993 BECAMP Desert Tortoise Population Monitoring Study.

Plot	Coordinates (SW corner)		Survey Dates	Total Sign Found				New Tortoises by Day				
	Easting	Northing		Tortoises	Carcasses	Burrows	Scats	1	2	3	4	5
202	586000	4075000	9/8-12/93	4	3	11	7	2 ^a	1	1	0	0
282	590000	4072000	9/7/93	0	0	0	0	0	-	-	-	-
558	565000	4061000	9/13-17/93	2	2	16	12	0	0	2	0	0

^aOne tortoise was <140 mm.

The Zippin method of removal is identical to a mark-recapture model incorporating a behavioral response to capture (Otis et al., 1978). Therefore, general traits of mark-recapture models also characterize the Zippin method. Two factors greatly influence mark-recapture models for estimating population size: capture probability and population size. Otis et al. (1978) suggested that for mark-recapture estimators to work, the minimum number of animals in the population should never be <25 if there are ≤ 10 capture occasions per sampling period. In addition, when average capture probabilities are low, population sizes must be even larger to obtain precise estimates. Skalski and Robson (1992, p. 87) presented graphs for use in calculating sample size requirements for the Zippin removal estimator. To obtain an estimate with seven sampling periods where there is a 90% probability that the estimate errs by $\leq 20\%$, the following combinations of minimum capture probabilities (p) and population sizes (N) are required: $p=0.3$, $N=20$; $p=0.2$, $N=100$; $p=0.1$, $N=2,000$.

The absolute density of tortoises on NTS is unknown, but Schneider et al. (1982) estimated that areas with a similar amount of sign to that found on NTS (EG&G/EM, 1991) had 0-19 tortoises/km² (0-50 tortoises/mi²). Assuming all tortoises were >140 mm (5.5 in.) in MCL (an unrealistic assumption used here only to set the lower limits of plot size) and that the density of tortoises was 10/km² (26/mi²), plot sizes would have needed to be 2 km² (0.8 mi²) with $p=0.3$, 10 km² (3.9 mi²) with $p=0.2$, and 200 km² (77.2 mi²) with $p=0.1$ to obtain a population estimate that errs by $\leq 20\%$.

Capture probabilities are the most uncertain portion of the sample size problem. No studies have reported a capture probability for tortoises which was based on one person searching an entire plot in one day. Most studies have employed one or more persons who searched a large plot over several days. For example, a study near Pahrump, Nye County, Nevada, employed two biologists who searched a 2.6 km² (1 mi²) plot over periods of 21, 9, and 8 days (Hardenbrook, 1994). The population estimate of tortoises >180 mm (7 in.) in MCL was 30 tortoises using the Bailey binomial method. During the first period, an average of 6 ha/day were searched, and the capture probability for the period for tortoises >180 mm (7

in.) in MCL was 0.6. During the second and third periods, an average of 15 ha/day was searched and the capture probability dropped to 0.3. While the reduced capture probability may have been due to factors such as reduced activity during the second two searches, the primary cause was most likely the increase in area searched each day.

Since the methods used in the BECAMP study stipulated that each biologist search 25 ha (61.9 ac)/day, the daily capture probability for desert tortoises was probably <0.3 .

It is evident that FWS (1993) methods are not suitable for estimating tortoise population sizes in low density areas. Despite comments to this effect on the Draft Desert Tortoise Recovery Plan, FWS did not amend these methods in the final Desert Tortoise Recovery Plan (1994). They did, however, state that they will consider other methods at a future workshop to be held in 1994. Using identical methods to monitor tortoise densities throughout their range is very appealing since comparisons can be made without concern about biases due to methodology. Unfortunately, both plot size and sampling effort would need to be increased to obtain useful estimates of tortoise densities on NTS.

Other methods for monitoring the trend of the NTS desert tortoise population may be more suitable and should be investigated. Skalski and Robson (1992, pp.88-93) described how to compare techniques and designs to determine relative cost and power. A recent example of this type of analysis compared two methods of monitoring northern spotted owls to determine the most appropriate technique for detecting a decline in the population size (Taylor and Gerrodette, 1993). The first method, termed the survey method, estimated population size using an annual line-transect survey. The second method, termed the demographic method, estimated the rate of change in population size based on annual survival and birth rates. They determined that for the lowest density areas, the demographic method was always more powerful (i.e., more likely to yield a significant result when a change occurred) than the survey method. Similar analyses could prove useful for the desert tortoise. Costs could be factored in as well, so that the costs of a given method yielding a predicted power of detecting a change could be determined.

Based on the FY93 BECAMP survey results, it was recommended that additional surveys using FWS (1993) methods be discontinued on NTS. Therefore, no Spring 1994 surveys were conducted. Any future efforts to monitor the trend of desert tortoise density on NTS should start with identifying other possible methods, determining their relative power to detect changes, and estimating their cost.

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