Trap Shyness and Avoidance Affects on Capture Proportions of *Dipodomys heermanni arenae*

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Abstract

This is a study on trap shyness and trap avoidance in the kangaroo rat species *Dipodomys heermanni arenae*. This species is being studied as a surrogate for the critically endangered *Dipodomys heermanni morroensis*. This is an ongoing study that has been continuing for the past three years, with four three-day session per year. The study is a specific look at the effects of the use of Sherman traps on kangaroo rat behavior between individual session days. Capture proportions for each of the three days of each session were calculated and compared through a t-test. The current results of this data set display no support for a significant effect of trap shyness and avoidance on this species of kangaroo rats.

Introduction

The kangaroo rat, *Dipodomys heermanni,* is considered to be a keystone species in the habitats in which it is found. This means that they strongly affect the abundance and distribution of other species in their community. Such influences are numerous, including their extensive burrow system that provides shelter for other species, as well as soil disturbances that may affect plant communities. They are large contributors to the engineering of their environment and the ecosystem they are a part of.

One of the subspecies of *D. heermanni* is the geographically isolated Morro Bay kangaroo rat (*Dipodomys heermanni morroensis*), an endangered species that has been declining

since the 1950s. It became a fully protected species in California in 1971, and was listed under the United States Endangered Species Act in 1974. As *D. heermanni morroensis* is now a potentially extinct subspecies, a surrogate is necessary to continue research on the subspecies. *D. heermanni morroensis* is unique in its dark color and lack of a complete hip-stripe. About twenty–five percent of Lompoc Kangaroo rats (*Dipodomys heermanni arenae*), found south of *D. heermanni morroensis*, also have an incomplete hip-stripe. (Villablanca) This provides evidence for them being the closest living relative of *D. heermanni morroensis.* In a study that performed karyotypic analysis of four different subspecies of *D. heermanni*, *D. heermanni morroensis* and *D. heermanni arenae* were shown to be highly related (Csuti 1971). Also, the close geographic proximity of these two subspecies is also an indication that these subspecies share a similar habitat and are closely related, allowing *D. heermanni arenae* to function as a proper surrogate.

These two subspecies of *D. heermanni* are scatter-hoarding granivores (they bury seeds in shallow pits) and are thought to have increased spatial memory. Spatial memory allows for the remembering and locating of food source sites. This is supported by an experiment performed by Barkley and Jacobs in which they compared the spatial recognition ability of a scatter-hoarding species of *Dipodomys* with a species less dependent on seeds. While the total number of targets found did not differ between the two species, the scatter-hoarding species showed a significantly higher accuracy in relocating food source sites after twenty-four hours. (Barkley and Jacobs, 2007)

The concept of increased spatial recognition ability in scatter hoarders may also be an indicator of trap success. An animal previously trapped may remember a trap site and decide to avoid it if it deems it as a traumatic experience. Also, Sherman livetraps may appear threatening

to kangaroo rats on first encounter. In a study performed by Michael O'Farrell, the capture proportions of Stephen's kangaroo rat (*Dipodomys stephensis*) caught using Sherman traps was compared with those using mesh traps (O'Farrell 1994). A significant difference was found, with a higher proportion of kangaroo rats being trapped using the mesh traps. Also, kangaroo rats frequently kicked sand and soil into the Sherman traps, disabling them and showing that they perceive the trap as a threat (O'Farrell 1994). This experiment is an indicator of trap shyness in kangaroo rats.

Previously conducted studies, such as the O'Farrell study on mesh versus box traps, have shown significance in differences in data results of kangaroo rat trapping success. With this knowledge, it is only prudent to study the differences in trapability that may be caused by the trapping method. Therefore, we have decided to study whether multiple exposures to a trap or whether previous capture will cause a significant affect on data collected. The purpose of the test performed was to determine if capture proportions of *D. heermanni arenae* varied significantly between the three days of a trapping session. It is believed that there would be a significant difference in proportions between the three days, and it is predicted that trap avoidance would increase throughout the three-day trial. This test is helpful to determine the significance of the number of trapping days that occur. Is the third trapping day insignificant? Is a lower number on the first day due to trap shyness, and if so, are the additional days necessary? If a fourth trapping day were possible, would it be worth it? This test is essentially a study on a study—a study to determine if trap shyness and avoidance could be skewing data for other experiments pertaining to the use of *D. heermanni arenae* as a surrogate for *D. heermanni morroensis*.

Methods

A twelve hundred meter trap line was set up at the Guadalupe-Nipomo Dunes National Wildlife Refuge in California, where *D. heermanni arenae* are found. Two Sherman extra-long livetraps were set within a two-meter radius at every twenty-meter interval. They were set in the evenings for three nights, for a total of one hundred and twenty traps set per night. Sherman livetraps are the most commonly used trap for small mammal trapping in North America, and are specifically designed for mammals with longer tails like kangaroo rats (Slade et al. 1993). Norman Slade performed a study comparing the different sizes of Sherman traps. A higher trap success was shown using longer traps versus normal sized traps (Slade et al. 1993). The traps were set in sandy areas with little ground cover using oatmeal as bait. The traps were covered with sand to provide insulation for the cold nights as well as to appear inconspicuous.

Early each morning traps were checked. Demographic data such as sex, age, and breeding condition were taken, and kangaroo rat weight was also measured using a Pesola field scale. These demographic data were taken to provide information for multiple experiments regarding the use of *D. heermanni arenae* as a surrogate species. Ear tags were checked for identification, and if a kangaroo rat was a new capture, it was tagged. These identification numbers were recorded in order to provide information on kangaroo rat capture rates. This three-day trapping session procedure was repeated three times a year for four years, yielding a sample size of twelve.

On the first day of checking the Sherman traps, the previously mentioned demographics were recorded. If a kangaroo rat already had an ear tag, it was considered a recapture from a previous trapping session, and the tag identification number was recorded. If no ear tag was present, it was considered a new capture and was tagged with a unique tag number that was also

recorded. Traps were reset in the evening. On the second morning, this checking procedure was repeated. However, it was also recorded if a kangaroo rat that was captured on the first day was captured again on the second day. Traps were again reset in the evening. On the third morning of checking traps it was recorded if a kangaroo rat was a recapture from the first, second, or both days, along with the rest of the demographics. These recaptures were recorded in order to provide information for creating capture proportions for each of the three days in order to determine if there is a significant difference between proportions of the three days.

Capture proportions of the kangaroo rats were calculated for each of the three days of each of the twelve sessions completed. Looking at one session at a time, the number of recaptures for each day was subtracted from the number of total captures for each day. This yielded the total number of new captures (kangaroo rats that had not yet been caught in the current trapping session) for each day. These values were added together to give the total observed population number of a three-day session. The total individual count (including recaptures) of each day was then divided by the session's observed population, providing a capture proportion for each day. This provides a sample size of twelve capture proportions (4 each for the first, second, and third days) to compare.

Since only 12 figures are available for each day of the sessions, there are not enough observations for an ANOVA. Instead, a single sample T-test was used to analyze the data. The t-test is capable of providing a confidence interval with relatively powerful results with a smaller observation population size. To keep the overall confidence level of the analysis, a Bonferroni correction was used. This means that a 98.75% confidence level was used on each individual test. The confidence intervals show whether the difference in the capture proportion mean of a session day lies outside of the range of possibility to be the same as the other days.

Since the t-test removes the paired element from the data, a nonparametric sign test was performed to reinforce the previous test in order to be thorough with the results (Sokal and Rohlf, 1994). The twelve capture proportions for each day were paired into three separate tests: the first and second days, the first and third days, and the second and third days. This test shows whether there is a disproportional amount of higher capture proportions on a given day.

Results

The hypothesis for this project was that throughout the course of a three-day trapping period, there would be significant differences among the trapping proportions caught on each day. It was predicted that there would be a drop in proportions throughout the session and especially on the third day. This would signify the effects of trap shyness or trap avoidance after being previously captured. The null hypothesis was that there are no significant differences among capture proportions of the three days—trap avoidance plays no significant role in general population capture proportion statistics. Table 1 shows the results of the performed t-test with the confidence level adjusted to 98.75% so that the three tests had an overall confidence level of 95%.

The confidence intervals of days one, two, and three overlap, so the test failed to reject the null hypothesis. The individual 95% confidence intervals are illustrated by Figure 1 where no one-day's range is separate from the others. The homogeneity of day one and day two values could potentially be an issue but the differences appear to be insignificant. The dot plot in Figure 2 places most of the proportion values of all three days to be normally distributed between 0.54 and 0.70, excluding some outlying values. The standard deviation difference between day one and two was only 0.022 and the difference in mean was only 0.0465. So while differences in the distribution of capture proportions are present, the values are insignificant to this study. Similar

to what was found in the Michael O'Farrell's study on Sherman live traps, there were observations of disabled traps due to kangaroo rats kicking sand at them (O'Farrell 1994). This indicates that the kangaroo rats have at times targeted the Sherman traps as a threat. Still, with the current data set, the affects of this behavior as well as trap avoidance were negligible in skewing the data between the three days of each session. There was no drop in capture proportion on the third day as predicted so there is no evidence of trap avoidance based on previous capture. The only trend evident in the slightest, though not statistically equivalent, is a lower mean on the first day. However, with the results from the t-test, no initial trap shyness can be supported with the current data set.

The results of the nonparametric sign test are displayed in Table 2. The null hypothesis for this test was that there would be no statistically significant sign deviation, providing no evidence for trap shyness or avoidance. Since a 95% confidence interval was used, the critical value for this test is 0.05. The test comparing day one to day two had a p-value of 0.172, while that comparing day two to day three had a p-value of 0.613. These comparisons yielded definitive results that there is no significant difference. The results comparing day one with day three, however, was only 0.005 over the critical value. For the design of this test, the null hypothesis is still not rejected and supports the previous t-test results. Still, this is a point of interest.

Table 1. One-sample t-test results. N is the sample size, followed by the mean capture proportions, the standard deviation, the standard error of the mean, and the 98.75% confidence intervals.

Variable	N	Mean	StDev	SE Mean	98.75% CI
Day 1	12	0.5857	0.0918	0.0265	(0.5066, 0.6647)
Day 2	12	0.6322	0.0698	0.0201	(0.5721, 0.6922)
Day 3	12	0.6353	0.0901	0.026	(0.5578, 0.7129)

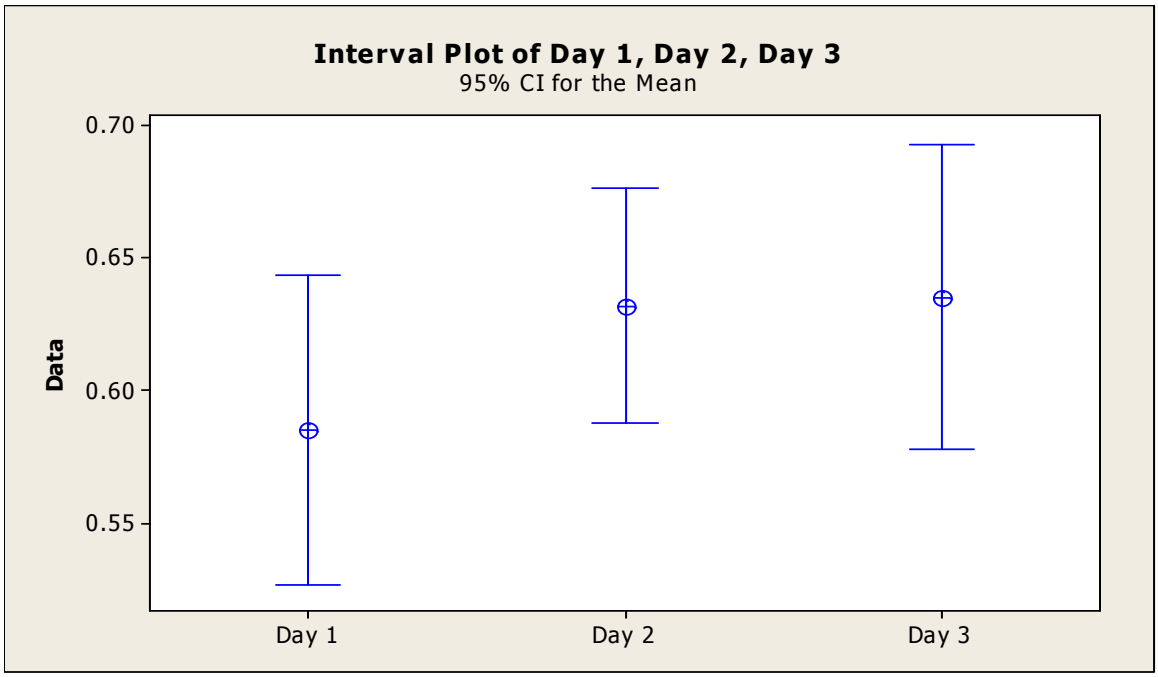

Figure 1. Mean capture proportions for each of the three days. Graph shown with unadjusted 95% confidence intervals.

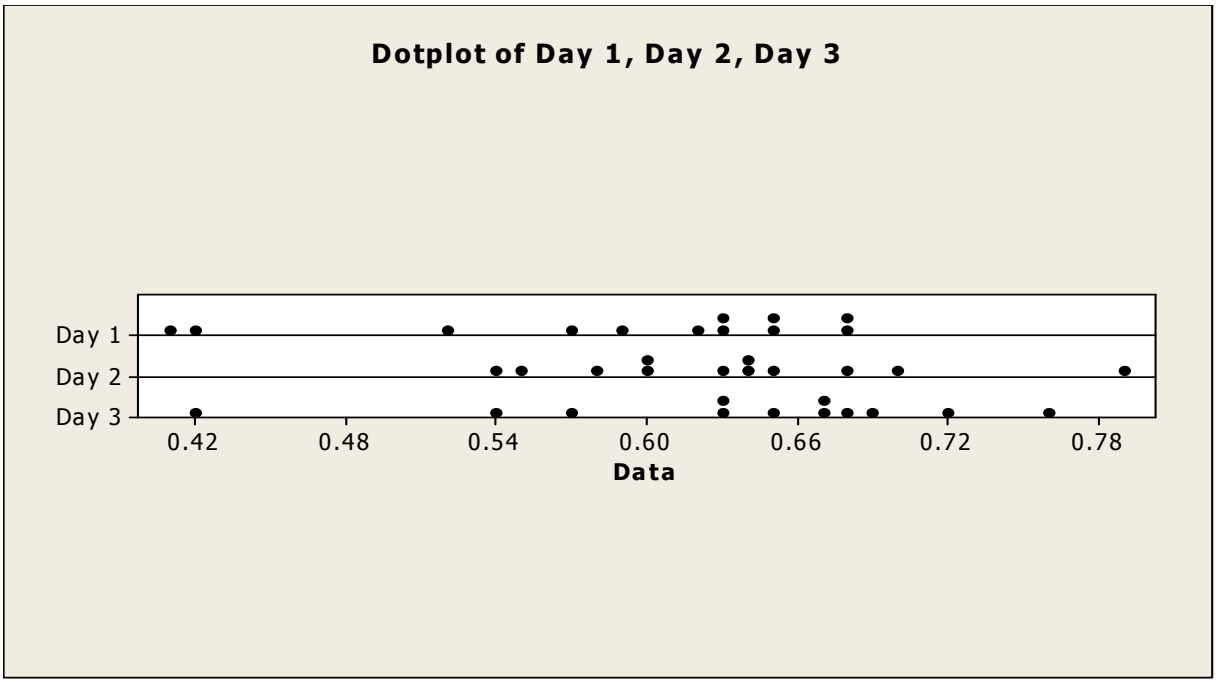

Figure 2. All capture proportions (daily capture rate for each individual known to be in the population) over all three day trapping sessions.

Table 2. Nonparametric sign test performed for three two-day comparisons. The test statistic, *x*, represents the least frequent sign. N is the number of pairs that show a difference.

Wilcoxon's Nonparametric Sign Test											
Test 1				Test 2				Test 3			
Day 1	Day 2	Difference	Sum	Day 2	Day 3	Difference	Sum	Day 1	Day 3	Difference	Sum
0.675	0.596	>	0.079	0.596	0.684	<	−0.088	0.675	0.684	<	−0.009
0.626	0.539	>	0.087	0.539	0.626	<	−0.087	0.626	0.626	=	0
0.413	0.548	<	−0.135	0.548	0.538	>	0.01	0.413	0.538	<	−0.125
0.647	0.647	=	0	0.647	0.718	<	−0.071	0.647	0.718	<	−0.071
0.616	0.697	<	−0.081	0.697	0.687	>	0.01	0.616	0.687	<	−0.071
0.626	0.636	<	−0.01	0.636	0.654	<	−0.018	0.626	0.654	<	−0.028
0.59	0.6	<	−	0.6	0.63	<	−	0.59	0.63	<	−

			0.01				0.03				0.04
0.683	0.683	=	0	0.683	0.671	>	0.012	0.683	0.671	>	0.012
0.516	0.629	<	−0.113	0.629	0.758	<	−0.129	0.516	0.758	<	−0.242
0.57	0.64	<	−0.07	0.64	0.57	>	0.07	0.57	0.57	=	0
0.649	0.579	>	0.07	0.579	0.421	>	0.158	0.649	0.421	>	0.228
0.417	0.792	<	−0.375	0.792	0.667	>	0.125	0.417	0.667	<	−0.25
		Total=	−0.558			Total=	−0.038			Total=	−0.596
	N=10	*x*=	3		N=12	*x*=	6		N=10	*x*=	2
		p=	0.172			p=	0.613			p=	0.055

Discussion

The results that this study was able to produce are not capable of rejecting the null hypothesis. This means that the results cannot conclude that there is a significant difference between the capture proportions between the three days of a trapping session. If *D. heermanni arenae* is apprehensive of the Sherman traps on the first day, it has little noticeable impact on the results. Also, if the spatial recognition ability of *D. heermanni arenae* is capable of allowing previously captured individuals to avoid the traps, this does not occur at a significant level. The trapping experience might not be too traumatic of an experience to outweigh taking food where it is available. This means that with the values currently available, other projects that use this data set are not skewed by varying non-gender biased capture proportions caused by trap shyness or trap avoidance. Since all three days are statistically the same, this helps support projects that are created half way through the data collection period. Studies that do not have data from all three days of a session do not have the potential of missing a more active day trapping-wise.

The results fail to provide any support for the prediction of the failed hypothesis that the capture proportion would decrease as the trapping session went on. This answers the question of whether the third day is any less important to the data set collection than days one or two. There would be a significant loss to the data collection if the third day were cut. Also, with no sign of declining amounts of information gained on later days of each session, there is no apparent reason to not expand the study beyond issues of budget and manpower. An additional day, if possible to do so, would be bringing an equivalent amount of data as the first day.

At the same time, this study does not definitively prove that the capture proportions among the three days are the same. The results of the day one to day three nonparametric sign test show that there may be some relationship between these capture proportions. Though with the results of this current test design and data set no relationship could be shown, a larger sample size may show more significant results in the future. It is also possible that with a larger sample size, a more powerful test can be performed. With the current sample size of twelve values per day, this project is limited to using t-tests. When there are twenty-four figures per day available, an ANOVA test could be used to produce more powerful results. It is still possible that future tests can show significance in this study despite the current results.

This study will benefit from future attention with an expanded data set. Also, a related question to be investigated is gender-based results. While general capture proportions are not significantly affected by trap shyness or avoidance, there may be a trend among males and females. This may be imperative information to have, especially for gender-based studies. As for now, the results of this study only support the current methods used in the data collection process.

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Appendix

Table 1. Total number of captures of each day for each session and the observed population (total number of captures not including recaptures) for each session.

Date	Day 1 Captures	Day 2 Captures	Day 3 Captures	Observed Population
April-08	10	19	16	23
July-08	37	37	37	57
October-08	57	64	57	100
January-09	32	39	47	62
April-09	56	56	55	82
July-09	59	60	63	100
September-09	67	68	70	107
December-09	61	69	68	99
March-10	55	55	61	85
June-10	43	57	56	104
September-10	72	62	72	115
December-10	77	68	78	114

Table 2. Calculated capture proportions for each day for each session.

Date	Day 1 Proportions	Day 2 Proportions	Day 3 Proportions
Apr-08	0.675	0.596	0.684
July-08	0.626	0.539	0.626

October-08	0.413	0.548	0.538
January-09	0.647	0.647	0.718
April-09	0.616	0.697	0.687
July-09	0.626	0.636	0.654
September-09	0.59	0.6	0.63
December-09	0.683	0.683	0.671
March-10	0.516	0.629	0.758
June-10	0.57	0.64	0.57
September-10	0.649	0.579	0.421
December-10	0.417	0.792	0.667