5-1972

An Evaluation of Trap Stimulus in Relation to Probability of Rodent Capture

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RM 72-9

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1971 PROGRESS REPORT

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MARCH 1972

ABSTRACT

Two experiments were conducted to examine the relationship between number of traps per station and probability of capture. The first tested the hypothesis that probability of capture is in some way increased at multiple trap stations. Response of animals to three variable conditions (single trap; two traps, one only set; two traps, both set) was compared. Preliminary results indicated that the important factor in increasing capture success was the availability of a second trap entrance rather than the increased stimulus value of a second trap.

The second experiment tested a set of hypotheses concerning the effect of a captured animal at a multiple trap station on the probability of subsequent captures. The response of animals to three variable conditions (two traps, one only set; two traps, live animal in one; two traps, dead animal in one) was compared. Preliminary results indicated no effect on overall probability of capture. There was, however, a significant relationship between age and state (alive or dead) of the test animal and the age ratio of subsequent captures. The analysis of these data is continuing.

INTRODUCTION

A commonly recognized problem in live-trapping studies of small mammal populations is the decrease in number of available traps as animals are captured. This is of concern to mammalogists because of possible bias toward those animals active early in the trapping period (Kikkawa, 1964).

A method that is often used to avoid such problems is the use of multiple-trap stations (Stickel, 1954; Brant, 1964; Smith, 1968; and others). The use of two traps per station has been specified in several of the population estimation methods proposed for use by the International Biological Program (Balph, 1971; Gentry et al., 1968; French et al., 1970).

Andrzejewski et al. (1966) point out that the use of multiple-trap stations is also a means of increasing trap density without an undue increase in habitat disturbance or the amount of labor required. This may be of advantage in situations of high population density as high trap densities increase the probability that sufficient traps are available for the animals in the area.

There is some evidence to indicate that the factors involved in the response of of animals to single- and multiple-trap stations are fairly complex. An understanding of these factors is of importance in the interpretation of data from sampling programs as various designs are not directly comparable.

In their evaluation of multiple-trap stations, Andrzejewski et al. (1966) observed an increase in number of captures as number of traps increased. The number of captures at a station was roughly proportional to the number of traps at the station. There was an indication, however, that the relationship was not linear as the number of captures at stations with more than three or four traps was less than would be expected on a proportional basis. They fail to indicate whether the increase in captures was due to multiple captures (one capture per trap per station) or an increase in single captures (one capture per station).

In a live-trapping program conducted in 1969 in Curlew Valley, on the Utah-Idaho border, double-trap stations captured significantly more animals than did single traps (see Table 1). Nearly all were single captures; there was a very low frequency of occurrence of multiple captures. Most of the multiple captures that did occur were recorded in Museum Special snap-traps rather than the Sherman and Havahart live-traps that were also tested. These data are summarized by Balph (1971).

Table 1. Comparison of response to single and double trap stations using three kinds of trap. Curlew Valley, Utah/Idaho, 1969.

	Havahart	Sherman	Museum Special	Total
% successful single stations	7.2	3.4	13.9	8.2
% successful double stations	16.9	11.25	16.5	14.8
% double captures (% of successful double stations)	5.4	2.0	32.3	14.5

These results suggest that an increase in trap number at a station in some way increases the probability of capture of a single animal. The very low frequency of occurrence of multiple captures, however, suggests that the presence of an animal in a trap in some way inhibits the approach of other animals and reduces the probability of further captures. The fact that more multiple captures were recorded in Museum Special snap-traps than in either of the live-traps tested suggests that such inhibition may in some way be related to the presence of a live animal in the first trap.

The use of multiple-trap stations is common in live-trapping studies of small mammal populations. Methods of sampling chosen for the IBP Desert Biome utilize two-trap stations. There is some evidence that the use of such designs involves problems in interpretation of data, due to an increase in probability of capture of a single animal, followed by an inhibition of further captures.

This study was designed to provide information that will aid in the interpretation of the results of such sampling programs, and in designing future programs for maximum efficiency.

OBJECTIVES

The objective of this study was to test the following hypotheses:

Hypothesis I: That the presence of two traps increases the probability of capture of a single animal.

Hypothesis II: That the presence of an animal in a trap at a two-trap station inhibits the approach of other animals and reduces the probability of further captures.

a. That the degree of inhibition is related to the physical state of the first animal captured, i.e. dead or alive.

b. That the degree of inhibition is related to the species, age, and sex of the first animal captured.

METHODS

Two groups of independent variables were tested in two separate series of experiments; each series of experiments applies to a particular hypothesis. Each trap set was considered a separate trial for a particular variable. Independent variables were as follows:

1. Single trap;
2. Two traps, single trap set;
3. Two traps, both set;
4. Two traps, live animal in one; and
5. Two traps, dead animal in one.

Sherman 7.62 x 7.62 x 25.4 cm. (3 x 3 x 10 in.) live-traps were used in all experiments. An effort was made to ensure that all traps were of the same sensitivity. Sensitivity measurements were made in the laboratory prior to the onset of field work.

Both series of experiments had the same basic design. Traps were installed in a 6 x 6, 50-meter grid located in uniform habitat. Traps were baited with a mixture of peanut butter and rolled oats. Subjective judgment was used in placement of traps to avoid bias due to animal trails and vegetation patterns funnelling animals into or away from traps. Multiple-trap stations had traps oriented in the same direction and spaced 0.5 meters apart. Each trap was visible from the other. Traps were operated only at night.

Research was located in and around West Carter Field, Curlew National Grasslands, Idaho. Emphasis was placed on the two most abundant nocturnal species of rodent, *Peromyscus maniculatus* and *Perognathus parvus*. Data collected included species, age, sex, experiment, set type, and day of capture. Data were recorded on field forms suitable for direct transcription to computer cards. DSCODES are A3UBC02 and A3UBC03.

Experiment 1. This series of experiments tested Hypothesis I utilizing the independent variables 1, 2, and 3. Variables 1 to 3 were randomly distributed at the 36 stations of a 6 x 6 grid, each variable appearing twelve times. Traps were set in the evening and checked shortly after sunrise. Animals were released when captured. Each experimental grid was run for two days, each station being deactivated after a capture. Variables were redistributed on an equal, random basis on day two. Species, age, and sex of all animals were recorded.

Experiment 2. This series of experiments tested the Hypothesis II complex, utilizing independent variables 2, 4, and 5. Experiments in this series were run for two nights, only the second night being considered in the analysis.

The first night all 36 stations in the 6 x 6 grid consisted of two active traps. When checked the following morning, those traps containing animals were provided with apple, extra bait, and nest material and covered with a wooden shake. Species, age, and sex of the animal was recorded.

When the grid was activated on the second night, those animals captured the previous night were either killed or allowed to live according to a system of random selection. One trap only was activated at each station in order that variables 2, 4, and 5 all be subject to test. When checked the following morning, species, age, and sex of all animals were recorded and the entire grid deactivated.

FINDINGS

Although the analysis is not yet complete, preliminary results are presented here. DSCODEs for the two experiments conducted in this study are A3UBC02 and 3.

A total of 10 replications of experiment 1 were conducted. The total number of trials of variables 1, 2, and 3 was 201, 196, and 195, respectively. Results of this experiment are summarized in Table 2 and compared graphically in Figure 1. A randomized block analysis of variance indicated that a significant difference exists in response to the three variables tested. Further analysis using Tukey's test revealed that response to variable 3 was significantly greater ($\alpha = .05$) than response to variables 1 and 2.

Ten replications of experiment 2 were also completed. The total number of trials of variables 2, 4, and 5 in this experiment were 210, 80, and 70, respectively. These data are summarized in Table 3 and compared graphically in Figure 2. A randomized block analysis of variance indicated no significant difference in response to the three variables.

Both analyses of variance were done with pooled data; it is now planned to break these data down and examine trap response by species, sex, and age.

A stepwise deletion multiple regression analysis was conducted on the data from variables 4 and 5 to examine the effects on trap response of species, age, sex, and state (alive or dead) of the test animals. Only *Peromyscus maniculatus* and *Perognathus parvus* were considered test animals in this analysis.

Significance was shown only when age of the captured animal was regressed against state (alive or dead), age, and the interaction between age and state, of the test animal. These relationships were significant at the $\alpha = 0.1$ level. Table 4 compares the age ratios of animals captured in experiment 2 and indicates an apparent species-specific, age-related response bias. Juvenile *Peromyscus maniculatus* appear to have an aversion to approaching traps that contain live animals.

The regression analysis indicates that age of the test animal influences approach as well. Table 5 demonstrates that there is a decrease in the juvenile:adult ratio of captured animals when the test animal is juvenile, independent of state. Also, there appears to be an increase in probability of capture when the test animal is a dead juvenile.

Table 2. Comparison of percent successful trials of variables 1, 2, and 3, experiment 1.

Replication	Variable 1 (Single trap)	Variable 2 (2 traps, 1 only set)	Variable 3 (2 traps both set)	% Double captures (% of successful var. 3 trials)
1	23.81	50.00	75.00	25.00
2	50.00	29.41	57.89	9.09
3	36.84	57.89	63.16	25.00
4	35.00	40.00	63.16	0.00
5	23.81	38.10	52.38	27.27
6	60.00	27.78	52.63	60.00
7	19.05	23.81	42.86	11.11
8	60.00	30.00	65.00	46.15
9	19.05	47.62	52.38	27.27
10	35.00	26.32	60.00	16.67
All reps. pooled	35.82	37.24	57.95	24.78
$\bar{X}$	36.256	37.09	58.45	24.76
s^2	246.87	134.22	79.39	313.61
s	15.71	11.59	8.91	17.71
$s_{\bar{x}}$	4.97	3.67	2.82	5.6
.95 C. I.	±11.24	±8.29	±6.37	±12.67

Table 3. Comparison of percent successful trials of variables 2, 4, and 5, experiment 2.

Replication	Variable 2 (2 traps, 1 only set)	Variable 4 (2 traps, live animal)	Variable 5 (2 traps, dead animal)
1	50.00	58.33	50.00
2	33.33	40.00	62.50
3	60.00	27.27	50.00
4	50.00	50.00	33.33
5	14.29	37.50	14.29
6	26.09	66.67	40.00
7	45.83	71.43	60.00
8	45.00	44.44	28.57
9	9.09	14.29	42.86
10	33.33	40.00	0.00
All reps. pooled	35.71	43.75	40.00
$\bar{X}$	36.65	41.89	36.84
s^2	272.08	303.87	390.73
s	16.49	17.43	19.77
$s_{\bar{x}}$	5.22	5.51	6.25
.95 C. I.	±11.8	±12.46	±14.14

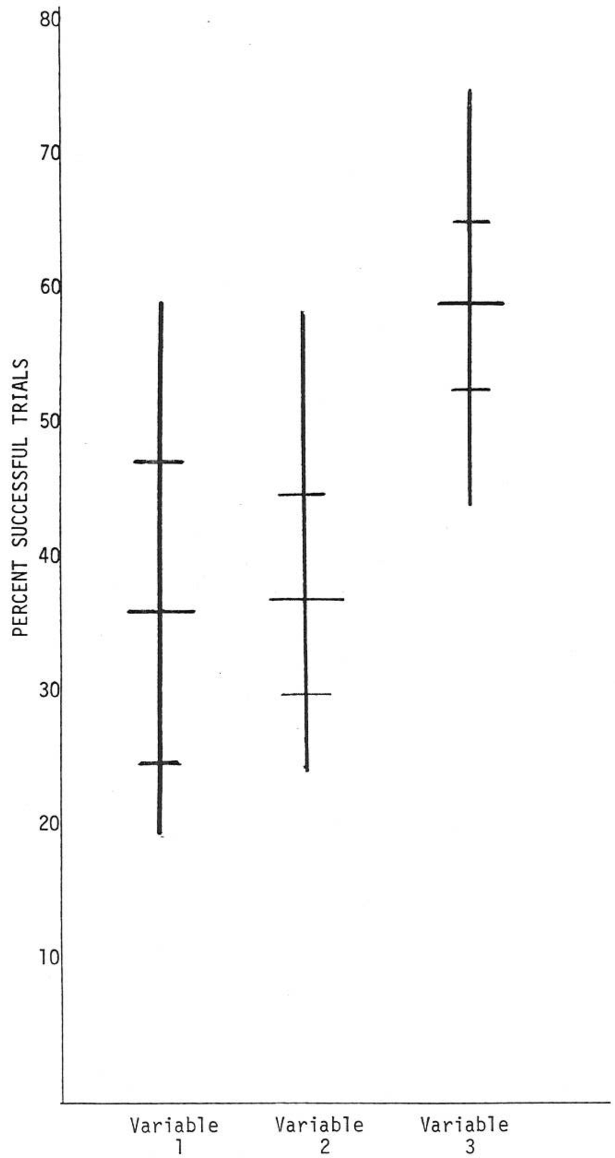

Figure 1. Comparison of response to variables 1, 2, and 3, experiment 1, showing range, mean and 95% confidence intervals.

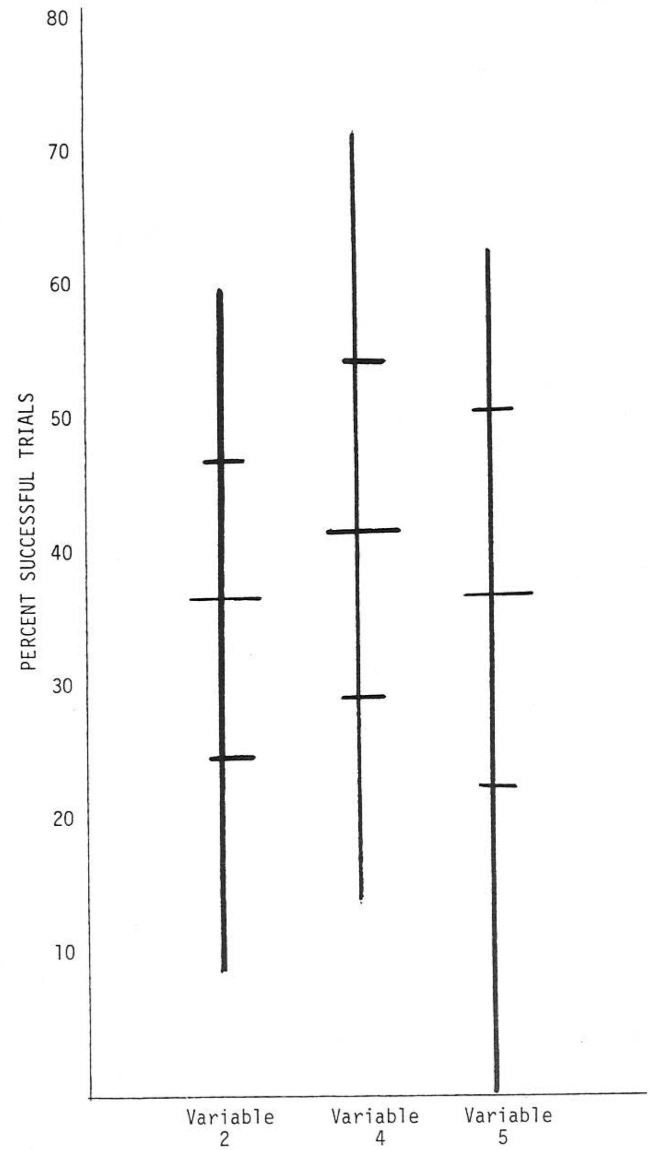

Figure 2. Comparison of response of variables 2, 4, and 5, experiment 2, showing range, mean, and 95% confidence intervals.

Table 4. Comparison of age ratios in captured animals, variables 2, 4, and 5, experiment 2.

Species	Variable 2 Juv:Ad	Variable 4 Juv:Ad	Variable 5 Juv:Ad
Peromyscus maniculatus	1.44	.75	1.22
Perognathus parvus	.33	.33	.33
Both species pooled	1.28	.611	1.0

Table 5. Comparison of age ratios and probability of capture, variables 2, 4, and 5, experiment 2.

Variable	# Trials	# *Peromyscus* captured	Juvenile:Adult Ratio	% Successful Trials
2, Empty trap	210	52	1.43	24.75
4, Live animal *	80	21	.75	26.25
5, Dead animal *	70	20	1.22	28.60
4, Live juvenile	24	8	.6	30.00
4, Live adult	43	10	1.0	23.30
5, Dead juvenile	20	11	.833	55.00
5, Dead adult	44	8	3.0	18.30
4, Live P. man.	67	18	.8	26.90
5, Dead P. man.	64	19	1.375	29.70
4+5, Juvenile	44	19	.725	40.90
4+5, Adult	87	18	1.57	21.82

*Includes *Peromyscus maniculatus* and *Perognathus parvus*. All others are *P. maniculatus* only.

DISCUSSION

It was initially felt that the increase in probability of capture in two-trap stations could possibly be explained in terms of stimulus strength and exploratory behavior (Barnett, 1958; Berlyne, 1960; Welker, 1961; and others).

When an animal comes in contact with a trap in the course of exploration, it is presented with a strange object. The response of animals to strange objects such as traps has been discussed by Shillito (1963), Kikkawa (1964), Trojan and Wojciechowska (1967), and Balph (1968). Generally, such objects are approached with caution until the animal habituates to the stimulus.

Degree of novelty, complexity, and stimulus contrast are all involved in determining the effect of a given stimulus on an animal (Berlyne, 1960; and others). Two traps offer a more complex stimulus to an animal and are possibly a stronger attractant than a single trap. Probability of capture could be increased by a two-trap station attracting more animals, by those animals that approach the station being stimulated to explore more and their attention being held longer, or by merely providing an additional trap entrance for an animal.

It is possible that response to a stimulus such as a trap is a species- or class-specific trait and that the same stimulus may attract some animals and repel others. For this reason it is necessary to examine the data by species, sex, and age class as any such effect may be masked in the analysis of pooled data. This aspect of the analysis has not been completed at this time but results will be included in the final report when it is submitted.

Thus far, the results of Experiment 1 indicate that the increased stimulus value of a second trap has little to do with the increased rate of capture at multiple-trap stations. If stimulus value alone were responsible there should be no difference in rate of response to variables 2 and 3. If stimulus value were partially responsible and the increased number of trap entrances also had an effect, an increased rate of capture would be expected in variable 2 over 1 and variable 3 over 2. Because only variable 3 had a response rate that was significantly higher than the others, it appears that probability of capture is primarily increased by the additional trap entrance.

The low frequency of occurrence of multiple captures observed in Curlew Valley in 1969 may possibly be due to inhibition caused by inter- and intraspecific relationships between the first animal captured and other animals that approach. Calhoun (1964) discusses the possible role of interspecific dominance relationships in inhibition of trap response. Kikkawa (1964) describes intraspecific aggression at traps in voles (*Clethrionomys glareolus*). These encounters were apparently related to dominance relationships. He also observed that mice *(Apodemus sylvaticus)* were very cautious when approaching a trap and that unfamiliar noises would cause them to pause and listen. It is possible the sounds made by an animal in a trap may inhibit the approach of other animals. The greater frequency of multiple captures in Museum Special snap-traps indicates that the physical state of the first animal captured (alive or dead) may be involved in inhibition of trap response. Experiment 2 was designed to test the effect of live and dead animals on subsequent probability of capture.

The results of the analysis of variance showed no significance between variables 2, 4, and 5 using pooled data. This indicates that the presence of an animal, whether dead or alive, has little influence on the percent trap success that can be expected at multiple-trap stations.

The multiple regression analysis, however, revealed that the presence of an animal in a trap may influence the age ratio of subsequent captures. There was a significant relationship ($\alpha = 0.1$) between the age of an animal captured and the age and state (alive or dead) of the test animal. This effect is masked in the analysis of variance because the sex and age class is not considered. As indicated in Table 4, *Peromyscus maniculatus* appears to have an age-specific aversion to approaching traps that contain live animals. This response appears to be specific for *Peromyscus*, but this may be an artifact of the small sample size of *Perognathus parvus*.

The differential response of *Peromyscus* to traps that contain live animals may be explained in terms of stimulus contrast and exploratory behavior. The stimulus contrast between a trap containing a live animal and the other two variables may be considerable and quite aversive to certain classes of animals. Vocalization, movement within the trap, and odor from the trapped animal may well serve as a warning or fear stimulus and cause other animals to avoid the adjacent empty trap. A certain class of animals, such as juveniles and sub-adults, may be more wary and hesitant in exploration than other classes and consequently may have a lower probability of capture under certain conditions.

Another possibility is that juveniles and sub-adults may be experiencing a density-related dispersal pressure and may actively avoid contact with other animals.

The differential response in *Peromyscus* is also related to age of the test animal. Table 5 compares the juvenile:adult ratios in *Peromyscus* captured at traps containing various combinations of variables 4 and 5. In every case, the age ratio of the captured animals is biased against the age class of the test animal, independent of state (alive or dead). Also, the probability of capture (expressed as percent successful trials) increased greatly when the test animal was a dead juvenile, though the age ratios maintained their bias.

Such results raise intriguing behavioral questions that cannot be answered in this preliminary report. It is difficult to say offhand what factors are responsible for the relationship between the age ratio of captured animals and the age of the test animal. The increase in probability of capture when the test animal is a dead juvenile is equally difficult to explain. It is planned to examine these data, and those from Experiment 1, in greater detail in an attempt to arrive at a rational explanation for such results. It is hoped that such an explanation can be offered in the final report.

EXPECTATIONS

It is hoped that this study provides information that will be of value in the interpretation of results of trapping programs. Toward this end we plan to examine our own validation sampling data to determine if the relationships observed in this study are involved there.

Only by understanding the behavioral factors involved in trapping can we hope to design sampling programs and interpret their results effectively. As indicated in this study, sampling design influences not only the probability of capture but the age ratio of the animals captured as well. These factors must be taken into account when interpreting the results of a trapping program and especially when comparing two or more different studies.

ACKNOWLEDGMENTS

Much appreciation is expressed to Ethel Mathews and Charles Romesburg for writing the computer programs and doing the statistical analysis.

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