P. F. X. Dunigan, Jr.

W. Lei[1]

U.S. Department of Energy
Richland, Washington 99352

and

W. H. Rickard

Battelle Pacific Northwest Laboratories
Richland, Washington 99352

Pocket Mouse Population Response to Winter Precipitation and Drought

Abstract

A relationship between autumn-winter precipitation and population of *Perognathus parvus* is demonstrated. Captures are compared to phytomass and monthly precipitation for a drought year and an average year.

Introduction

In the monographic study of a population of Great Basin Pocket mice (*Perognathus parvus*) in the arid shrub-steppe of south-central Washington, O'Farrell *et al.* (1975) identified food as appearing to be "an essential resource" critical to cueing the behavioral and physiological response of the population. Schreiber (1973) thought that cheatgrass (*Bromus tectorum*) is probably the most significant single dietary item used by pocket mice and demonstrated an apparent relationship between increased cheatgrass production and reproductive success in pocket mice. Beatley (1969) concluded that the occurrence or absence of reproduction in desert heteromyids in southern Nevada is correlated with the abundance of winter annuals. Furthermore, she notes that if the amount of autumn rainfall was measured, it was usually possible to predict whether there would be significant reproduction in the heteromyid population in the following spring. In both of these instances, the production of both annual and perennial grasses is dependent on autumn and winter precipitation to recharge soil water and promote plant growth. Therefore, there is an inferred relationship involving precipitation, food production and availability, and population response in *P. parvus*. We attempted to demonstrate the relationship between precipitation and population response by live trapping a pocket mouse population. By comparing our results with the previous studies performed at the same location, temporal trends in the spring population captures were related to the previous autumn-winter precipitation levels.

The study was initiated in April, 1977 in the wake of one of the driest winters on record in eastern Washington. The study was concluded in June, 1978 following a winter with average precipitation. Therefore, a relationship between precipitation and the pocket mouse population would be all the more apparent.

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[1]Present address: New York University, Tuxedo, New York 10987.

Study Site Description

The study location is the U.S. Department of Energy's Arid Lands Ecology (ALE) reserve located on the Hanford Site in south-central Washington. The trapping grid is located on a gentle northeast facing slope at the base of Rattlesnake Mountain. The plot altitude is approximately 360 m above mean sea level. The soil type on the study plot is Ritzville silt-loam up to 2.0 m deep overlying basalt. Measurements of precipitation and temperature have been recorded since 1968 at the plot as part of the ALE micrometeorological network (Thorp and Hinds, 1977). The vegetative cover on the plot consists of big sagebrush, bluebunch wheatgrass and other species characteristic of the *Artemisia tridentata/Agropyron spicatum* association in near pristine condition (Daubenmire, 1960). There is very little cheatgrass in the study area (Rickard *et al.*, 1975).

The study site is one of four 9.0 ha plots that were established to study the ecological effects of cattle grazing on small mammals. This former study was a part of the IBP Grasslands Biome Ecosystems Analysis program. Technical Reports Nos. 174 and 243 in this program describe the study site in further detail (O'Farrell *et al.*, 1972 and 1974). The plot used in our study was moderately grazed, but with the cessation of grazing and field trapping in 1975, it was not used for study purposes until the initiation of our project in 1977.

Methods and Materials

The study plot contained a 12 x 12 rectangular trap grid with Sherman live traps placed at 15 m intervals. Each trap slid into a "mailbox" sleeve, and together these were placed under a galvanized metal tent. The purpose of the sleeve and tent was to shade the trap and thus keep a trapped animal cooler in hot weather. Dacron batting was placed in each trap to act as nesting material and to insulate the animal in cooler temperatures. A small handful of "bird" seed was also deposited in each trap to help prevent torpor. We extended the grid perimeter to include one-half the distance between traps, i.e., 7.5 m; the effective trapping area was calculated to be 3.24 ha.

Trapping sessions occurred on weekends at three- to four-week intervals throughout the period of the study. Traps were opened and baited with a peanut butter-oatmeal mixture on Friday evening. Traps were inspected on Saturday and Sunday in the early morning. Hence each trap session consisted of two trap nights with 144 traps open per night, giving a total of 288 trap nights per session.

Captured animals were individually identified by toe amputation. Each animal was inspected to determine species, sex, age class (either juvenile or adult), pelage, reproductive condition, and weight. After inspection and data recording, the animal was released near the point of capture.

Primary productivity expressed as grams per square meter per year was obtained by clip harvest of sixteen 0.5 m^2 circular plots randomly placed in a 9 ha plot adjacent to the plot containing the trap grid. Species were identified in each circular plot, clipped and weighed after oven-drying at 50°C. Two harvests were made in 1978; once in April to obtain a measure of the phytomass of Sandberg bluegrass and early maturing annuals, and once in early June to estimate the phytomass of late flowering perennial grasses and forbs. In 1977, only one plant harvest was made when it became apparent that the severe drought conditions would not permit the usual sequence of plant development and maturation.

Results

Monthly precipitation levels of 12 month periods during 1969-70, 1970-71, 1975-76, and 1976-77 are listed in Table 1. The data indicate that the majority of precipitation falls in the autumn and winter months, October to April. This season has been termed the "bioyear precipitation" (Thorp and Hinds, 1977) due to the heavy reliance of the vegetation on soil water stored during this period of the plant growing season. Thorp and Hinds (1977) noted that the average bioyear precipitation on our plot was about 20 cm. Summation of the bioyear precipitation levels for the years listed in Table 1 shows that 1969-70 (23.2 cm) was an above average season; 1971-72 (18.9 cm) and 1975-76 (19.2 cm) were average seasons; and 1976-77 (4.6 cm) was far below average.

The spring (April+May+June) trapping results of O'Farrell *et al.* (1972 and 1974) for the years 1971 and 1972 are compared with our results in Table 2. The number of traps set each night, the total number of nights in which traps were activated, and the total trap effort (number of trap nights) for this three month period are also compared in Table 2. The data of O'Farrell *et al.* in 1971 and 1972 were not achieved in the same manner as our data of 1977 and 1978. The difference occurs in the total trap effort that took place in the respective two year periods, particularly as affected by the number of traps set per night. In 1971, the initial spring population response was estimated through a total trap effort of 4320 trap nights. In 1972, this figure fell to 2256 trap nights while our effort consisted of 1152 trap nights in both 1977 and 1978. To make the data comparable, we normalized the "traps set per night" (Column A, Table 2) to 144. The spring population response for each year was then multiplied by this normalization factor to give the normalized population levels listed in Column F of Table 2. We believe this is a legitimate calculation since the average home ranges of female and male (*P. parvus*) have been approximated to be 6 and 16 m respectively (O'Farrell, 1975). Thus, in 1977 and 1978 with only 144 traps opened per night, all trappable *P. parvus* may not have been accounted for since the traps were 15 m apart. In other words, once a trap had been filled, that trap was no longer available to pocket mice with over-

TABLE 1. Monthly precipitation (cm) measured at the study site.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.
1969-70	0.8	0.0	4.2	11.8	3.5	1.3	1.6	1.8	0.4	0.0	0.0	0.0
1970-71	1.5	2.1	5.2	3.6	0.5	5.6	0.4	2.5	0.9	0.4	0.8	2.1
1975-76	3.1	3.3	3.0	2.9	3.2	1.9	1.8	0.6	0.3	0.9	1.8	0.1
1976-77	0.4	0.1	0.4	0.5	1.9	1.3	0.0	1.4	1.5	0.2	4.9	3.9

TABLE 2. Summary of April, May, June trapping results for pocket mice at the study site.

Year	A Traps set per night	B Total nights opened	C Total trap effort (A x B)	D Spring captures	E Normalization factor	F Normalized spring captures (D x E)
1971[1]	288*	15	4320	167	0.50	84
1972[2]	188**	12	2256	99	0.77	76
1977	144	8	1152	69	1.00	69
1978	144	8	1152	43	1.00	43

*2 Sherman live traps placed at each of 144 trap sites.
**2 Sherman live traps placed at each of 44 peripheral trap sites; 1 trap placed at remaining sites.

[1]O'Farrell **et al.**, 1972.
[2]O'Farrell **et al.**, 1974.

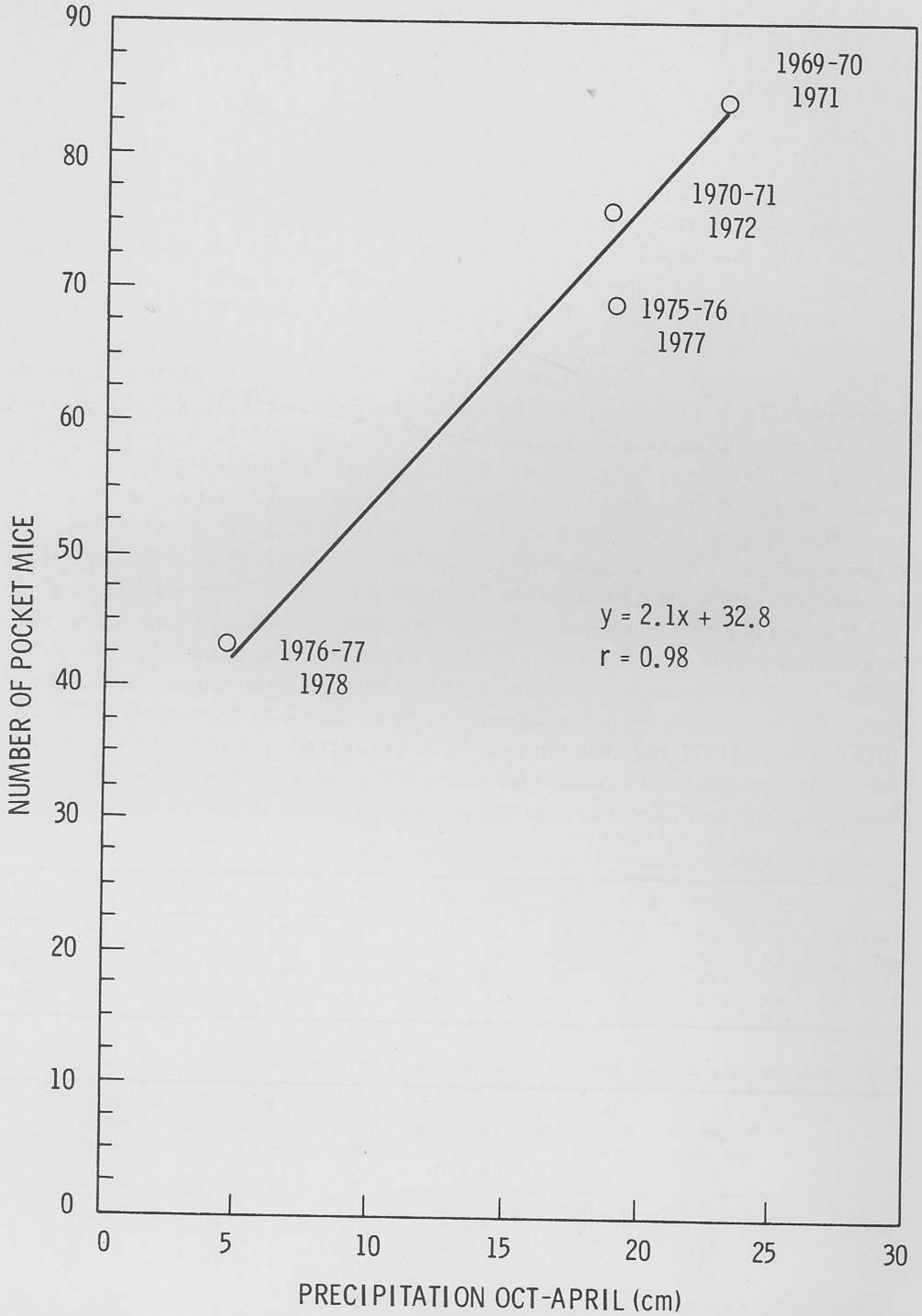

Figure 1. The relationship between the number of pocket mice and October through April precipitation.

lapping or neighboring home ranges to that of the trapped animal. By placing two traps at each trap location and trapping for an extended period of time, O'Farrell *et al.* showed in 1971 that more pocket mice may indeed be captured.

The normalized spring captures are compared to the bioyear precipitation levels of the preceding season in Table 3. These data are plotted in Figure 1, with the *P. parvus* spring captures plotted as a function of the October-April precipitation totals. A regression of the plot yields the following linear equation:

$$y = 2.14\ x + 32.78$$

A calculation of Pearson's correlation coefficient between these two variables gave r = .98, indicating a strong relationship between the autumn-winter precipitation and the *P. parvus* captures of the next spring.

TABLE 3. Summary of precipitation during the plant growing season October through April in relation to the trap catch of pocket mice (**Perognathus parvus**).

October-April precipitation (cm)		Normalized **P. parvus** spring captures (numbers)		Reference
23.2	(1969-70)	45	(1971)	O'Farrell et al., 1972
18.9	(1970-71)	76	(1972)	O'Farrell et al., 1974
19.2	(1975-76)	69	(1977)	This study
4.6	(1976-77)	43	(1978)	This study

Discussion

The trappability of the *P. parvus* closely follows the adaptive strategies described by O'Farrell *et al.* (1975); i.e., pocket mice emerge from winter torpor and are readily trapped during the spring when fresh food supplies are probably the greatest. The onset of reproductive activity is coupled with food gathering. These combined physiological drives facilitate trapping of pocket mice in the spring, usually between April and June (O'Farrell *et al.*, 1975). Our trapping results in 1977 and 1978 confirm this observation. Since the spring population size is a function of the reproductive activity/success of the previous summer, and since breeding may be curtailed or encouraged in response to food availability and quality which is in turn a function of bioyear precipitation, the spring captures are a good indicator of the previous fall-winter precipitation level. Conversely, by knowing the fall-winter precipitation total, one may predict the size of the *P. parvus* population in the spring of the following year, if indeed a relationship between fall-winter precipitation level and spring pocket mouse population size does exist.

O'Farrell and co-workers (1975) attempted to quantify a relationship similar to the above by using the Jolly-Seber stochastic model to estimate the *P. parvus* summer population size and then regressing these data against October-April precipitation levels. They, too, observed a linear relationship for the four-year period 1967-70 with a correlation coefficient of r = .99. They noted that no correlation is found when the population data are regressed against total annual precipitation. This finding indirectly confirms the notion that fall-winter precipitation is the better indicator of primary productivity and hence food availability for rodent species in arid ecosystems.

Plotting the normalized spring captures against the previous fall-winter precipitation levels also yields a good correlation (r = .98). Except for the artifice of normalization, the correlation was performed with real capture data and not with modelled numbers as in O'Farrell *et al.* (1975). The purpose of both correlations was the same: to relate the bioyear precipitation level to some indicator of *P. parvus* population size. The good correlation in both instances further supports the hypothesis that *P. parvus* population response is cued by an environmental factor, as discussed specifically by O'Farrell *et al.* (1975) and more generally by Beatley (1969). The factor indicated by this evidence is food. Thus, the strong correlation between an abiotic factor such as precipitation and the response of *P. parvus* is probably mediated by the availability of quality food items such as fresh seeds.

The results of live phytomass harvests are shown in Table 4. The impact of the 1977 drought upon plant productivity is clearly indicated. Only a fraction of the normal phytomass was produced in 1977. However, primary productivity was restored during the 1978 growing season. The 70 g/m^2 of herbaceous phytomass produced in 1978 is much like the range of 61-75 g/m^2 produced in the years 1971-74 (Rickard *et al.*, 1976). The 1978 phytomass consisted of a flush of annual plant growth, especially *Festuca octoflora*, which is a prolific seed producer similar to other annual grasses. *Bromus tectorum*, another annual grass, actually dominates the herbaceous vegetation in disturbed ground at other places in the ALE Reserve, but was sparingly represented in our study plot.

Kritzman (1974) has shown that populations of *P. parvus* on the ALE Reserve are primarily granivorous in the summer and early fall, although insects are consumed prior to the production of seeds. Thus, the above reasoning could be verified by monitoring

TABLE 4. Live herbaceous phytomass measured in the years 1977 and 1978 and expresed as g/m^2/yr.

Taxa	1978	1977
Perennial grasses		
Agropyron spicatum	25.7	3.1
Poa sandbergii	9.4	0.43
Stipa thurberiana	0.73	—
Stipa comata	0.06	—
Perennial forbs		
Astragalus purshii	2.40	1.8
Crepis atrabarba	0.70	0.07
Lupinus laxiflorus	T	—
Calochortus macrocarpus	T	—
Lomatium macrocarpum	T	—
Low shrub		
Erigeron filifolius	22.0	1.9
Phlox longifolia	0.84	1.3
Antennaria dimorpha	—	1.4
Annual grasses		
Festuca octoflora	4.7	—
Bromus tectorum	0.26	—
Annual forbs		
Descurainia pinnata	2.1	—
Draba verna	0.18	—
Holosteum umbellatum	T	—
Sisymbrium altissimum	0.77	—
Plantago patagonica	T	—
Tragopogon dubius	T	—
Total live phytomass g/m^2/yr	69.6	10.0

T=Trace Amount

the levels of seed production to study correlations not only with population response in *P. parvus* but with levels of autumn-winter precipitation. Confirmation of such a relationship would provide a predictive tool to estimate the size of pocket mouse populations by measuring the fall and winter precipitation. Nevertheless, the chemical mechanisms that trigger the reproductive response in the pocket mouse population remain obscure.

Acknowledgments

The authors are grateful to the following persons who have contributed to this study: Kenneth Gano and Jim Furfaro provided technical advice; F. R. Standerfer, H. E. Ransom, and M. W. Tiernan provided support and encouragement. Work was performed under contract No. EY-76-C-06-1830 with the U.S. Department of Energy.

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Received July 2, 1979
Accepted for publication August 22, 1979