Characteristics of pocket gopher populations in relation to selected environmental factors in Pelican Valley, Yellowstone National Park
by Clifton Conrad Youmans

A thesis submitted in partial fulfillment of the requirements for the degree, of MASTER OF SCIENCE in Zoology
Montana State University


Abstract:
In 1977 and 1978 I examined characteristics of pocket gopher populations in relation to vegetation, soil texture, soil moisture, and snow melt phenology on nine belt transects (100 m by 10 m) established in Pelican Valley, Yellowstone National Park. Pocket gopher numbers on belt transects were indexed from 48-hour mound counts and trapping. Three hundred-one pocket gophers were dead-trapped during the study. Mound-building activity was lowest after snow melt in June and generally highest in August. Mound counts were not a reliable index of gopher numbers when taken prior to late July. Abundance of winter soil casts in June 1978 was correlated significantly ($P < .05$) with mound counts from the previous late summer and fall of 1977. The period of peak parturition was determined to be from mid-April to mid-May. Placental scars were persistent and quantifiable and enabled computation of a mean litter size of 4.9 (n=67). Maximum litter size recorded was seven. Females had significantly ($P < .025$) larger litters (x=5.1) their second (1978) reproductive effort than their first (1977, x=4.4). Significant ($P < .025$) differences in fertility occurred between 50 females collected from Festuca idahoensis/Desohampsia aaespitosa habitat types (x=4.7) and 42 females collected from Artemisia aana/Festuaa idahoensis community types (x=5.2). Population turnover averaged 76.5 percent on two belt transects which were live-trapped. Production of young exceeded replacement requirements. Juveniles composed 80 percent of 64 pocket gophers dead-trapped in September, 1978. Combined line intercepts of Melioa speotabilis and Perideridia gairdneri correlated significantly ($P < .01$) with 48-hour mound counts. Abundance of Collomia linearis also correlated significantly ($P < .01$) with 48-hour mound counts. Soil textures on belt transects did not appear to influence pocket gopher numbers, however soil depths and soil temperatures may have done so. Soil moisture limited distribution of pocket gophers. Swales were typically too wet for pocket gopher use until late summer. Dispersing juveniles established territories on the edge of swales in August, when soil moisture was lowest. Marked differences in the depth of snow on 1 May between 1977 and 1978 did not appear to influence juvenile survival and hence fall population levels.

CHARACTERISTICS OF POCKET GOPHER POPULATIONS IN RELATION TO SELECTED ENVIRONMENTAL FACTORS IN PELICAN VALLEY, YELLOWSTONE NATIONAL PARK

by

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A thesis submitted in partial fulfillment of the requirements for the degree

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in

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Date October 2, 1979

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## ABSTRACT

In 1977 and 1978 I examined characteristics of pocket gopher populations in relation to vegetation, soil texture, soil moisture, and snow melt phenology on nine belt transects (100 m by 10 m) established in Pelican Valley, Yellowstone National Park. Pocket gopher numbers on belt transects were indexed from 48-hour mound counts and trapping. Three hundred-one pocket gophers were dead-trapped during the study. Mound-building activity was lowest after snow melt in June and generally highest in August. Mound counts were not a reliable index of gopher numbers when taken prior to late July. Abundance of winter soil casts in June 1978 was correlated significantly ($P < .05$) with mound counts from the previous late summer and fall of 1977. The period of peak parturition was determined to be from mid-April to mid-May. Placental scars were persistent and quantifiable and enabled computation of a mean litter size of 4.9 ($n=67$). Maximum litter size recorded was seven. Females had significantly ($P < .025$) larger litters ($\bar{x}=5.1$) their second (1978) reproductive effort than their first (1977, $\bar{x}=4.4$). Significant ($P < .025$) differences in fertility occurred between 50 females collected from *Festuca idahoensis/Deschampsia caespitosa* habitat types ($\bar{x}=4.7$) and 42 females collected from *Artemisia cana/Festuca idahoensis* community types ($\bar{x}=5.2$). Population turnover averaged 76.5 percent on two belt transects which were live-trapped. Production of young exceeded replacement requirements. Juveniles composed 80 percent of 64 pocket gophers dead-trapped in September, 1978. Combined line intercepts of *Melica spectabilis* and *Perideridia gairdneri* correlated significantly ($P < .01$) with 48-hour mound counts. Abundance of *Collomia linearis* also correlated significantly ($P < .01$) with 48-hour mound counts. Soil textures on belt transects did not appear to influence pocket gopher numbers, however soil depths and soil temperatures may have done so. Soil moisture limited distribution of pocket gophers. Swales were typically too wet for pocket gopher use until late summer. Dispersing juveniles established territories on the edge of swales in August, when soil moisture was lowest. Marked differences in the depth of snow on 1 May between 1977 and 1978 did not appear to influence juvenile survival and hence fall population levels.

# INTRODUCTION

The dynamics of pocket gopher populations in relation to ecosystem characteristics have been examined by numerous researchers. Attempts to isolate specific extrinsic ecosystem components and describe their influence on pocket gopher numbers and distribution have resulted in the identification of several important factors: water content at peak snowpack and depth of snow in spring (Hansen and Ward, 1966; Reid, 1973); weather and its influence on annual food supplies and cover (Howard and Childs, 1959); production of annual and perennial forbs (Keith et al., 1959; Tietjen et al., 1967); and ground water levels and snow depths (Ingles, 1949; Hansen, 1962).

The inherent complexity of pocket gopher-ecosystem interactions generally limits the degree to which site-specific data may be extrapolated to other locales. A need for specific information on pocket gophers in Pelican Valley, Yellowstone National Park arose from interest in interactions between grizzly bears (*Ursus arctos horribilis*) and northern pocket gophers (*Thomomys talpoides*). Mealey (1975) and Graham (1978) suggested that pocket gophers and their caches may serve as seasonally important food items for grizzlies in Yellowstone National Park.

Pelican Valley was selected as the study location due to its relative accessibility, vegetation in the valley being representative of large grass/shrub complexes found within the Yellowstone ecosystem (Mealey, 1975), and the high frequency of grizzly use along the southern edge of the valley, coinciding with generally high indices of pocket gopher numbers (Graham, 1978).

Objectives of this study were to select specific representative sites in Pelican Valley on which pocket gopher numbers could be quantified, monitored, and compared with data gathered concurrently on vegetative composition, standing crop, soil moisture, soil texture, and snow melt phenology. Changes in pocket gopher numbers were analyzed by gathering data on pocket gopher natality, sex ratios, age structure, annual population turnover, recruitment, period of peak parturition, and home range size. Frequency of infection with the parasitic nematode *Capillaria hepatica*, average weights, and composition of a pocket gopher cache were also determined. Field work was conducted from June to September in 1977 and from June to October in 1978.

## STUDY AREA

Pelican Valley lies east of the geographic center of Yellowstone National Park and immediately to the northeast of Yellowstone Lake (Figure 1). Elevations vary from approximately 2362 m to 2437 m. The valley is approximately 2500 hectares in area. The mean annual temperature recorded at Lake Yellowstone weather station from 1948 to 1974 is 0.2° C (Dirks, 1974). July is the warmest month with a mean daily maximum of 22° C while the coldest month, January, has a mean daily minimum of -18° C (U.S. Weather Bureau, Climatological Data for Wyoming). Lake Camp snow course, approximately eight kilometers west of the valley at an elevation of 2392 m, had a mean snow depth of zero cm on 2 May, 1977 and 55.8 cm on 30 April, 1978 (Table 1, USDA Soil Conservation Service and Federal-State-Private Cooperative Snow Surveys 1977 and 1978).

Table 1. Snow depth and water content of snow on approximately 1 May for Lake Camp Snow Course, 1977 and 1978.

| Date | Depth of Snow (cm) | Water Content (cm) |
|---|---|---|
| 2 May 1977 | 0 | 0 |
| 30 April 1978 | 55.8 | 25.4 |

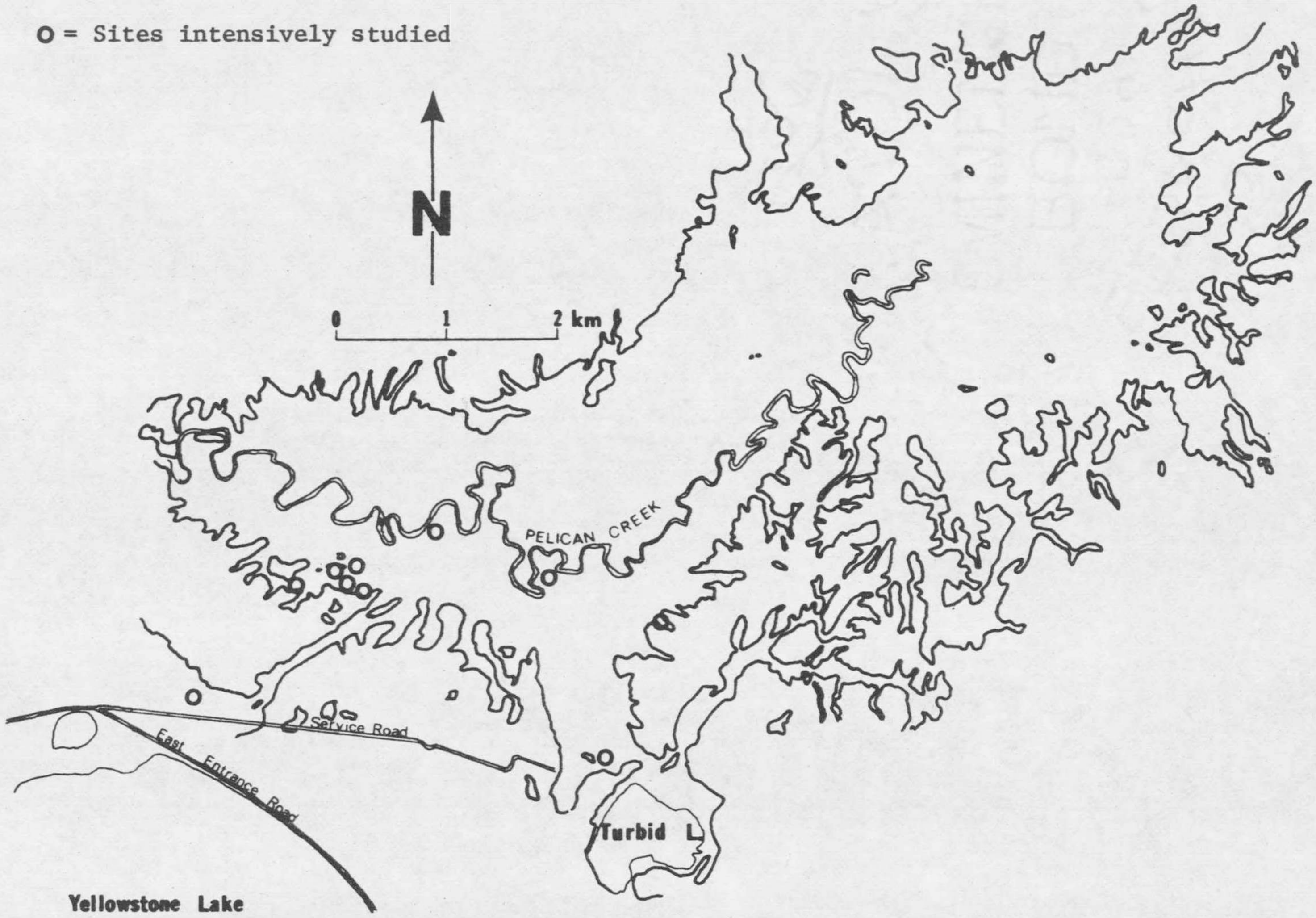


Figure 1. Pelican Valley, Yellowstone National Park

Graham (1978) observed that timber/grassland edge effectively divides Pelican Valley into separate ecological units. In particular, the southern edge of the valley exhibits a mosaic of small, discrete ecological units or 'patches'. Graham (1978) suggested that grizzlies exhibit a foraging strategy characterized by movement between small patches of seasonally high food abundance. Such foraging strategy may represent a long-term adaptation to fluctuations in spatial-temporal distributions of food (Royama, 1970; Smith and Sweatman, 1974; Pyke et al., 1977). In light of these observations, characteristics of pocket gopher populations on small, representative, and generally homogeneous ecological units were of particular interest.

## METHODS

Belt transects were established along the southern edge of Pelican Valley on sites considered to be representative of existing plant communities and soil types. Eight belt transects 100 m long and 10 m wide were established during the summer of 1977. One additional belt transect of the same dimensions was established in June of 1978. These belt transects served as the primary sites of data collection during both field seasons.

### Vegetation

The vegetation on all belt transects was classified as to habitat type (h.t.) (Mueggler and Handl, 1974) or community type (c.t.) (Graham, 1978) and quantitatively measured.

Vegetative composition on five of the nine belt transects was representative of a *Festuca idahoensis/Deschampsia caespitosa* (FEID/DECA) h.t. (FEID/DECA belt transect Nos. 1 through 5). Three belt transects were representative of an *Artemisia cana/Festuca idahoensis* (ARCA/FEID) c.t. (ARCA/FEID belt transect Nos. 1 through 3). One belt transect was representative of *Deschampsia caespitosa/Carex* spp. (DECA/*Carex*) h.t. (DECA/*Carex* spp. belt transect No. 1). Graham (1978) found that the FEID/DECA h.t. and the ARCA/FEID c.t. composed 51 percent and 31 percent respectively of all grizzly observation sites for both Pelican and Hayden Valleys.

Composition and canopy coverage of low growing vegetation were determined in August on each of the eight belt transects in 1977 and on each of the nine belt transects in 1978. A modification of the method described by Daubenmire (1959) was used. Twenty 2x5 decimeter plots were placed at five meter intervals along the centerline of each belt transect in 1977. Intensity of sampling was increased in 1978 to 25 plots placed at four meter intervals. Scientific and common names of plant species follow Hitchcock et al. (1969), Booth and Wright (1959), and Booth (1972).

Line intercepts coinciding with the centerline of each belt transect were used to index the relative abundance of yampa (*Perideridia gairdneri*) and purple oniongrass (*Melica spectabilis*) for the month of August in both 1977 and 1978. These two species are of possible importance to grizzly bears (Graham, 1978).

Data on standing crop for the month of August in 1978 were obtained on the nine belt transects by utilizing clip plots (USDA Forest Service, 1963).

Two of the nine belt transects were intensively sampled using 10 circular clip plots, each equal to 9.6 $ft^2$. The remaining seven belt transects were sampled using 10 circular clip plots each equal to 0.96 $ft^2$. On all nine belt transects a stratified random sampling scheme determined the location of clip plots. Belt transects were partitioned into 10 $m^2$ sections along their lengths. One clip plot was randomly selected within each 10 $m^2$ section of the belt transects. Plant species clipped from each plot were bagged separately. Some species occurring only infrequently were lumped together. Clipped vegetation was oven dried at 50° C to a constant weight, then removed from bags and weighed to the nearest 0.01 gram.

Ordination and cluster analysis of canopy coverage data from belt transects for 1977 and 1978 followed Goldstein and Grigal (1972).

## Indices of Pocket Gopher Numbers

Indices of pocket gopher numbers during snow-free months were accomplished through the use of mound counts (Reid et al., 1966) within each belt transect. Mound counts were made at arbitrary intervals during the 1977 field season and monthly intervals during the 1978 field season.

A relative index of prior gopher activity during winter snow cover was obtained in June of 1978 by quantifying abundance of winter soil casts. On each of eight belt transects, total centimeters of intercepted soil casts along each of three parallel lines were recorded. Placement of lines coincided with each side and the centerline of belt transects. The total number of centimeters intercepted per belt transect was compared with previous mound counts taken in late summer of 1977 and mound counts taken in June, 1978.

Dead-trapping and Necropsy

Macabee traps were used to collect pocket gophers from belt transects and other sites with similar vegetation and soils in Pelican Valley. Three hundred-one pocket gophers were collected during the 1977 and 1978 field seasons. Information on rates of mound building, natality, sex ratios, age classes, body weights, and the presence of parasites was obtained.

All pocket gophers within two belt transects (FEID/DECA 1 and ARCA/FEID 1) were trapped out during September, 1978 to obtain individuals live-trapped, marked, and released during the previous year's field season. Numbers of individuals collected on these two belt transects, along with mound counts taken immediately prior to trapping allowed for computation of the mean number of mounds built per pocket gopher per 48 hour time interval.

Pocket gophers on a semi-isolated north facing hillside (FEID/DECA h.t.) comprising an area of approximately 0.5 ha were trapped during the 1978 field season. Approximately 90 percent of all individuals on this site were collected to obtain information on the population characteristics of a discrete pocket gopher population.

Field weights were obtained for 231 pocket gophers collected during the 1978 field season through the use of a dial spring scale accurate to ± two grams. Specimens were placed in Whirl Pak plastic bags upon collection in the field and frozen the same day. No specimens remained in traps longer than 24 hours.

In the laboratory, specimens were subsequently thawed and weighed to the nearest 0.1 gram. Comparison of laboratory weights with field weights revealed an average weight loss of approximately five grams due to desiccation. Compensation for weight loss due to desiccation was made in order to obtain approximate field weights of pocket gophers collected during the 1977 field season.

Pocket gopher natality was measured by counting placental scars and embryos of uteri excised from adult females. Rolan and Gier (1967) determined that placental scar counts, if interpreted judiciously, correlated well with embryo counts in *Peromyscus maniculatus* and *Microtus ochrogaster*. Preparation of excised uteri followed Orsini (1962).

Adult pocket gophers were discriminated from young in the field during the months of June and July on the basis of size and pelage. Accurate separation of adult males from young in the fall was not possible. However, the presence of a pubic gap and the size of the uterus in females allowed for accurate separation of adults from young in the fall (Hisaw, 1924; Hansen, 1960). Adult females were separated into year classes on the basis of numbers of placental scars after a mean litter size for the population was determined.

During necropsy, pocket gopher liver tissue was excised, pressed between two glass microscope slides, and examined under magnification for determination of presence or absence of *Capillaria hepatica*, a parasitic nematode. Cunningham (1966) suggested that heavy liver infection from this parasite may affect the fat-storing ability of pocket gophers.

Live-trapping

Pocket gophers were live-trapped, marked, and released on FEID/DECA Belt Transect No. 1 and ARCA/FEID Belt Transect No. 1 during August of 1977. A modification of the pocket gopher live-trap described by Baker and Williams (1972) was used. Live-trapping enabled specific data to be gathered on population turnover and the computation of a ratio of mounds built per gopher per 48 hours for 1977 on both belt transects. Additionally, live-trapping provided known age individuals as standards for age determination and average litter size in females.

Burrow systems were located by probing the soil with an Oakfield Apparatus near fresh pocket gopher mounds. Live-traps were set around the periphery of burrow systems in order to obtain home range size. Capture sites were marked and subsequently mapped to accurately measure home range size. Individual pocket gophers were generally captured more than once; the maximum number of recaptures was that of an adult female captured 10 times. Home range sizes were determined for individuals captured three or more times.

To minimize possible trap-related mortality, traps were checked on an hourly basis and live-trapping was conducted only during daylight hours. Despite such efforts, a few individuals showed obvious signs of physiological stress upon release. These individuals were considered trap-related mortalities if no subsequent recaptures were accomplished.

Soils

During the 1977 field season, collection of soil samples was restricted to the month of July. Soil samples were used to determine the soil texture on belt transects. Soil samples were taken at two depths at 20 m intervals along belt transects. Samples from zero to 10 cm, and 10 to 30 cm in depth were collected using an Oakfield Apparatus. Soil texture was determined through a modification of a method described by Bouyoucos (1928).

During the 1978 field season, soil samples were obtained at monthly intervals on nine belt transects at the 25 m and 75 m transect marks. Collection methods followed those of 1977 except that field and oven dry weights were obtained on all samples, and a relative index of water saturation was obtained.

Pocket gopher tolerance to percent water saturation of soil was estimated during the 1978 field season. Three line transects were established between FEID/DECA Belt Transect No. 1 and ARCA/FEID Belt Transect No. 1 which are separated by a low DECA/*Carex* spp. h.t. swale. Monthly soil samples were taken at five meter intervals along these three line transects at depths of zero to 10 cm, and 10 to 30 cm. Comparison of oven dried soil weights and field weights allowed for computation of approximate percent saturation of water for each sampling period. Presence or absence of pocket gopher mounds within five meters of either side of each line transect was recorded simultaneously with collection of monthly soil samples.

Snow Melt Phenology

Aerial photography missions were flown in a Piper Super Cub aircraft on 28 April, 1977 and 1 June, 1978. On both dates, late melt snow patterns were photographed by using a 35 mm camera.

## RESULTS

### Indices of Pocket Gopher Numbers

Relative numbers of pocket gophers as indexed through mound counts (Reid et al., 1966) on belt transects during 1977 and 1978 are shown in Figures 2 through 7. On all belt transects, mound-building activity was lowest in the spring and increased throughout the summer months. Highest mound counts were generally obtained during August. A decline in mound-building activity, following a peak in late July occurred on FEID/DECA 1 (Figure 2), FEID/DECA 3 (Figure 4), ARCA/FEID 1 (Figure 6), and ARCA/FEID 3 (Figure 7).

Final mound counts on each belt transect in 1977 were compared with mound counts obtained at approximately the same time in 1978 (Table 2). Differences between final mound counts in 1977 and closest-date mound counts in 1978 are not significant ($P > .05$, paired t-test). Mound-building activity appeared to be greater in 1978 than in 1977 on belt transects FEID/DECA 1, FEID/DECA 3, and ARCA/FEID 3. Limited mound counts during the 1977 field season on ARCA/FEID 2 restricts strict comparison between the two years, however casual observations during August of 1977 indicated that mound-building activity was well below 1978 levels.

The ratios of mounds built per pocket gopher per 48 hours on