HOME RANGE OF THE WESTERN JUMPING MOUSE, *ZAPUS PRINCEPS*, IN THE COLORADO ROCKY MOUNTAINS

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ABSTRACT.— Western jumping mice, *Zapus princeps*, were live-trapped during the summer of 1975 in an aspen forest in the Front Range of the Colorado Rocky Mountains. Home range sizes were calculated using the exclusive boundary strip method, and it was discovered that males had larger home ranges (298–3315 m^2, $\bar{x}$ = 1743 m^2) than females (680–1275 m^2, $\bar{x}$ = 1041 m^2). Mean range length was 96.5 m for males and 78.5 m for females. Spatial relationships showed that females tended to be more territorial than males, based on the females' higher percentage of exclusive home ranges, greater distance between centers of activity, and more uniform spacing.

Jumping mice (Zapodidae) are widely distributed over North America. The two eastern species (*Zapus hudsonius* and *Napaeozapus insignis*) have been the subject of considerable research (e.g. Snyder 1924; Sheldon 1934, 1938a, 1938b; Hamilton 1935; Blair 1940; Quimby 1951; and Whitaker 1963a, 1963b). However, ecological literature on the western jumping mouse (*Zapus princeps*) is sparse. Krutzsch (1954) briefly discussed the natural history of *Z. princeps* in the Rocky Mountains, and Brown (1967a, 1970) has provided information on its reproductive and seasonal activity patterns. Although information is available on habitat selection by *Z. princeps* (Brown 1967b, Clark 1971, Armstrong 1972), little is known of their spatial patterns within a single habitat type. Analysis of these spatial patterns was the thrust of the present study.

MATERIALS AND METHODS

The study was conducted in an aspen forest adjacent to the University of Colorado Mountain Research Station, Nederland, Colorado, at an elevation of approximately 2900 m. This forest was mesic and willow (*Salix*); monkshood (*Aconitum columbianum*), cowparsnip (*Heracleum lanatum*), Canadian reed grass (*Calamagrostis canadensis*), and bluegrass (*Poa* spp.) dominated the understory.

The study area consisted of an 8 x 10 grid of trapping stations spaced 10 m apart. Three small Sherman live traps were placed at each station. The study area was sampled for four days twice a month during July, August, and September 1975. On capture, each individual was sexed, weighed, marked by toe-clipping, and then released. Location of capture for each individual was also recorded.

The exclusive boundary strip method was used to measure home range size. The external points of capture are connected, and the resultant area is considered the home range of the individual. Centers of activity were calculated using Hayne's method (1949) and were used to assess nearest neighbor distance (Clark and Evans 1954).

RESULTS

A total of 58 individuals was captured during the summer of 1975 in 5760 trap-nights, representing an average monthly density of 31.0/ha (range 28.0–35.0). This density was extremely high compared to values obtained by Brown (1970), whose population densities averaged 3.2/ha over a four-year period. Population numbers were stable on a monthly basis, probably due to

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the high longevity characteristic of *Zapus* (Quimby 1951, Brown 1970).

All animals captured five or more times were used in the calculation of home range size (N = 37). The average home range size of males was 1743 m^2 (298–3315 m^2), and that of females was 1041 m^2 (680–1275 m^2). The mean range length (greatest distance between captures) was 96.5 m for males and 78.5 m for females. These differences between the sexes were highly significant ($p < .01$, t-test). Brown (1970) obtained mean range length values twice the present values (210.0 m and 155.0 m respectively), but this is because the population of *Zapus princeps* that he studied showed an extremely narrow, elongated distribution along a mountain stream.

DISCUSSION

Home Range Size

Home range, as applied to mammals, has been defined by Burt (1943) as "the area transversed by the individual in its normal activities of food gathering, mating, and caring for young." Home range values for *Zapus princeps* in this study were considerably lower than those found by Myers (1969). Myers obtained home range values of 3075 m^2 for males and 2350 m^2 for females. There are several possible reasons for the discrepancy: (1) track- versus trap-revealed home ranges, (2) different population densities, and (3) differences in vegetation structure of the habitat. Myers used the tracking method of Justice (1961) to monitor animal movements, and the results of track- versus trap-revealed home ranges do not seem to be directly comparable. Metzgar (1973) found that track-revealed home ranges were larger than trap-revealed home ranges.

Myers captured a total of 25 *Zapus princeps* throughout the whole summer on a 1.1 hectare plot, whereas in the present study the average monthly density was 31.0/hectare. It has been well documented that home range size varies inversely with population density (Burt 1943, Getz 1961, Van Vleck 1969, Mazuriewicz 1971, and Maza et al. 1973).

Also, Myers does not describe the habitat's vegetation structure, which may influence home range size. In the present study, the aspen forest was very productive, and Kenagy (1973) proposed that in years of high resource levels animals forage over smaller areas since in the smaller areas food is readily available and less energy expenditure is required for foraging. And O'Farrell et al. (1975) point out that home ranges of *Perognathus parvus* were affected jointly by resource levels and population size; neither of these factors acted independently.

The exact reason for the large difference in calculated home range sizes is not known, but home range size is quite labile and many factors, both intrinsic (e.g. population size) and environmental, influence its size.

The home range size of *Zapus princeps* is similar to that of the meadow jumping mouse, *Z. hudsonius*, in Minnesota. Quimby (1951) used the inclusive boundary strip method, where the external points of capture are considered centers of rectangles whose boundaries are half the distance to the next trapping station, to determine home range size in *Z. hudsonius*. To facilitate comparison with the present study, Quimby's values were reduced 15 percent (see Stickel 1954); this reduction results in home range sizes of 1479 m^2 for males and 1307 m^2 for females. The similarity in home range size is not surprising, since Quimby (1951) found that the preferred habitat of *Z. hudsonius* in Minnesota was willow thickets—and the understory of the aspen forest in the present study was dominated by willows.

McNab (1963) proposed that "hunters" (carnivores, insectivores, and granivores) require a larger home range than "croppers" (herbivores). The home range size of two other species of rodents (*Microtus longicaudus* and *M. montanus*) found in the area were calculated using the same method. *Zapus princeps* is a primary granivore, with seeds of the graminoids being most important, while members of the genus *Microtus* are primary herbivores (Lechleitner 1969, Clark 1971). The average home range of *Z. princeps* was significantly larger ($p <$

.001, t-test) than that of the microtines (Table 1). The rationale for the difference in home range size is that food resources of hunters show a more dispersed distribution than that of croppers, and therefore must travel farther on foraging trips.

TABLE 1.—Home range size of three species of rodents.

Species	N	Home Range Size		Range Length	
		Male	Female	Male	Female
Microtus longicaudus	11	485 m^2	364 m^2	42.0 m	30.5 m
Microtus montanus	4	283 m^2	—	25.0 m	—
Zapus princeps	37	1741 m^2	1012 m^2	96.5 m	78.5 m

Territoriality

Getz (1961) suggested that territoriality can be inferred from five criteria: (1) percentage of exclusive (non-overlapping) home ranges between members of the same sex, (2) percentage of at least partially exclusive home ranges between members of the same sex, (3) distance between centers of activity, (4) distribution of centers of activity, and (5) sex of individuals involved in multiple captures. In this study 71 percent of the males had inclusive home ranges, while no females had inclusive home ranges. Both males and females had home ranges that were partially exclusive (29 percent and 84 percent respectively). Sixteen percent of the female home ranges were totally exclusive.

Centers of activity were calculated according to the method of Hayne (1949). The average distance between centers of activity was 11.1 m for males and 15.3 m for females. This difference in mean distance between centers of activity was significant ($p < .01$, t-test).

Getz (1961) hypothesized that if the sex ratio of the population is equal and if territorial behavior is not displayed, then the nearest neighbor should be of the same sex at least half the time. In this study, the nearest neighbor was always the opposite sex. Hanson and Fleharty (1974) believed this indicated that territorial behavior was exhibited by both sexes, but there may be an alternative explanation. In some rodent species mated pairs often share the same nest or nest in close proximity, and this may be the case with *Zapus princeps*. The fact that the nearest neighbor is of the opposite sex may just be a by-product of this reproductive behavior, and not a by-product of territorial behavior.

The distribution of centers of activity should approach uniformity if territorial behavior is displayed (Getz 1961). Clark and Evans (1954) established "R" as the ratio of the observed mean distance to nearest neighbor to the expected mean distance to nearest neighbor in an infinitely large random distribution. R has a finite range, with values indicative of perfectly clumped (0.00), random (1.00), and uniform (2.1491). Distributions of *Zapus princeps* based on centers of activity showed that both sexes tended towards uniform spacing ($R = 1.33$ for males and 1.51 for females). This difference between the sexes was significant ($F = 3.455$, $p < .01$).

There were no multiple captures of *Zapus princeps* in the present study. Quimby (1951) indicated that *Z. hudsonius* was a solitary feeder, and multiple captures were rare. The same may be true with *Z. princeps*.

The analysis of spatial relationships suggests that males are quite tolerant to each other (71 percent of home ranges inclusive), and that females tend to be more territorial than males, based on their higher percentage of exclusive home ranges, greater distance between centers of activity, and more uniform spacing.

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