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KUNWAR P. BHATNAGAR, *Department of Anatomy, University of Louisville Health Sciences Center, P.O. Box 35260, Louisville, Kentucky 40232.* *Submitted 26 January 1978. Accepted 19 February 1978.*

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A COMPARISON OF DIFFERENT TRAPPING CONFIGURATIONS WITH THE ASSESSMENT LINE TECHNIQUE FOR DENSITY ESTIMATIONS

A live-trapping technique for density estimation of small mammal populations was described by O'Farrell et al. (J. Mamm., 58:575–582, 1977). Two basic trapping configurations were used—a grid with assessment lines, and two parallel census lines with assessment lines. These configurations were used independently for a comparison between snap (kill) and live trapping techniques; the two habitats trapped were sufficiently different to negate a valid comparison of the grid and census line configurations.

The census method described by O'Farrell et al. (1977) allows the use of a variety of configurations and a number of assessment lines. This flexibility permits the use of the method in all land habitats. The aims and resources available dictate the size and basic configuration to be used. The purpose of the study reported on here was to compare two different trapline configurations that represent extremes in trapping effort.

The study area is located 40 km N Las Vegas, Clark County, Nevada (R64E, T16S, S30 SW¼). The area is a flat plateau with sandy soil. Vegetation is sparse and consists primarily of *Larrea divaricata* and *Ambrosia dumosa*. This habitat is unique because there is only one resident species of nocturnal rodent (*Dipodomys merriami*). Three transient species (*Perognathus formosus, P. longimembris*, and *Onychomys torridus*) were infrequently captured, mainly on the outer margins of the assessment lines. A set of parallel census lines (40 stations each) transected by six assessment lines was superimposed on a 12 by 12 station grid transected by eight assessment lines. Intertrap spacing was 15 m. Sherman live traps were used. For schematic diagrams and more detailed information see O'Farrell et al. (1977).

Seasonal density estimates were obtained on the following trapping schedule. For the January estimates we trapped on the census lines for 7 nights (19 to 25 December 1974), allowed a 4-night recovery period, and then trapped on the assessment lines for 4 nights (30 December 1974 to 2 January 1975). Traps were checked twice nightly. Results from this season differed from all others in that we began trapping during the last phase of the full moon, which drastically inhibited rodent activity as evidenced by poor trap success. Moonlight has been shown to inhibit desert rodent activity elsewhere (O'Farrell, J. Mamm., 55:809–823, 1974). We then allowed a 6-night recovery period before trapping on the grid (9 to 14 January 1975). Grid trapping was always done for three consecutive nights with trap checkes at 2-h intervals. Then we trapped on the assessment lines for three more consecutive nights with traps checked only in the morning.

Through the remainder of the study we attempted to avoid trapping if more than a half moon was present. In April 1975, census lines were trapped for 4 nights (7 to 10 April) and assessment lines for 3 nights (11 to 13 April). After a 2-night recovery period the grid and assessment lines were trapped (16 to 21 April). The July sample entailed 5 nights on the census lines (3 to 7 July) with assessment line trapping from 8 to 10 July. After a 3-night recovery period the grid and assessment lines were trapped from 14 to 19 July. Finally, the October estimates were obtained from 3 nights each on the census and assessment lines (26 September to 1 October); then a 3-night recovery period followed by trapping on the grid and assessment lines from 5 to 10 October. The variation in census line trapping results were dependent on obtaining less than 20% new

TABLE 1.—*Comparison of density estimates and pertinent population and area data between census lines and grid configurations for* Dipodomys merriami. *N_G = number of animals captured on basic configuration; R_P = ratio of marked to total animals within the area of effect; N_A = adjusted number of animals within the area of effect (N_G/R_P); W_A = width of the area of effect; A = area of effect; D = density (N_A/A).*

Sex and statistics	Census lines					Grid				
			July					July		
	January	April	Adult	Juvenile	October	January	April	Adult	Juvenile	October
Males										
N_G	2	31	14	11	29	9	19	8	12	35
R_P	0.00	0.70	0.67	0.50	0.55	0.88	0.65	0.60	0.73	0.52
N_A	2.00	44.29	21.00	22.00	53.17	10.29	29.23	13.33	16.50	67.5
W_A (m)	7.5	122.0	26.5	100.8	79.6	22.5	97.5	67.5	37.5	202.5
A (ha)	1.83	24.3	7.09	19.98	15.94	4.37	12.14	8.61	5.64	28.97
D (number/ha)	1.10	1.82	2.96	1.10	3.34	2.36	2.41	1.55	2.93	2.33
Females										
N_G	6	18	20	10	28	15	14	14	6	20
R_P	0.27	0.73	1.00	1.00	0.63	0.79	0.62	0.85	0.72	0.80
N_A	22.00	24.55	20.00	10.00	44.33	19.09	22.62	16.55	8.40	25.00
W_A (m)	15.9	68.9	37.1	37.1	68.9	52.5	127.5	52.5	82.5	202.5
A (ha)	5.53	14.03	8.72	8.72	14.03	7.05	16.25	7.05	10.31	28.97
D (number/ha)	3.98	1.75	2.29	1.15	3.16	2.71	1.39	2.35	0.82	3.54
Total	5.08	3.57	7.50		6.50	5.07	3.80	7.65		5.87

animals the last night, in order to be reasonably sure that most of the trappable animals present had been caught.

Table 1 presents a comparison of density estimates obtained with the census lines and grid configurations. An examination of width of the area of effect (W_A) indicates the importance of determining this index of animal movements each time the population is sampled. W_A is obtained by determining the distance that originally marked animals move from the edge of the basic configuration. Detailed explanations of all symbols and terms were given by O'Farrell et al. (1977). It is standard procedure to obtain W_A by using the radius of a circular home range (Whitford, J. Mamm., 57:351–369, 1976). This radius is based upon home range movements collected through the year, a method that compounds any errors. We calculated composite home range radii for each month sampled with the following results: January, 52.9 m; April, 47.2 m; July, 34.1 m; October, 34.8 m. Using home range radii to estimate W_A would have given greatly different areas of effect and inaccurate densities.

For each season, we calculated separate density estimates for males and females, then summed these to obtain a total density value (Table 1). The basic calculations are influenced by the group that moves the farthest and will yield inaccurate estimates if a single total density estimate is calculated combining males and females. Inasmuch as the sexes usually exhibit different W_A movements, we chose to calculate separate densities and sum them to obtain a species density for a given time interval.

An examination of the density extimates obtained from each basic configuration shows that the two methods are comparable (Table 1). Values did not differ by more than one animal per ha through the entire study. A comparison of these values was made using densities calculated with the Schnabel method, which is equivalent to sequential Lincoln Indices (Smith et al., pp. 25–53, *in* Small mammals: their productivity and population dynamics, Golley et al., eds., Cambridge Univ. Press, 1975). The following Schnabel estimates were calculated: January, 3.72/ha; April, 6.96/ha; July, 11.01/ha; October, 13.56/ha. These values differ greatly from those obtained with the assessment line methods (Table 1) and show an increase for each sampling period.

The small differences observed between the grid and census line configurations may be due to the geometry of these designs as well as the number of traps on the sampling plot. Obviously, the census lines do not sample the same area covered by the grid. We believe that the grid yielded more precise areas of effect due to the greater number of traps in a limited area. The grid also enables the study of detailed home range movements, spatial relationships, and other aspects of small mammal community dynamics.

The grid arrangement, however, has several drawbacks. There are more trapping stations requiring a greater number of traps as well as additional time and manpower. A grid with assessment lines yields the most information but represents such a major commitment in materials and labor that the ability to study replicate plots simultaneously is severely limited.

Census lines with assessment lines, on the other hand, yield the basic population measurements for less material and labor. Inasmuch as this configuration requires less time and effort to establish, several replicate plots can be monitored simultaneously. If replicate plots are sampled within one habitat type, then mean densities and confidence intervals can be calculated (O'Farrell et al., 1977). If density is the measurement goal, we recommend the census line configuration because it will yield values comparable to those obtainable by the more costly and time consuming grid arrangement.

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MICHAEL J. O'FARRELL AND GEORGE T. AUSTIN, *Zoological Society of Nevada, P.O. Box 4036, Las Vegas, Nevada 89106 and Department of Biological Sciences, University of Nevada, Las Vegas 89154.* *Submitted 19 December 1977. Accepted 29 April 1978.*

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QUALITATIVE CRANIAL CHARACTERS DISTINGUISHING *SIGMODON HISPIDUS* AND *SIGMODON ARIZONAE* AND THE DISTRIBUTION OF THESE TWO SPECIES IN NORTHERN MEXICO

Cotton rats of the *Sigmodon hispidus* complex in southwestern United States and northern Mexico were examined karyotypically and morphologically by Zimmerman (Publ. Mus. Michigan State Univ., Biol. Ser., 4:389–454, 1970). He recognized two species, *Sigmodon hispidus* and *S. arizonae*, on chromosomal evidence. The morphological characters mentioned for differentiating these species proved inconsistent and inconclusive when used with the several hundred specimens in our collection. Therefore, we sought different characters for distinguishing the species.

Populations of *Sigmodon hispidus* from the vicinity of Yuma, Yuma County, Arizona, and *S. arizonae* from the vicinity of Parker, Yuma County, Arizona, were used to begin our analysis. The shape of the occipital "shield," width of the ventral surface of the presphenoid, shape of the anterior spine on the infraorbital plate, shape of the ventral border of the foramen magnum, and angle formed by the basisphenoid and basioccipital appeared to have potential as usable

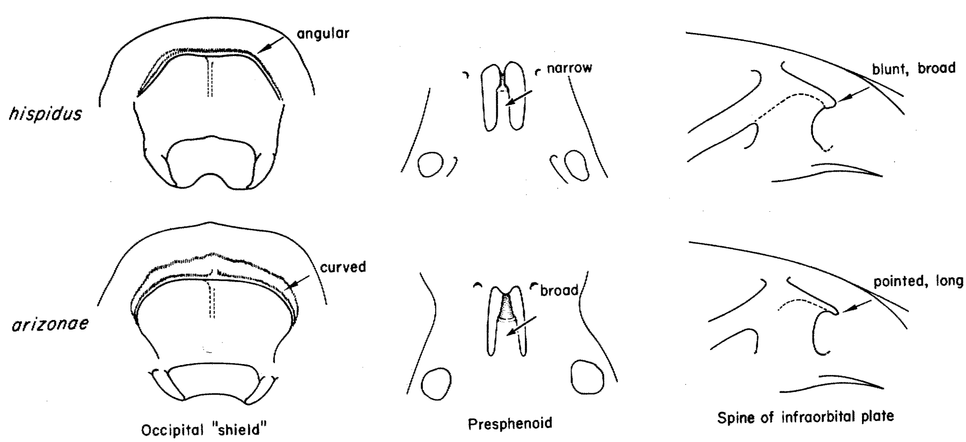

FIG. 1.—Portions of the skulls of *Sigmodon hispidus* and *S. arizonae* showing three characters discussed in the text. Drawings are based on photographs of Arizona specimens.