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SMALL MAMMAL SURVEY ON THE JORNADA AND PANTEX SITES

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ABSTRACT

This summarizes the small mammal survey on the Jornada and Pantex study sites in the comprehensive network of the U.S. IBP Grassland Biome. A total of 371 small mammals were marked by live-trapping, and 301 small mammals were collected from snap-trapping. These animals provided data on density and biomass. Three sampling periods (spring, summer, autumn) provided comparative population and biomass data. Biomass for all species of small mammals varied from 2621 g/ha to 1130 g/ha on the Jornada, whereas at Pantex, biomass varied from 908 g/ha to 584 g/ha.

INTRODUCTION

This reports the results of a study of small mammals on two second-order sites (Jornada and Pantex) in the Comprehensive Network Program of the IBP Grassland Biome. Field investigations were initiated April 4, 1970 and concluded November 8, 1970. Three data sets were collected from both sites in spring, summer, and autumn. Demographic, biomass, and reproductive data were obtained from the results of programs of live- and sacrifice-trapping on both areas. A total of 371 small mammals were marked by live-trapping (232 on the Jornada; 139 at Pantex), whereas 301 small mammals were collected from the kill-trapping removal program (194 on the Jornada and 107 at Pantex). All specimens sacrificed were preserved either as museum study skins or as whole specimens in liquid preservative. Additional specimens of mammals were collected from areas other than the selected IBP study sites. Some data were collected on lagomorph populations by walking mile transects. The following graduate students assisted me in the gathering and recording of data: W. H. Conley, R. E. Martin, K. G. Matocha, and R. W. Wiley.

MATERIAL AND METHODS

Live traps (Sherman, aluminum 3" x 3 1/2" x 9" collapsible) and museum special mouse traps were used in this study. Two grids of 144 stations, 12 rows by 12 spaced at 15-m intervals, were layed out on both the Jornada and Pantex Sites. Thus, each study plot covered 2.76 ha. Each station site was marked with a stake (galvanized at the Jornada and wooden at Pantex), and each station site was identified with a row and column number (i.e., 1/1).

Two live traps and two museum special snap traps were placed at each station, resulting in 288 live and 288 snap traps on each of the grids, respectively. All traps were prebaited with a combination of peanut butter and rolled oats for a five-day period. All traps were then set and checked for 10 consecutive days. At the end of five days of trapping, all traps were shifted one-half the diagonal distance between traps, resulting in the location of traps in the center of squares formed by the original station sites. This was done to provide a minimal effort at randomization of trap placement and to reduce the possibility of learned trap-response on the part of live-trapped mammals.

Traps were usually set at sundown (1600 to 2030) each day. Snap traps were checked in the initial trapping days at approximately 2200 hours. Mammals caught in snap traps in the evening checks were removed to the respective field headquarters and the traps were left unset. Traps that were sprung were reset, and a notation of the number and site of sprung traps was made. Both live and snap traps were checked early in the morning, with live animals being released at their site of capture after pertinent data were recorded. All sacrificed specimens were removed to the field stations for further analysis after each specimen was tagged as to its point of capture (in terms of row and column numbers) on the grid plot. All traps were sprung in the morning.

Data from the live-trap grids were recorded on NREL-10 (Field Data Sheet - Vertebrate Live Trapping, see Appendix).

All live-trapped small mammals were toe-clipped, sexed, aged, and identified as to kind at the site of capture. The condition of each animal was noted (torpid, normal, or dead) at the time of removal from the live traps. The toe-clipping sequences used were in accordance with Fig. 1 in Technical Report No. 35 (French, 1970). Only one of four digits on either of the hind feet was ever removed on heteromyids, owing to their special digital conformation. The reproductive condition of each animal was recorded as follows: males--non-breeding, breeding (?), breeding (these conditions were inferred from the position of the testes, scrotal or inguinal); female--vulva inactive, turgid, or cornified. Data on pregnancies and lactation in the case of females were also recorded. State of molt, if an animal was molting was recorded.

The status of all snap traps (set, with a catch, sprung-empty, missing) was recorded on NREL-13 (Snap Trap Effort). All sacrificed mammals were removed to the field laboratories to be analyzed and autopsied. Data derived were recorded on NREL-12A (Mammal Collection) and NREL-14 (Mammal Reproductive). Both of these record sheets record source of specimen from the grid (by row and column) as well as identification of species and specimen code number. Standard external measurements were recorded, and each specimen was weighed to the nearest tenth of a gram on a dial-a-gram triple-beam balance. Stomachs were removed and preserved in liquid (70% alcohol) for further analysis. Lens from eyes were also preserved in 10% solution of formaldehyde. Condition of pelage (molting or not) was recorded. Reproductive data recorded were: (i) males--age, size of testes in mm, degree of convolution of epididymus, and size of seminal vesicles; (ii) females--age, condition of mammary glands and pubic symphasis, number and size and position of embryos (if present), site and number of resorbing embryos, number of old and new placental scars, number of corpora lutea, and presence or absence of corpora albicantia.

Jackrabbits were censused by walking mile transects from 1400-1600 hours. The route of travel was through relatively uniform habitat type with a change of direction being made every one-fourth mile walked. Thus, a diamond-shaped pattern was followed. The angle of flush of each rabbit was recorded. This was done to avoid recounting animals. A total of 15 transects were walked for each sampling period.

METHODS OF ANALYSIS

One of the principal aims of this study was to provide an estimate of the density of the population of small mammals. Conversion of density data into estimated standing crop biomass was then calculated. A number of methods were employed to estimate population size on the two areas of study. Population size on the live-trapped areas was estimated using the Jolly Stochastic procedure (see Jolly, 1965). This method was recommended by French (1971). The Hansson method (Hansson, 1969) was preferred for population estimates based on snap trap data. When these procedures were not usable (because the assumptions of the procedures themselves could not be met), other methods were used as follows: (i) live-trap data--Craig-Eberhardt method (Eberhardt, 1969), Edwards and Eberhardt Regression, Lincoln Index, or modified Lincoln Index; and (ii) Snap-trap--Zippin or regression method (Zippin, 1956).

Using these various methods, a density estimate for each sampling period was converted into small mammal biomass for all species and for each species. This was accomplished by using body weights collected from the specimens sacrificed on the snap-trap grids. Stomach weights and reproductive tract weights were not subtracted from total body weight but were considered part of the total energy mass. Conversion of wet body weight to dry body weight followed the procedure of Golley (1960). Wet weight was multiplied by 0.3.

STUDY AREAS

Jornada Site Description

The study plots were located in Pasture 9 (see Fig. 1) of the U.S. Department of Agriculture Jornada Experimental Range in Dona Ana County, New Mexico (approximately 20 miles north of Las Cruces, New Mexico). This site is about six miles west of the Jornada Headquarters at an elevation of 1350 m. The live-trap grid was located approximately 30 m north of the IBP grassland exclosure in a lightly grazed pasture. The snap-trap grid was located approximately 50 m east of the southern border of the exclosure in similar habitat to that of the live-trap plot. The two plots were 4/10 of a mile apart.

The entire study area is a desert grassland with black grama (*Bouteloua eriopoda*) the dominant grass in the study plots. Other grasses of some importance are fluff grass (*Tridens pulchellus*), mesa dropseed (*Sprorbolus flexuosus*), three-awns (*Aristida* sp.), tobosa (*Hilaria mutica*), and Muhlygrass (*Muhlenbergia* sp.). Forbs present are bladderpod (*Lesquerella fendleri*), lambsquarters (*Chenopodium* sp.), spectacle-pod (*Dithyrea wislizenii*), leatherweed (*Croton* sp.), globemallow (*Sphaeralcea* sp.). Common shrubs on the area are yucca (*Yucca elata*), snakeweed (*Gutierrezia sarothrae*), ephedra (*Ephedra* sp.), and mesquite (*Prosopis juliflora*). Some prickly pear and cholla (*Opuntia*) are also present. There are excellent descriptions of the Jornada Experimental Range (Paulson and Ares, 1962; Herbel and Nelson, 1966; Buffington and Herbel, 1965; Herbel and Pieper, 1970).

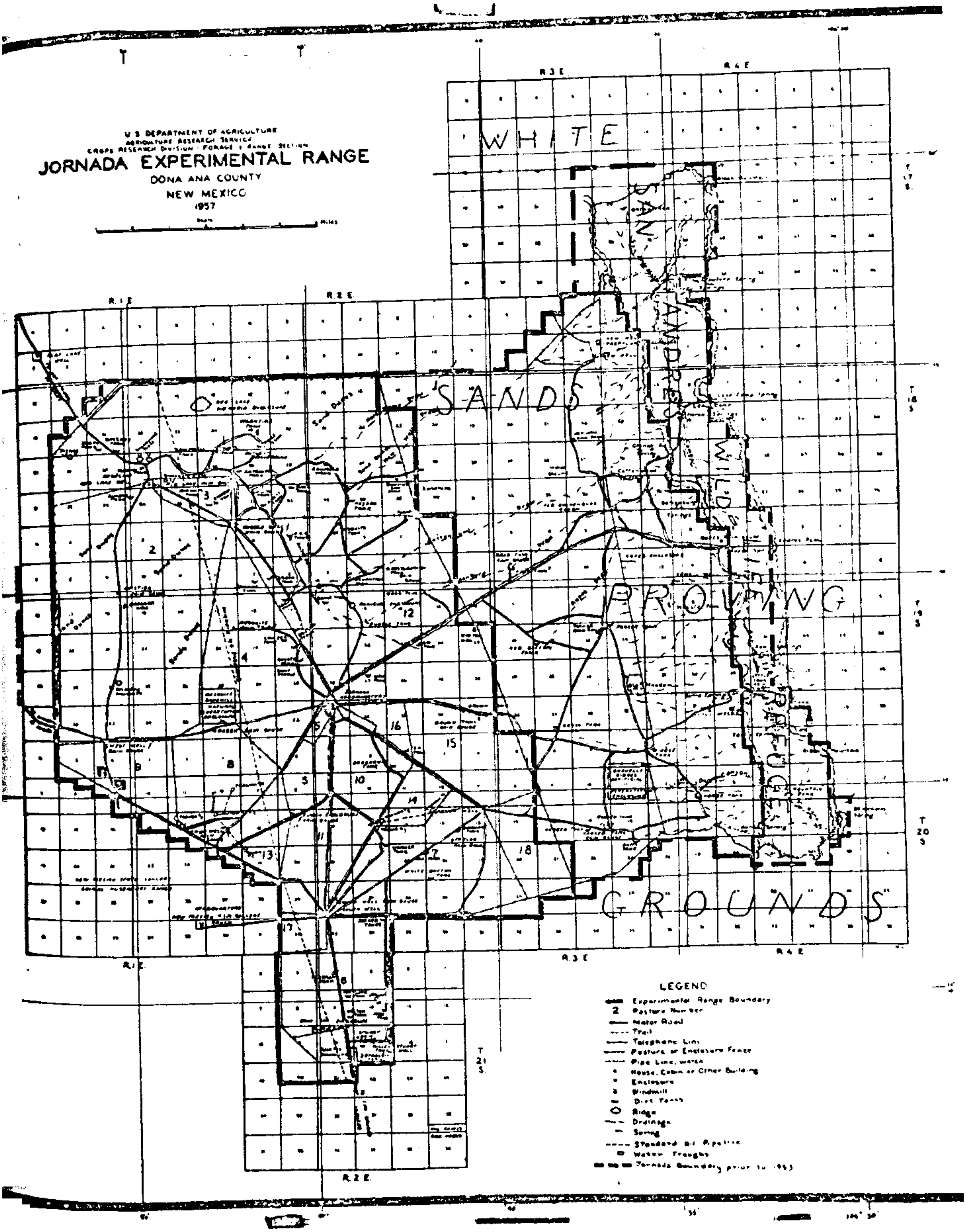

Fig. 1. Map of Jornada Experimental Range showing location of study plots. Westernmost plot was live-trap grid.

Average annual precipitation recorded at Jornada Headquarters was 22.76 cm over a 54-year period. Most rain falls from July through September. Some areas may go without measureable precipitation for years (Herbel, personal communication). June is the hottest month (average 36°C) and January the coldest (13°C). Brisk winds blow in the spring (with gusts of 60 to 70 mph).

Pantex Site Description

The study plots were located on IBP Site 2 (Huddleston, 1970, Appendix 2 and Fig. 2) approximately 12 miles northeast of Amarillo, Potter County, Texas on the Texas Tech University Research Farm. The live-trap grid was located within the IBP exclosure in a formerly grazed area, whereas the snap-trap grid was placed 3/10 of a mile to the west in a lightly grazed pasture. Predominant grasses on both plots were blue grama (*Bouteloua gracilis*), buffalo grass (*Buchloe dactyloides*), western wheatgrass (*Agropyron smithii*), and sand dropseed (*Sporobolus cryptandrus*); forbs present were sunflowers (*Helianthus* sp.), plantain (*Plantago purshii*), coneflower (*Ratibida columnaris*), dalea (*Dalea aurea*), and prickly pear (*Opuntia polyacantha*).

Topography is flat, and the area is approximately 1097 m in elevation. Average annual precipitation is 52.6 cm (based on 62 years of records) with 66% occuring between May through September. Highest mean temperatures occur in July (24+°C) whereas lowest mean temperatures are in January (5.5°C). Wind velocities reach highs in March and April. Gusty winds from 60 to 70 mph are not uncommon at this time.

Pantex Site Map

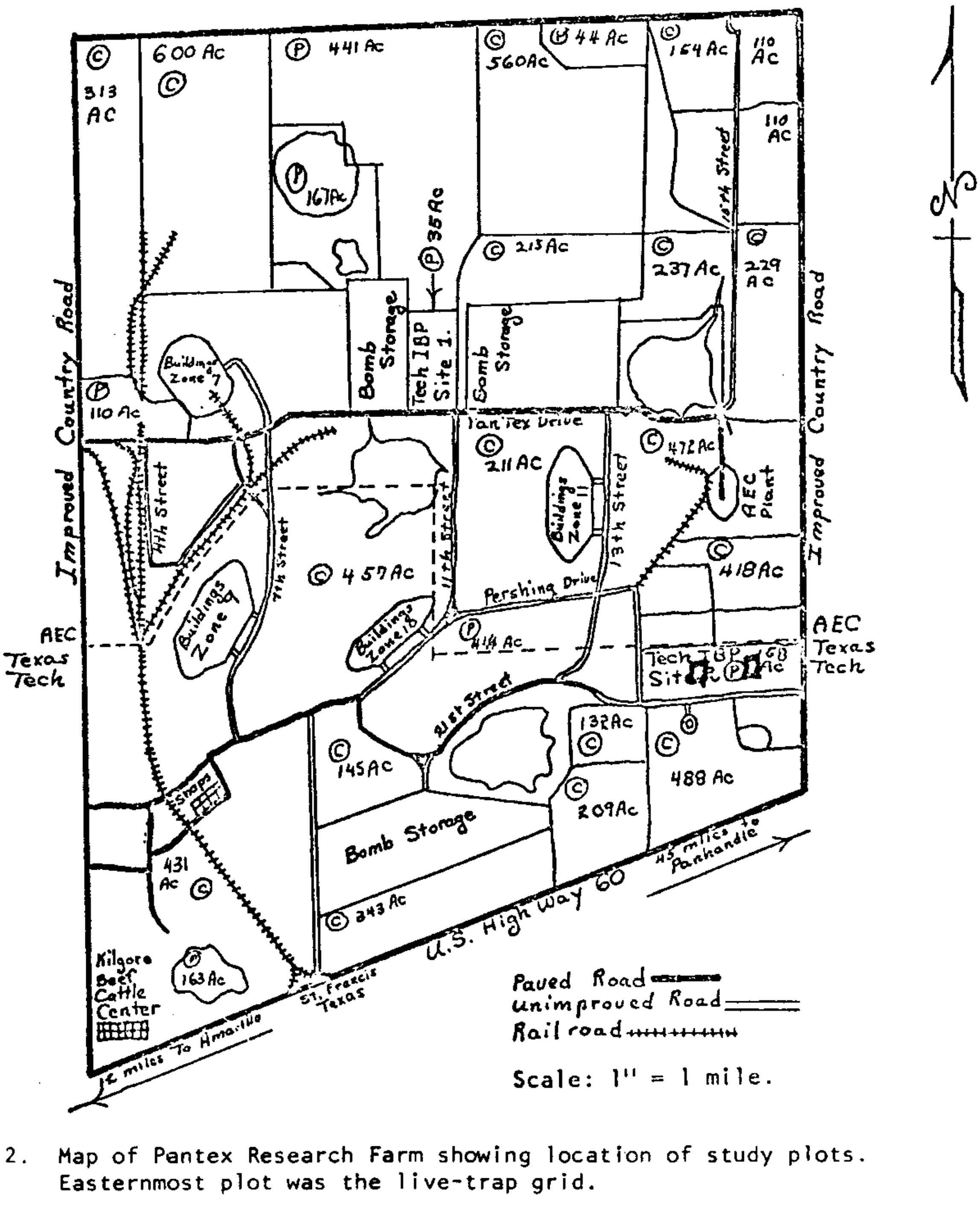

Fig. 2. Map of Pantex Research Farm showing location of study plots. Easternmost plot was the live-trap grid.

Jornada Site--Sampling

The following species were collected in the three sampling periods: (i) Live-trap grid: *Spermophilus spilosoma, Perognathus flavus, P. penicillatus, Dipodomys ordii, D. spectabilis, D. merriami, Peromyscus maniculatus, Onychomys leucogaster, Neotoma micropus, N. albigula;* and (ii) Snap-trap grid: *Spermophilus spilosoma, Perognathus flavus, Dipodomys ordii, D. spectabilis, Onychomys leucogaster.* Additional species collected or recorded were: *Notiosorex crawfordi, Myotis yumanensis, M. velifer, M. thysanodes, Pipistrellus hesperus, Plecotus townsendii, Antrozous pallidus, Tadarida brasiliensis, Sylvilagus audubonii, Lepus californicus, Ammospermophilus interpres, Spermophilus variegatus, Cynomys ludovicianus, Geomys arenarius, Reithrodontomys megalotis, Peromyscus eremicus, Sigmodon hispidus, Vulpes macrotis, Mustela frenata, Taxidea taxus, Mephitis mephitis, Canis latrans,* and *Lynx rufus.*

The most abundant rodent on both the live- and snap-trap grids was Ord's kangaroo rat, *Dipodomys ordii.* Wood (1969) reports this species to be the most abundant in five different habitat types studied on the New Mexico State University Ranch located about three airline miles southwest of our plots. His study from 1960-63 reports in order of abundance the spotted ground squirrel, *Spermoplulus spilosoma, D. ordii*, and *D. spectabilis* the most important species in the blackgrama grass climax habitat (similar to our study plots). Our data (see Table 1) suggest *D. ordii* more abundant than *S. spilosoma.* The differences between our studies may result from trapping technique. Our traps were closed through much of the daylight hours when spotted ground squirrels are most active. Thus, this species may be more important in terms of density and standing crop biomass than our data suggest.

Table 1. Density estimates of rodents based on data from the live-trap grid plot, Jornada Site, 1970.

Species	April				July				November			
	E & E Regr	C & E	LI	MLI	E & E Regr	C & E	LI	MLI	E & E Regr	C & E	LI	MLI
Spermophilus spilosoma		29	18	35	21	23	12	30	2	8	6	9
Dipodomys ordii	121	115	108	145	78	76	56	71		36	32	47
Dipodomys spectabilis	27	15	13	17	41	28	22	30	4	18	15	24
Dipodomys merriami										1		
Perognathus flavus	26	26	16	22								
Perognathus penicillatus							6	10				
Peromyscus maniculatus												
Onychomys leucogaster		13	12	21		12	8	12		7	6	7
Neotoma albigula		9								1		
Neotoma micropus						2	7	12		1		

Wood (1965) reported *D. merriami* an important species on poor condition desert grassland. On our study plots this species was recorded only once. Its absence is probably related to the sandy nature of the soil type on both live- and snap-trap grid sites.

Density of rodents on the live-trap grid was greatest in spring and lowest in autumn (see Table 2). Although the various methods of estimating density on the study plots produced results varying from each other, the trend of reduced density in the autumn was evident. Recruitment to the population occurs chiefly in the spring with subsequent dilution taking place throughout the summer and autumn. Data from the snap-trap grid (see Table 3) is somewhat misleading in relation to density. This was largely because of the seemingly slow rate of reinvasion of the snap-trap plot on the part of the peripheral rodent populations. In addition, a den of desert foxes (*Vulpes macrotis*) was established between the April and July checks. At least four foxes were counted and two trapped and shot. These animals may have served to reduce the rodent population to a point below that occurring in areas not adjacent to a den site.

Estimates of biomass densities by species are in Table 4, and biomass density estimates for all species are lumped together in Table 5. Although *D. ordii* is the most important species in both numbers and biomass, it is possible that *Spermophilus spilosoma* may be equally important if not more important in this habitat type as Wood (1969) suggested. Daytime trapping on both plots would have revealed a higher density and biomass for this species. In addition, the density and biomass estimates for the woodrats, *Neotoma albigula* and *N. micropus* are probably too low. These species have an extremely restricted home range, and unless a station occurred close to a mesquite-nest area, no wood rats were taken, although there was ample evidence of their activity

Table 2. Density estimates of rodents based on data from the live-trap grid plot, Jornada Site, 1970 (all species).

Method	April	July	November
E & E Regr.	164	157	70
Craig-Eberhardt	163	150	73
Lincoln Index	147	108	64
Mod. Lincoln Index	199	141	93
Minimum No. Alive (average of 10 days with maximum and minimum known alive)	69.5 (91-54)	49.7 (67-14)	22 (30-17)
Jolly Stochastic Model (Max. No.) ±2 S.E.	117.9 (±59.6)	109.3 (±36.4)	78 (±39.3)

Table 3. Density estimates of rodents based on data from the snap-trap grid plot, Jornada Site, 1970.

Species	April			July			November		
	Actual Number	Zippin	Hansson Max. Est.	Actual Number	Zippin	Hansson Max. Est.	Actual Number	Zippin	Hansson Max. Est.
Spermophilus spilosoma	2	3		2	3				
Dipodomys ordii	53	52	54	33	34	33	8	16	
Dipodomys spectabilis	17	17	19*	1	1				
Dipodomys merriami									
Perognathus flavus	21	21	22	3	3		2	3	
Perognathus penicillatus									
Peromyscus maniculatus									
Onychomys leucogaster	1	1		1	1		2	2	
Neotoma albigula									
Neotoma micropus									
All species	94	93	97*	40	40	41	12	43	

*Rounded to nearest whole number.

Table 4. Biomass of rodents (in grams) based on population data from live-trap grid plot, and weights from sacrificed animals, Jornada Site, 1970. (All figures rounded to nearest whole number).

Species	April				July				November			
	E & E	C & E	LI	MLI	E & E	C & E	LI	MLI	E & E	C & E	LI	MLI
Spermophilus spilosoma		3446	2139	4159	1713	1876	979	1632	240	960	720	1080
Dipodomys ordii	5500	5227	4909	6591	3598	3505	2593	3275		1918	1705	2505
Dipodomys spectabilis	2142	1190	1031	1349	4153	2836	2228	3039	405	1823	1519	2431
Dipodomys merriami										130		
Perognathus flavus	184	184	113	156								
Perognathus penicillatus							72	120				
Peromyscus maniculatus												
Onychomys leucogaster		344	318	556						259	222	259
Neotoma albigula		177								175		
Neotoma micropus						420	1470	2520		210		
Total Weight		10571	8512	12812	946	8639	7333	10586		5476	4167	6275
Biomass/hectare		3830	3084	4642	3429	3130	2656	3835		1984	1509	2273

Table 5. Biomass of rodents based on population data from live-trap grid (all species) and average weights (all species) from sacrificed animals, Jornada Site, 1970. Measurements are given in g/ha.

Method	April	July	November
E & E Regr.	2367.1	2652.2	1083.7
C & E	2620.9	2508.1	1130.1
LI	2362.7	1805.8	990.8
MLI	3199.9	2357.6	1439.8
Min. No.	1117.5 (1463.2-868.3)	831.0 (1120.3-234)	340.6 (464.4-263.1)
Jolly	1895.8 (±958.4)	1827.6 (608.6)	1207.6 (±603.8)

and presence. Key species of the rodent fauna, in terms of density and biomass, are Ord's kangaroo rat, spotted ground squirrel, and the banner-tail kangaroo rat (see Table 4).

Standing crop biomass in grams per hectare, based on the various density estimates, is in Table 5. Biomass estimates based on minimum number known alive may be overly conservative and the modified Lincoln Index method too great. Because of the similarity in the estimates (where sufficient demographic data were available), the Craig-Eberhardt or Jolly method seems the most useful. Thus, the best estimate for standing crop biomass of small mammals in the spring was 2620.9 g, 2508.1 g in July, and 1130.1 g in the autumn.

Jackrabbit transects revealed the following data (rabbits observed per mile walked--15 samples): spring, 1.86; summer, 2.12; autumn, .78. Thus, black-tailed jackrabbits seemed on the decline from the spring to the autumn samples. Similar trends were noted at the Pantex Site.

Live- and snap-trapping produced similar trend results in terms of catch. Most animals were taken in the initial three days of trapping (see Fig. 3 and 4). The effect of minimal randomization by moving traps was not marked. The slight increase in catch was a result of edge effect (when peripheral lines of traps were moved into areas not previously trapped).

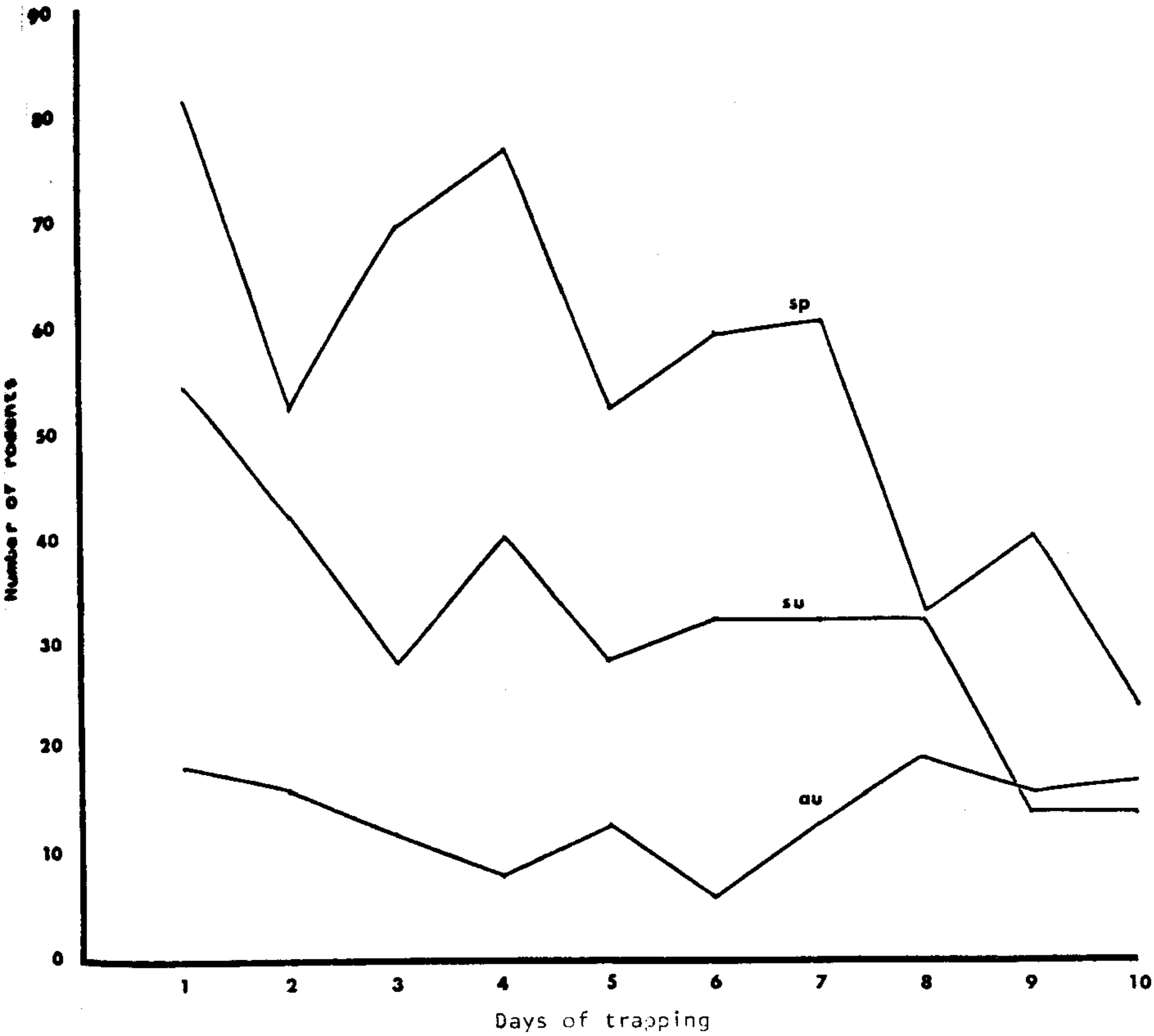

Fig. 3. Number of rodents taken in live-traps in the ten day trapping sequence (sp = spring sample, su = summer sample, au = autumn sample) on the Jornada Experimental Range.

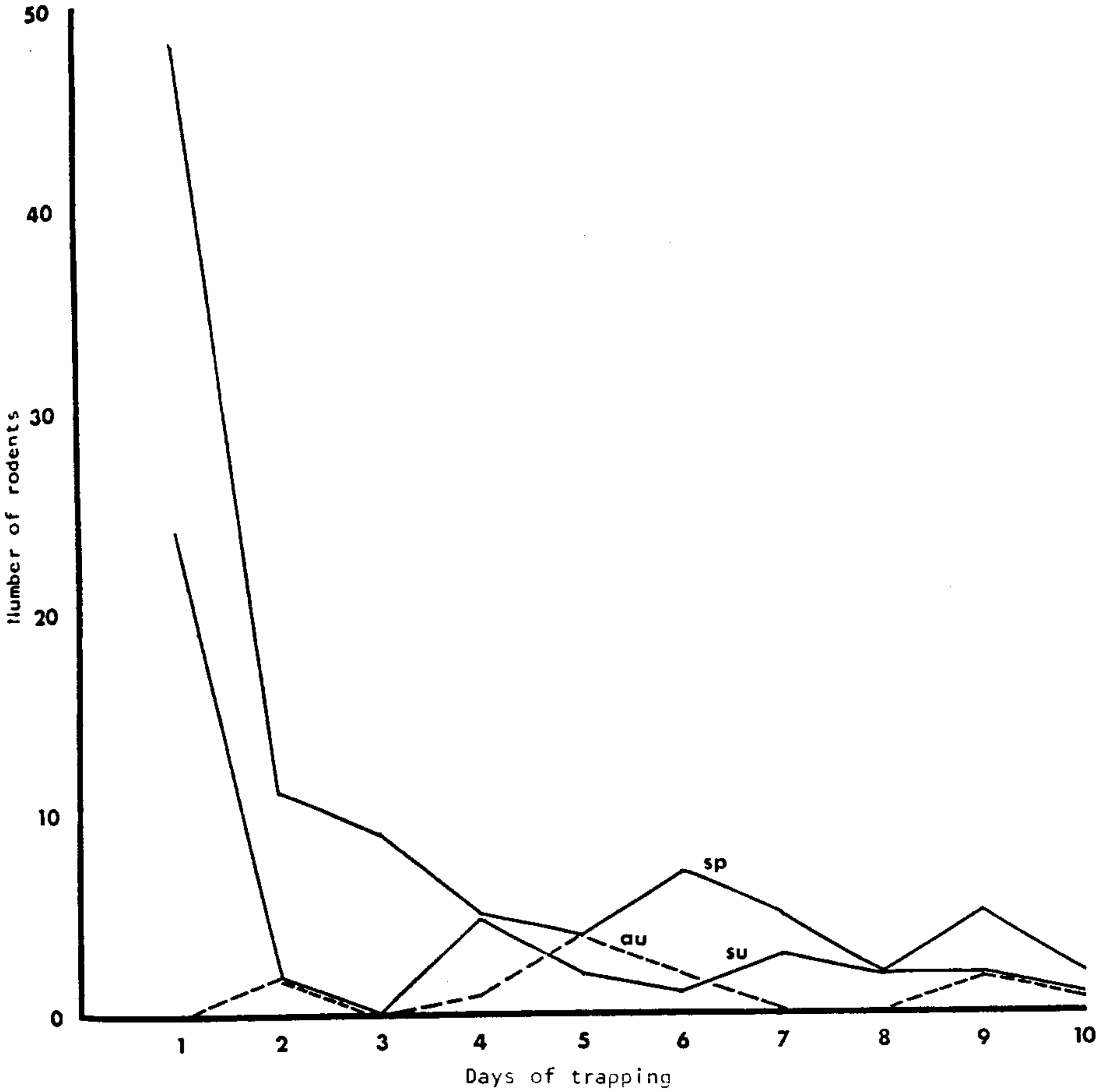

Fig. 4. Number of rodents taken in snap-traps in the ten day trapping sequence (sp = spring sample, su = summer sample, au = autumn sample) on the Jornada Experimental Range.

Pantex Site--Sampling

The following species were collected in the three sampling periods: (i) live-trap grid: *Spermophilus tridecemlineatus*, *Perognathus flavescens*, *P. merriami*, *P. hispidus*, *Reithrodontomys megalotis*, *R. montanus*, *Peromyscus maniculatus*, *Onychomys leucogaster*, *Sigmodon hispidus*, *Neotoma micropus*; and (ii) snap-trap grid: *Spermophilus tridecemlineatus*, *Perognathus merriami*, *P. hispidus*, *Reithrodontomys montanus*, *Peromyscus maniculatus*, *Onychomys leucogaster*, *Sigmodon hispidus*. Additional species collected or recorded were: *Cryptotis parva*, *Myotis velifer*, *Tadarida brasiliensis*, *Sylvilagus audubonii*, *Lepus californicus*, *Geomys bursarius*, *Rattus norvegicus*, *Mus musculus*, *Canis latrans*, *Vulpes velox*, *Mephitis mephitis*.

Peromyscus maniculatus and *Reithrodontomys montanus* were the most abundant species taken in live- and snap-traps. However, because traps were closed through much of the daylight hours, fewer thirteen-lined ground squirrels were taken than are actually present. I think this species is the most important in terms of biomass in the late spring through early autumn period despite the fact that our data do not show this. A prolonged drought in the period of our study adversely affected the rodent population and may have distorted our density and biomass data (compared to average years of precipitation).

The Pantex Site small mammal fauna (in numbers and biomass) is largely composed of cricetids compared to the Jornada heteromyid fauna. The cricetids are more inclined to forage on leafy vegetation being less restricted to the seed diet of the heteromyids. Also, the cricetids are seemingly less refractory to live-trapping and marking than heteromyids. Furthermore, cricetids re-established themselves into the snap-trap study plot quite rapidly. There was no dilution of trapping success at Pantex as compared to the Jornada. This pattern may also result from recruitment into the population at Pantex which occurred principally in the late summer. Thus, populations may be at peak density in the autumn at Pantex, whereas a spring to late spring peak density pattern occurs at the Jornada.

A considerable disparity between the live-trap grid and the snap-trap grid exists relative to the plains pocket mouse, *Perognathus flavescens*. These were caught frequently on the live trap grid (see Table 6) but were virtually absent from the snap-trap grid (see Table 7). This species is extremely wary of snap traps (I have approximately three years of observational data on these animals from Kermit, Texas revealing the same phenomena). Thus, the data from the live-trap grid provides more useful density and biomass estimates. *Peromyscus maniculatus* increased both in numbers (see Table 6) and in biomass (see Table 8) from spring through autumn, whereas *Reithrodontomys montanus* remained rather stable in numbers and biomass through the same period. Few *Sigmodon hispidus* were taken from our grid plots owing to the lack of sufficient cover. This species does occur in considerable numbers in taller grasses that have been protected from grazing by cattle. In fact, it is an abundant species in the summer and autumn in many areas at Pantex.

Density of rodents increases slightly in the autumn (see Table 9). A number of the plains harvest mice and deer mice examined in the autumn were subadult or juveniles indicating a mid to late summer recruitment period. Density information obtained from the snap-trap grid (see Table 8) does not seem wholly reliable in providing an estimate for biomass because of the absence of a number of species caught in the

Table 6. Density estimates of rodents based on data from the live-trap grid plot, Pantex Site, 1970.

Species	May				August				October			
	E & E	C & E	LI	MLI	E & E	C & E	LI	MLI	E & E	C & E	LI	MLI
Spermophilus tridecemlineatus		2				13	7	12				
Perognathus flavescens		50	39	69		64	70	136		1		
Perognathus merriami										3		
Perognathus hispidus						1	1	1		1		
Reithrodontomys megalotis						3				4		
Reithrodontomys montanus		50	25	40		45	25	45		68	51	91
Peromyscus maniculatus		5	4	10	37	31	21	29	57	58	44	64
Onychomys leucogaster		1				1				9	3	6
Sigmodon hispidus										1	1	1
Neotoma micropus										1		

Table 7. Density estimates of rodents based on data from the snap-trap grid plot, Pantex Site, 1970.

Species	May			August			October		
	Actual Number	Zippin	Hansson Max. Est.	Actual Number	Zippin	Hansson Max. Est.	Actual Number	Zippin	Hansson Max. Est.
Spermophilus tridecemlinealus				4	3				
Perognathus flavescens							1	1	
Perognathus merriami				1					
Perognathus hispidus	1	1			1				
Pectirodontomys montanus	14	15		13	12		24	75	69
Peromyscus maniculatus	14	15		13	16		19	18	
Onychomys leucogaster							3	4	
Sigmodon hispidus							1	1	
All Species	29	30	30	31	32	31	48	99	96

Table 8. Biomass of rodents (in grams) based on population data from live-trap grid plot, and weights from sacrificed animals, Pantex Site, 1970. (All figures rounded to nearest whole number.)

Species	May			August			October		
	C & E	LI	MLI	C & E	LI	MLI	C & E	LI	MLI
Spermophilus tridecemlineatus	250			1126	606	1039			
Perognathus flavescens	550	429	759	768	840	1632	18		
Perognathus merriami							31		
Perognathus hispidus				37	37	37	42		
Reithrodontomys megalotis				31			39		
Reithrodontomys montanus	542	271	434	453	252	453	603	452	806
Peromyscus maniculatus	87	69	173	564	382	527	963	731	1063
Onychomys leucogaster	45						284	95	189
Sigmodon hispidus							63	63	63
Neotoma micropus							145		
Total weight	1474	589	1366	2979	2117	3689	2189	1341	2122
Biomass/hectare (in grams)	534	214	495	1079	767	1337	793	486	769

Table 9. Density estimates of rodents based on data from the live-trap grid plot, Pantex Site, 1970 (all species).

Method	May	August	October
E & E Regr.	108	83	97
Craig-Eberhardt	104	107	120
Lincoln Index	74	71	90
Modified Lincoln Index	125	110	141
Minimum No. Alive (average of 10 days with maximum and minimum known alive)	Indeterminate	16.3 (21-10)	24.5 (39-17)
Jolly Stochastic Model (Max. No. ±2 SE)	Indeterminate	96 (±124.1)	108 (±215.1)

live-trap grid. Thus, I have relied on the live-trap grid data in estimating the density of the population.

Standing crop biomass of rodents is in Tables 8 and 10. The important role in biomass dynamics of the thirteen-lined ground squirrel is evident in Table 8. Biomass of rodents may have reached a peak in the summer data collecting period, although an early snow storm occurring in October may leave the biomass data distorted. No ground squirrels were taken in the collecting period in October, though this species is normally active in this season in this area. More collective data (all species) were obtained from the Craig-Eberhardt method of analysis, and I have relied on it to make an estimate of standing crop biomass. Thus, the best estimate for standing crop biomass of small mammals was 583.7 g in May, 907.9 g in August, and 638.3 g in October.

Jackrabbit transects revealed the following data (rabbits observed per mile walked--15 samples per each collecting period): spring, 1.54; summer, 2.38; and autumn, 1.02. The same trend of fewer jackrabbits in the autumn was also noted at the Jornada Site.

Similar trends in catch were noted on both live- and snap-trap grids (see Fig. 5 and 6). No appreciable differences were noted after moving the traps at the end of the first five-day trapping interval. Peripheral invasion seemed to occur on the last day in the October sampling period.

Table 10. Biomass of rodents based on population data from live-trap grid (all species) and average weights (all species) from sacrificed animals, Pantex Site, 1970. Measurements are given in g/ha.

Method	May	August	October
C & E Regr.	606.1	704.3	515.9
C & E	583.7	907.9	638.3
LI	415.3	602.5	478.7
MLI	701.5	933.4	749.9
Min. No.	No data	138.3 (178.2-84.8)	130.3 (207.4-90.4)
Jolly	No data	814.6 (±1053.1)	574.4 (±1143.5)

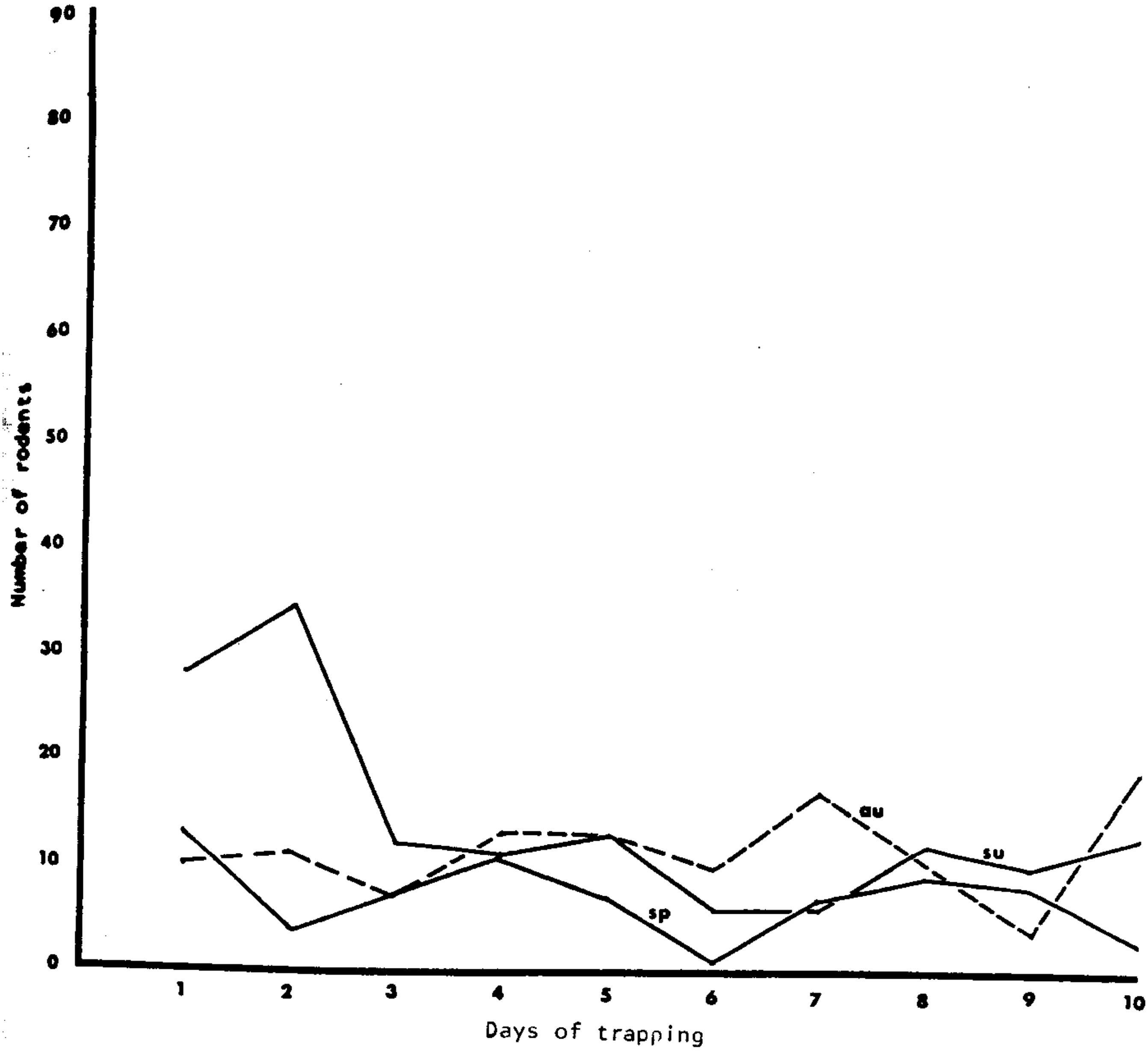

Fig. 5. Number of rodents taken in live-traps in the ten day trapping sequence (sp = spring sample, su = summer sample, au = autumn sample) on the Pantex Site.

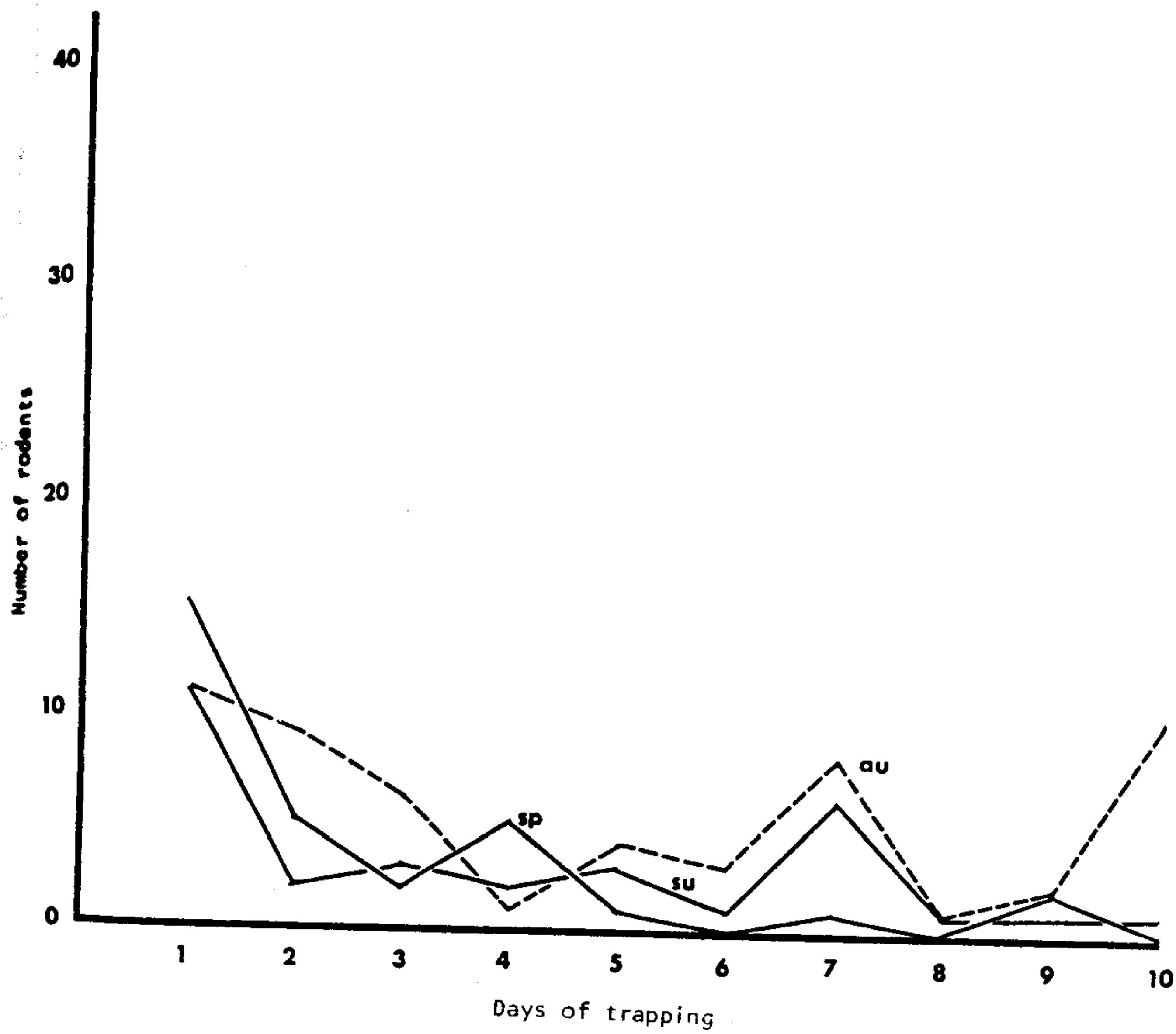

Fig. 6. Number of rodents taken in snap-traps in the ten day trapping sequence (sp = spring sample, su = summer sample, au = autumn sample) on the Pantex Site.

SUMMARY

Considerable differences in small mammal density and biomass were found between the two sites studied and on a given site between seasons. The general trend at the Jornada Site was one of gradual reduction of density and biomass throughout the three sampling periods. Thus, the spring sample produced the greatest density and biomass and the autumn sample the lowest. These data may reflect the results of an early spring recruitment period followed by a gradual reduction in the population throughout the summer resulting from mortality factors that were unmeasured. At Pantex, the populations were lowest in spring, with a gradual increase into the autumn. Recruitment occurred chiefly in the summer. Thus, the autumn population was composed of a mixture of juveniles, subadults, and adults. Reduction in the small mammal populations at Pantex must occur principally in the winter period, although I have no data to substantiate this.

On both study sites, biomass estimates of small mammals are probably too low because the ground squirrel populations were inadequately measured. Nonetheless, small mammal biomass at the Jornada was nearly twice that at Pantex. The Pantex Site suffered an extended drought in 1970 which may have reduced small mammal population below a level present in years of average precipitation.

Data in Table 11 reveal the standing crop biomass of small mammals in dry weight. Small mammals on the Jornada proved more important consumers than at Pantex.

Table 11. Average small mammal standing crop biomass density by site and date.

Site	Sample Period	Wet Weight g/ha	Dry Weight g/ha	Dry Weight g/m^2
Jornada	April	2620.9	786.3	.079
Pantex	May	583.7	175.1	.018
Jornada	July	2508.1	752.4	.075
Pantex	August	907.9	272.3	.027
Jornada	November	1130.1	339.0	.034
Pantex	October	638.3	191.5	.019

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APPENDIX I

Field Data

Live Trap Data

Small mammal live trapping data were collected in 1970 at the Jornada and Pantex Sites. These data are stored as Grassland Biome Data Sets A2U1008 and A2U100A. Data were collected on form NREL-10. A sample data form and an example of the data follow.

*** EXAMPLE OF DATA ***

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                    PEMA  0 3 0122    0        0  5  6
                    REMO  0 3 0123    0        0  9  4
                    PEMA  0 3 0124    9        0 11  8
                    PEMA  0 3 0125 1           0  3  9
                    PEMA  0 3 1020 1           0  1  7
                    PEMA  0 3 0132    0        0  1  4
                    SPTR  0 3 0133    0        0  1  9
                    SPTR  0 3 0134 0           0  7 12
1010RWW0408705 2.74 REMO  0 3 0021 0           0  1  2
                    PEFL  0 3 0022 0           0  3  3
                    SPTR  0 3 0023 0           0  4  4
                    PEMA  0 3 0024 1           0  5  3
                    PEFL  0 3 0025 0           0  8  3
                    PEMA  0 3 0050 0           0 12  3
                    PEMA  0 3 0122    0        0  5  6
                    PEFL  0 3 0051 0           0  4  6
                    PEMA  0 3 1200 0           0 11  8
                    PEFL  0 3 0052    0        0  2  7
                    PEFL  0 3 0053    0        4  1 11
1010RWW0508705 2.74 PEFL  0 3 0054    0        0  1  2
                    PEHI  0 3 0055    0        0  1  4
                    PEFL  0 3 0025    0        0  7  3
                    PEFL  0 3 0101 0           0 11  4
                    PEMA  0 3 0122    0        0  6  6
                    PEMA  0 3 0102    1        0  2 12
                    PEMA  0 3 0103 0           0  2 11
1010RWW0608705 2.74 REMO  0 3 0104    0        0  6  2
                    PEHI  0 3 0055    0        0  1  4
                    PEFL  0 3 0025    0        4  6  3
                    PEFL  0 3 0003 0           4  8  3
                    REMO  0 3 0123    0        0 11  4
                    PEMA  0 3 0050 3           0 12  4
                    PEMA  0 3 0105    2        0  5  6
                    PEMA  0 3 0122    0        0  4  6
                    PEMA  0 3 0132    0        0  2  7
                    REMO  0 3 0110 0           0 11  8
                    SPTR  0 3 0133    0        0  1 12
                    PEMA  0 3 0111    1        0 10 11
                    PEMA  0 3 0120 0           0 12 12
1010RWW0708705 2.74 PEFL  0 3 0200    0        0  2  1
                    PEHI  0 3 0055    0        0  4  4
                    SPTR  0 3 0121    0        0  4  4
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	PFMA	0	3	0024	1		0	5	3
	PEMA	0	3	0122		0	0	6	4
	PEFL	0	3	0130	0		4	8	3
	PFMA	0	3	0124		0	0	12	3
	SPTR	0	3	0134	0		0	6	6
	REME	0	3	0131		0	0	1	6
	REME	0	3	0135		0	0	4	7
	REMO	0	3	0140	0		0	10	10
	PEMA	0	3	0102		1	0	1	12
	PEMA	0	3	0120	3		0	12	12
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	PEMA	0	3	0142	3		0	9	12
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	REMO	0	3	0153	0		0	3	3
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	PEMA	0	3	0122		0	0	5	3
	PEFL	0	3	0003	0		0	8	3
	PEMA	0	3	0124		0	0	11	3
	PEMA	0	3	0154		0	0	3	8
	PEMA	0	3	0142	0		0	9	12
	ONLE	0	3	0151		0	0	12	12
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	PEHI	0	3	0055		0	0	4	3
	PFFL	0	3	0003	0		0	8	3
	PFFL	0	3	0123		3	0	11	4
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	PEMA	0	3	0124		0	0	12	3
	PEMA	0	3	1200	0		0	5	6

PEMA	0	3	0122		3	0	1	6
REMO	0	3	0201		0	0	7	8
PEMA	0	3	0132		0	0	1	9
PEMA	0	3	0142	0		0	9	12
ONLF	0	3	0151		0	0	12	12

Snap Trap Grid Data

Small mammal snap trap grid data were collected in 1970 at the Jornada and Pantex Sites. These data are stored as Grassland Biome Data Sets A2U1018 and A2U101A. Data were collected on forms NREL-12A, NREL-13, and NREL-14. Samples of these forms and an example of the data follow.

FIELD DATA SHEET - MAMMAL COLLECTION

DATA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	TRAP DAY	HOUR	GRID TRAP		GENUS	SPECIES	SUBSPECIES	SPECIMEN NUMBER	MARK	LENGTH	TAIL	FOOT	EAR	WEIGHT	MOLT	PARASITES	STOMACH WEIGHT	FOOD	EYE LENS	SPECIMEN	MAP REFERENCE		
			Day	Mo.	Yr.						Row	Col																	TWN	RNG	S

MARK
0 None
1 Snap-trap grid, unmarked
2 Snap-trap grid, marked
3 Live-trap grid, unmarked
4 Live-trap grid, marked
5 Other trapping

MOLT
0 No evidence
1 Post-juvenile
2 Post-subadult
3 Adult (vernal)
4 Adult (autumnal)
5 Molt of unknown stage
6 Undetermined

PARASITES - EYE LENS
0 Not saved
1 Preserved

SPECIMEN
0 Not saved
1 Skin
2 Skull
3 Skin and skull
4 Skeleton
5 Liquid preservative

FOOD
0 None
1 Stomach only
2 Cheek pouch only
3 Both

DATA TYPE
01 Aboveground Biomass
02 Litter
03 Belowground Biomass
10 Vertebrate - Live Trapping
11 Vertebrate - Snap Trapping
12 Mammal - Collection
13 Snap Trap Effort
14 Mammal Reproductive
20 Avian Flush Census
21 Avian Road Count
22 Avian Road Count Summary
23 Avian Collection - Internal
24 Avian Collection - External
25 Avian Collection - Plumage
30 Invertebrate
40 Microbiology-Decomposition
41 Microbiology-Nitrogen
42 Microbiology-Biomass
43 Microbiology-Root Decomposition
44 Microbiology-Respiration

SITE
01 Ale
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 Hopland
08 Jornada
09 Osage
10 Pantex
11 Pawnee

TREATMENT
1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Grazed 1969, ungrazed 1970
6
7
8
9

FIELD DATA SHEET - MAMMAL REPRODUCTIVE

DATA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	TRAP DAY	HOUR	GRID TRAP		GENUS	SPECIES	SUBSPECIES	SPECIMEN NUMBER	MALE					FEMALE																
			Day	Mo.	Yr.						Row	Col					EXTERNAL	TESTES LN	TESTES WD	EPIDID	SEM VES	EXTERNAL	MAMMARY	PUBIC SEM	NORMAL EMBRYOS L	NORMAL EMBRYOS R	EMBRYO LENGTH	RESORB L	RESORB R	SCARS NEW L	SCARS NEW R	SCARS OLD L	SCARS OLD R	CORPORA LUTEA L	CORPORA LUTEA R	TRACT WEIGHT	CORP ALB	SPEC SOURCE

MALE
0 Adult, non-breeding
1 Subadult, non-breeding
2 Juvenile, non-breeding
3 Adult breeding ?
4 Subadult breeding ?
5 Juvenile breeding ?
6 Adult breeding
7 Subadult breeding
8 Juvenile breeding
9 Undetermined

FEMALE
0 Adult, vulva inactive
1 Subadult, vulva inactive
2 Juvenile, vulva inactive
3 Adult, vulva turgid
4 Subadult, vulva turgid
5 Juvenile, vulva turgid
6 Adult, vulva cornified
7 Subadult, vulva cornified
8 Juvenile, vulva cornified
9 Undetermined

SEMINAL VESICLES
0 No observation
1 Minute
2 Small
3 Well developed

EPIDIDYMUS
0 No observation
1 Not convoluted
2 Slightly convoluted
3 Convoluted

MAMMARY
0 No observation
1 Small
2 Large
3 Lactating

SOURCE
1 Snap trap grid
2 Live trap grid
3 Other trap line
4 Misc. collection

PUBLIC SYMPHASIS
0 No observation
1 Closed
2 Slightly open
3 Open

DATA TYPE
01 Aboveground Biomass
02 Litter
03 Belowground Biomass
10 Vertebrate - Live Trapping
11 Vertebrate - Snap Trapping
12 Mammal - Collection
13 Snap Trap Effort
14 Mammal Reproductive
20 Avian Flush Census
21 Avian Road Count
22 Avian Road Count Summary
23 Avian Collection - Internal
24 Avian Collection - External
25 Avian Collection - Plumage
30 Invertebrate
40 Microbiology-Decomposition
41 Microbiology-Nitrogen
42 Microbiology-Biomass
43 Microbiology-Root Decomposition
44 Microbiology-Respiration

SITE
01 Ale
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 Hopland
08 Jornada
09 Osage
10 Pantex
11 Pawnee

TREATMENT
1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Grazed 1969, ungrazed 1970
6
7
8
9

*** EXAMPLE OF DATA ***

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1310RLP0208702 2.74 2200                    2
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1310RLP0308702 2.74 0745                          2
1310RLP0308702 2.74 0745              1
1310RLP0308702 2.74 0745     1                 1           1
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1310RWW0508702 2.74 2300
1310RWW0508702 2.74 2300
1310RWW0508702 2.74 2300
1310RWW0508702 2.74 2300                    2
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1410RLP0708702 2.74 050700 9 8REMO PAN0049         11100  000000000   01
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1310RWW0708702 2.74 2230    2                    2
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1210RLP0908702 2.74 07070011 7PEMA PAN00551 161 66 19 14 23.500    115
1210RLP0908702 2.74 070700 8 9REMO PAN00561 102 49 15 12  5.310    115
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1410RLP0908702 2.74 070700 4 1PEMA PAN0052   070422
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1410RLP1208702 2.74 100730 6 IREMO PAN0059         61122 0200000021   01
```

Miscellaneous Trapping

Small mammal miscellaneous trapping data were collected in 1970 at the Jornada Site. These data are stored as Grassland Biome Data Set A2U1028. Data were collected on forms NREL-12A and NREL-14. An example of the data follows.

*** EXAMPLE OF DATA ***

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1208RLP  11702 2.74  210000310DIOR JOR01444 208114 36 14 47.10    115
1208RLP  11702 2.74  210001007DIOR JOR01434 222126 35 12 40.30    115
1208RLP  11702 2.74  110000712DIOR JOR01404 213114 38 14 50.80    115
1208RLP  11702 2.74  510001003DIOR JOR01944 231123 36 13 47.90    115
1208RLP  11702 2.74  510000701ONLE JOR01954 155 52 23 15 22.90    115
1208RLP  11702 2.74  310001112DIOR JOR01984   0  0 38 15 48.10    115
1208RLP  11702 2.74  310000805DISP JOR01994   0  0 54 18104.60    115
1208RLP  11702 2.74  310000610PEMA JOR02004 172 75 22 16 17.00    115
1208RLP  11702 2.74  710000811DIOR JOR02023 239135 37 12 48.60    115
1208RLP  11702 2.74  710000211DIOR JOR02013 231127 36 14 52.40    115
1208RLP  11702 2.74  710000703DIME JOR02033 221129 38 11 34.10    115
1208RLP  11702 2.74  810000211DIOR JOR02124 161 55 23 14 27.40    115
1208RLP  11702 2.74  810001109DIOR JOR02134 233123 36 12 41.20    115
1208RLP  11702 2.74  810000110ONLE JOR02144        36 12 29.60    115
1208RLP0811702 2.74 1010000304DIOR JOR02084 226119 31 10 41.80    115
1208RLP0811702 2.74 1010000201DIOR JOR02094        36 13 44.00    115
1208RLP0811702 2.74 1010000710DISP JOR02104        54 16105.10    115
1208RLP0811702 2.74 1010000112DIOR JOR02114 214105 37 15 48.20    115
1208RLP0811702 2.74  910000111DIOR JOR02064        37 15 52.50    115
1408RLP  11702 2.74  210001212DIOR JOR0145 6 10 633                     2
1408RLP  11702 2.74  210000310DIOR JOR0144 6 11 633                     2
1408RLP  11702 2.74  210001007DIOR JOR0143         610                 02
1408RLP  11702 2.74  110000712DIOR JOR0140         310                 12
1408RLP  11702 2.74  510001003DIOR JOR0194         6 0       11   11   12
1408RLP  11702 2.74  510000701ONLE JOR0195 0  4 211                     2
1408RLP  11702 2.74  310001112DIOR JOR0198 6  9 533                     2
1408RLP  11702 2.74  310000805DISP JOR0199         010                 02
1408RLP  11702 2.74  310000610PEMA JOR0200         012       34        12
1408RLP  11702 2.74  710000811DIOR JOR0202 6  7 332                     2
1408RLP  11702 2.74  710000211DIOR JOR0201 6 10 633                     2
1408RLP  11702 2.74  710000703DIME JOR0203         010            01   02
1408RLP  11702 2.74  810000211DIOR JOR0212         0                   02
1408RLP  11702 2.74  810001109DIOR JOR0213         0                   02
1408RLP  11702 2.74  810000110ONLE JOR0214         0                   02
1408RLP0811702 2.74 1010000304DIOR JOR0208         710                  2
1408RLP0811702 2.74 1010000201DIOR JOR0209 6 11 533                     2
1408RLP0811702 2.74 1010000710DISP JOR0210         0                    2
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1408RLP0811702 2.74  910000111DIOR JOR0206 6 12 633                     2
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