Technical Report No. 109

SMALL MAMMAL SURVEY ON THE BISON, BRIDGER, COTTONWOOD, DICKINSON, AND OSAGE SITES

R. S. Hoffmann, J. K. Jones, Jr., and H. H. Genoways

Museum of Natural History

The University of Kansas

Lawrence, Kansas 66044

Grassland Biome

U. S. International Biological Program

August 1971

TABLE OF CONTENTS

ABSTRACT

Live- and snap-trapping of grids at five Network Sites on the northern Great Plains (Osage, Cottonwood, Dickinson, Bridger, and Bison) provide the basis for estimates of small mammal standing crop biomass density at one or two times during the growing season at these sites.

Osage had a high prairie vole (*Microtus ochrogaster*) population, comprising about 90% of the biomass total, in late May to early June. Biomass density was calculated as 1591.4 g/ha live weight (=0.048 g/m^2 dry weight). Vole numbers declined somewhat over the summer, but still constituted 80 to 85% of the biomass total in late August; biomass density was estimated as 1121.7 g/ha live weight (=0.034 g/m^2 dry weight).

Small mammal densities were extremely low in both mid-June and mid-August at Cottonwood, and no one species was dominant. Biomass density estimates were 114.8 g/ha live weight (=0.003 g/m^2 dry weight) and 181.2 g/ha live weight (=0.005 g/m^2 dry weight), respectively.

Densities also were fairly low at Dickinson, with no dominant species; biomass density in mid-June was estimated as 295.0 g/ha live weight (=0.009 g/m^2 dry weight), and in early August as 369.3 g/ha live weight (=0.011 g/m^2 dry weight). However, biomass density estimates based on live-trapping an irregular grid in a small exclosure were much higher because of the presence in the exclosure of a ground squirrel (*Spermophilus tridecemlineatus*) colony. Ground squirrels constituted 75 to 85% of the biomass total, estimated as 2464.0 g/ha live weight (=0.075 g/m^2 dry weight) and 976.0 g/ha live weight (=0.029 g/m^2 dry weight) for the first and second periods, respectively.

Only single mid-season samples were taken at Bridger and Bison. At the former site, biomass density was moderate to high because of pocket gophers, which constituted 60 to 90% of the biomass total of 2375.8 g/ha live weight (=0.071 g/m^2 dry weight) on the snap-trapped grid, and 358.1 g/ha live weight (=0.011 g/m^2 dry weight) on the live-trapped grid. At Bison, the montane vole (*Microtus montanus*) constituted 90% of the biomass total of 397.4 g/ha live weight (=0.012 g/m^2 dry weight).

INTRODUCTION

The purpose of the studies reported herein was to survey the status of, and provide estimates of, small mammal populations on second- and third-order sites in the Comprehensive Network Program of the IBP Grassland Biome project. In the period May 15 to September 2, 1970, field parties from the University of Kansas studied and collected mammals on five Comprehensive Network sites (see Fig. 1) in the northern and central plains as follows: Osage (two collection periods), Cottonwood (two collection periods), Dickinson (two collection periods), Bridger (one collection period), and Bison (one collection period). Details of work accomplished at these sites in 1970 is reported herein. The composition of field crews varied throughout the summer, with the following persons involved: E. C. Birney, A. Cadena, J. R. Choate, R. J. Cinq-Mars, H. H. Genoways, R. S. Hoffman, J. K. Jones, Jr., R. P. Lampe, and R. W. Turner. Mammals collected have been catalogued in the Museum of Natural History at the University of Kansas. Some amphibians and reptiles were collected on Comprehensive Network sites, and also are catalogued in the Museum's collections (Appendix I).

METHODS

Grids

All grids excepting the live-trap grid at Dickinson were squares of 12 × 12 stations (144 total). The interval between each station in the rows and columns was 15 m, giving the grid an area of 2.76 ha. Each grid station was semipermanently marked with a wooden stake. Each stake was numbered with its row and column position.

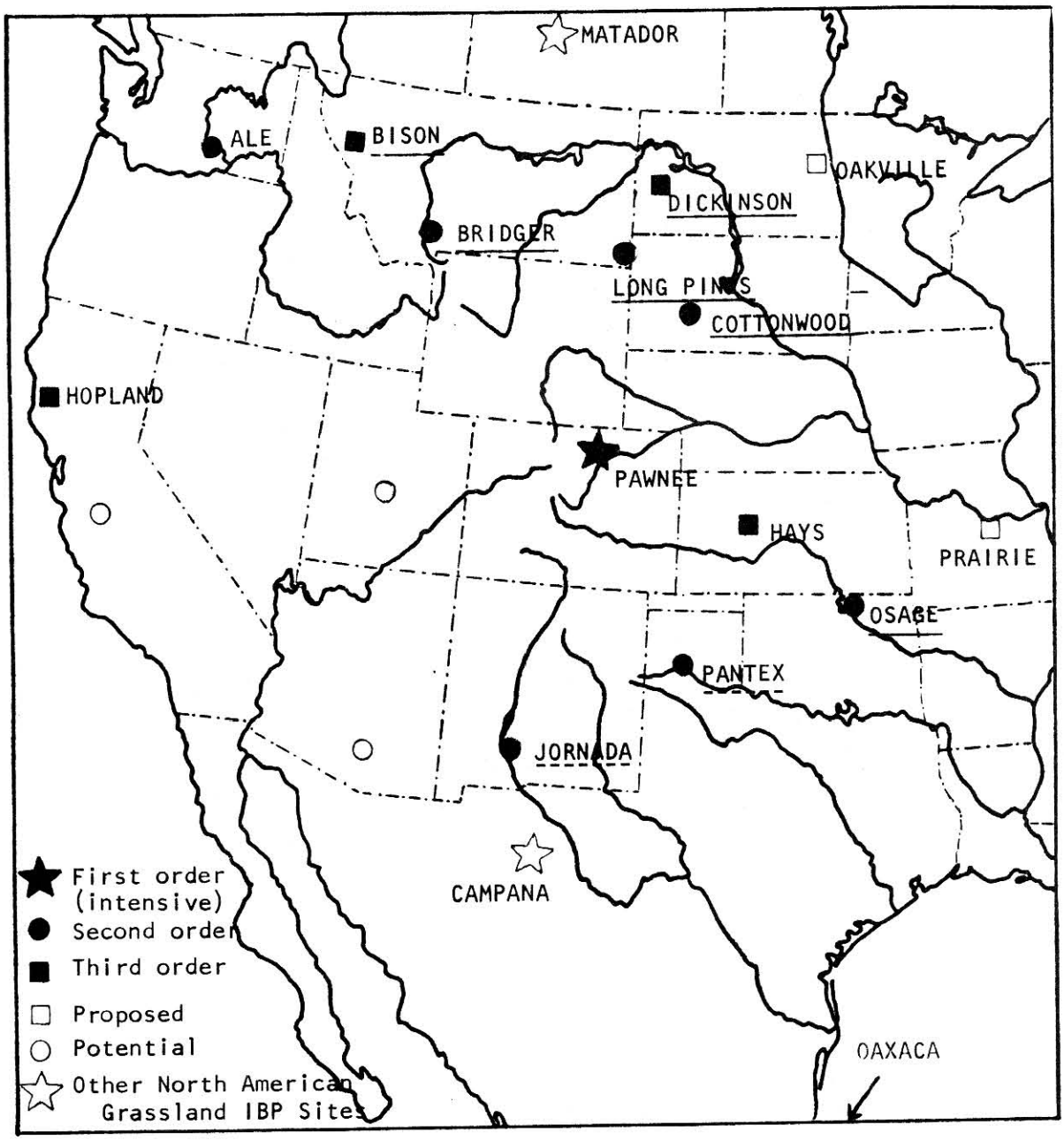

Fig. 1. IBP Grassland Biome sites. Underlined sites (__) are reported herein; sites with dashed underline (___) were studied by Texas Tech. The Oaxaca and Long Pine sites are not IBP sites, but are mentioned in connection with species diversity.

At Dickinson the live-trap grid was smaller than the normal grid because it was placed within a four-acre ungrazed enclosure. The grid consisted of nine rows and a varying number of columns. Two rows had eight columns, two had seven columns, two had six columns, two had five columns, and one had four columns.

Trapping

Two Animal Trap Company Museum Special snap-traps were placed at each station on the snap-trap grids, and two aluminum Sherman live-traps were placed at each station on the live-trap grids. All traps were prebaited for five days before they were set to catch animals. Traps were baited with a mixture of oatmeal and peanut butter. After the prebaiting period, all traps were set for 10 consecutive days unless rainy weather interfered, in which instance a night would be skipped. After five nights of trapping, the traps were shifted one-half the diagonal distance between traps so that most traps were located in the centers of the squares of the original grid, in a minimal effort to randomize trap placement.

Traps were set in the late afternoon (usually between 1700 and 1900) each day. Snap-traps were checked in the evening about one hour after dark. Any animals found in them at that time were removed from the traps and the traps were left unset. Traps that were found to be sprung, but containing no animals, were reset. Both live- and snap-traps were checked early in the morning (usually between 0600 and 0700) and all were sprung at that time, to be reset the same evening again.

Data Types

Four data types were recorded on small mammals from our grids. Examples of data sheets are included with this report (Appendix II).

Information from the live-trap grids was recorded on a "Vertebrate--Live Trapping" data sheet. Recorded on this sheet was the generic and specific identity of the animal and its condition in the trap (normal, torpid, escaped, or dead). All small mammals were marked by toe clipping and the code number of each recorded. Four toes were used on each foot for clipping, starting with the right hind foot. The relative age (juvenile, subadult, or adult) and reproductive condition (females--inactive, cornified, vulva turgid, or pregnant or lactating; males--non-breeding, questionably breeding, or breeding) of each specimen was recorded. If an animal was found to be molting, the stage of molt was noted. Finally, the grid location where the specimen was captured was recorded.

On the snap-trap grid a "snap-trap effort" sheet was used to record field observations. On this sheet the condition of each trap was noted as to whether it was unsprung, contained an animal, or sprung and empty.

For each animal from the snap-trap grid and any dead animals from the live-trap grid, additional information was recorded on two data sheets--Mammal Collection and Mammal Reproductive. The Mammal Collection sheet has information on grid location of capture, generic and specific identity, field collector's number, external measurements, stage of molt, and type of specimen prepared. Saved from most specimens were ectoparasites, stomachs for analysis of contents, and eye lenses for use in age determination. On the Mammal Reproductive sheets, reproductive condition and relative age were noted as for the live-trapped animals. In addition, for males, the length and width of the testes and the condition of the epididymis and the seminal vesicles were noted. The condition of the mammary glands and pubic

symphysis were recorded for females, and, from internal study, the following information: number and size of embryos, number of embryos being resorbed, number of old and new scars, number of corpora lutea, presence or absence of corpora albicantia, and weight of the reproductive tract if it contained embryos.

Other Censusing Methods

One-mile long flushing transects were walked in an effort to census jackrabbits at the various sites. However, these proved to be relatively unsatisfactory inasmuch as jackrabbits were seen only at Cottonwood during the first collection period.

Attempts to census pocket gophers utilized two methods. At sites where the gopher populations were low, they were trapped from the grids, using Macabee gopher traps to ascertain the total number actually present. At Bridger, where the pocket gopher population was high, trapping was conducted only on a part of the snap-trap grid and the number of fresh mounds was counted after a rain on the grid.

For additional discussion of methods used in small mammal sampling, see French (1971).

Statistical Techniques

The various methods for estimating population size gave fairly concordant results at each site (Fig. 2). Whenever possible, the Jolly stochastic procedure (Jolly 1965) was used to estimate population size on the live-trap grid as recommended by French (1971), and the Hansson procedure (Hansson 1969) was used for the snap-trap grid. However, when the assumptions of these procedures could not be met and no population estimate could be

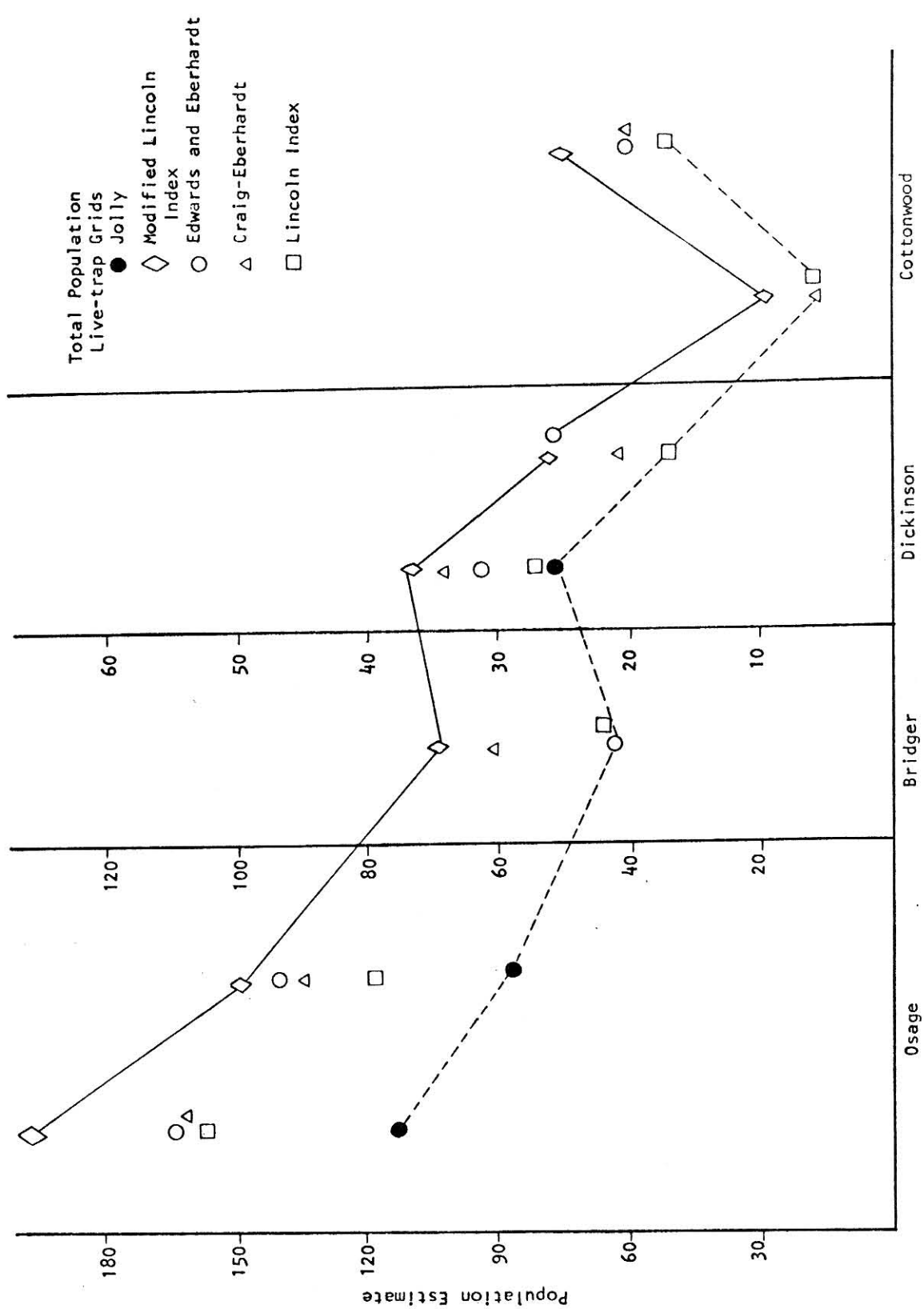

Fig. 2. Comparison of total population density estimates based on different estimating techniques and total numbers of individual small mammals captured, by species, at OSAGE, BRIDGER, DICKINSON, and COTTONWOOD.

obtained, the Craig-Eberhardt procedure (Eberhardt 1969) was used for live-trap data, and the Zippin or regression method (Zippin 1956) was used for snap-trap data.

All weights were adjusted by subtraction of stomach weight and weight of reproductive tracts of pregnant females from total body weight. To convert wet body weight to dry body weight, the wet weight was multiplied by 0.3. The conversion of wet to dry weight is based upon results obtained by Golley (1960) for *Microtus pennsylvanicus*.

STUDY AREAS

The Comprehensive Network Sites visited by field teams from the University of Kansas included Osage, Cottonwood, Dickinson, Bridger, and Bison; each of these sites is discussed briefly below. Information is presented on types of grids used, location of grids, vegetation on grids, and general climate and topography of the area.

Osage

The Osage Site is located on the K. S. Adams Ranch at a place 12 miles north and five miles east of Shidler, Osage County, Oklahoma. Both live-trap and snap-trap grids were studied at this site. The live-trap grid was located in an ungrazed pasture just to the west of the ranch headquarters. Rows 11 and 12 were located in an area that was cultivated 12 years ago but has not been worked since; the successional vegetation in this area was considerably different from the tallgrass on the remainder of the grid, having a dense, tall growth of forbs. The snap-trap grid was located in the same pasture, 250 m west of the live-trap grid. However, in winter a fence

is placed along the eastern edge of the snap-trap grid so that cattle may reach a hay shelter. The grass in this area is somewhat shorter than the grass on the live-trap grid, probably as a result of this light grazing.

To the north and west of the grids is a road beyond which is moderately grazed pasture (north) and wheat land (west). About 150 m south of the grids is a shelter-belt and beyond this about 250 m is a small lake. There appeared to be little or no slope on the live-trap grid, but on the snap-trap grid there was a gentle slope to the west and south.

The average January temperature at Osage is 36.9°F and the average July temperature is 81.8°F. The average annual precipitation is 36.6 inches, with 25.0 inches being received from April to September. However, the summer of 1970 was unusually dry in northeastern Oklahoma.

This area of northeastern Oklahoma is characterized by tallgrass prairie in uncultivated upland areas and deciduous trees along the canyons and streams. Common grasses (Risser 1970) in the pasture where the grids were placed included big bluestem (*Andropogon gerardi*), little bluestem (*A. scoparius*), switch grass (*Panicum virgatum*), Scribner panicum (*P. scribnarianum*), side oats grama (*Bouteloua curtipendula*), blue grama (*B. gracilis*), Indian grass (*Sorghastrum mutans*), tall dropseed (*Sporobolus asper*), and fall witchgrass (*Leptoloma cognatum*). Forbs in the area were heath aster (*Aster ericoides*), wild indigo (*Baptisia leucophaea*), dotted gayfeather (*Liatris punctata*), and white prairie clover (*Petalostemum candidum*).

Cottonwood

Both grids at the Cottonwood Site were located on the Cottonwood Range Field Station, which is two miles east of Cottonwood, Jackson County, South

Dakota. Live-trap and snap-trap grids were placed in summer pasture 3, which has been lightly grazed since 1942.

Both grids were located on north- and south-facing slopes, which sloped toward the center of the grids and then drained toward the west. Cottonwood Creek and a small dam and reservoir were about one-half mile to the northwest of the grids. The average annual temperature on the station is about 47°F, with the average daily temperature in January being 32.5°F and in July 90.8°F. The average annual rainfall at the station is 15.22 inches, with May (2.78 inches) and June (2.99 inches) being the wettest months.

Under good range conditions, the vegetation of the field station is dominated by midgrasses, especially western wheatgrass (*Agropyron smithii*) and green needlegrass (*Stipa viridula*) with an understory of shortgrasses, mainly consisting of blue grama (*Bouteloua gracilis*) and buffalo grass (*Buchloe dactyloides*). Several forbs are conspicuous during the early part of the year. For additional information on plants of the Cottonwood Site, see Lewis (1970).

Dickinson

The Dickinson Site is located on the Dickinson Experiment Station, which is one mile north and one mile west of Dickinson, Stark County, North Dakota. A snap-trap grid and, although this is a third-order site, a partial live-trap grid, were studied at Dickinson. The irregularly-shaped, 1.1 ha live-trap grid was placed in an enclosure that has not been grazed since 1961, and represented the only ungrazed area available to us on the site. The snap-trap grid was in a pasture that had been heavily grazed in late autumn each year.

The entire site is located on a gentle ridge oriented northwest-southeast, with two small prominences (one at the northwest end of the site and the other near the center) that rise 50 to 100 ft above the remainder of the ridge. Much of the slope has angles of approximately 5 to 15°. The live-trap grid was located in the saddle between the prominences, with a part of the grid on the northeast face of the slope and the other part on the southwest slope. The snap-trap grid was located on the ridge to the southeast of the central prominence. This grid had about two-thirds of the traps on the northeast slope and the remainder on the southwest slope.

The average annual temperature at Dickinson is 40.7°F, with the average temperature in January being 11.0°F and in July 69.0°F. The average annual precipitation is 15.5 inches. June (average precipitation of 3.5 inches) is the wettest month of the year; May (2.2 inches) and July (2.2 inches) also receive relatively large amounts of precipitation. December (average precipitation of 0.4 inch) is the driest month of the year.

The grassland vegetation of the site is fairly typical of northern plains mixed grass prairie (see Whitman 1970). The grassland type has been designated as needle and thread/blue grama/sedge type. Principal grasses and sedges that composed 80% of the total cover are needle and thread (*Stipa comata*), blue grama (*Bouteloua gracilis*), western wheatgrass (*Agropyron smithii*), threadleaf sedge (*Carex filifolia*), and needleleaf sedge (*Carex eleocharis*). Important secondary grasses, making up about 15% of the total cover, are prairie June grass (*Koeleria cristata*), green needlegrass (*Stipa viridula*), plains reed grass (*Calamagrostris montanensis*), prairie sand reed (*Calamovilfa longifolia*), and Sandberg bluegrass (*Poa secunda*). Numerous species of broad-leaf plants account for about 5% of the total cover. On

three sides of the site are cultivated fields that are cropped to small grain or corn. On the south side of the site is the right-of-way for Interstate 94, which is mowed at least once a year.

Bridger

The Bridger Site is located on Bangtail Ridge in the Bridger Mountains in southwestern Montana. Elevation of the site is about 7600 ft for the live-trap grid and 7900 ft for the snap-trap grid. The live-trap grid was located 6.5 miles north and 12 miles east of Bozeman, *in* Park County, Montana.

The first nine rows of this grid were placed within an ungrazed enclosure that is being used for other grassland studies; the last three rows were located outside of the enclosure. When the grids were set, little difference was noted between the vegetation inside and outside of the enclosure; however, the area outside the enclosure was moderately grazed by sheep during the last five days of the study. The vegetation of the snap-trap grid, which was located about one mile north of the live-trap grid, was somewhat similar to the area outside the enclosure on the live-trap grid, but showed the effects of heavier grazing. The snap-trap grid was also moderately grazed by sheep during the last part of the study.

The live-trap grid was located on a south-facing slope. The first six rows of the grid were in a relatively level area, but the last six were located on a fairly steep slope. The snap-trap grid sloped gently to the southwest. Mean annual temperature at the Forsyth Ranch (located four miles north-northwest of the experimental site) is 45.9°F, with a mean annual minimum of 32.0°F and a maximum of 59.9°F. The average annual precipitation

is 12.17 inches, with May and June (2.13 and 2.86 inches, respectively) being the wettest months and December (0.32 inch) the driest.

Collins (1970) has classified the vegetation of the area as mountain bunchgrass-forb type. Among the common grasses and forbs on the grid were mountain timothy (*Phleum alpinum*), spiked wood rush (*Luzula spicata*), silvery lupine (*Lupinus argenteus*), and Northwest cinquefoil (*Potentilla gracilis*).

Bison

This site is located on the National Bison Range, which has its headquarters near Moiese, Lake County, Montana. The Bison Range is an 18,500-acre area that supports herds of several large herbivores. Only a snap-trap grid was studied at this site. The grid was located near the center of the western edge of the range at a place one mile northeast of Agency, Sanders County, Montana. The grid site was considered to be lightly grazed.

The grid was located on a steep northwest-facing slope (slope varying from about 30 to 45°). The mean annual temperature at the Bison Range headquarters is 45.1°F, with January being the coldest month (23.4°F average) and July the warmest (66.9°F average). The average annual precipitation is 12.74 inches. May and June (1.78 and 1.99 inches, respectively) are the wettest months of the year and February (0.66 inch) is the driest.

Morris (1970) has classified the grasslands of the National Bison Range as a Palouse Prairie Grassland. Local vegetation types are strongly influenced by topography, but on the grid the dominant grass was Idaho fescue (*Festuca idahoensis*) and in areas of rock outcrops the forb, balsam root (*Balsamorrhiza sagittata*), was abundant.

RESULTS

Osage

Small mammals collected on the Osage Site during both sampling periods included the following:

Snap-trap grid: *Cryptotis parva*, *Blarina brevicauda*, *Spermophilus tridecemlineatus*, *Reithrodontomys montanus*, *Peromyscus leucopus*, *Peromyscus maniculatus*, *Microtus ochrogaster*.

Live-trap grid: *Blarina brevicauda*, *Reithrodontomys montanus*, *Sigmodon hispidus*, *Microtus ochrogaster*.

Other mammals taken or observed in the general vicinity of the site: *Didelphis marsupialis*, *Eptesicus fuscus*, *Lepus californicus*, *Sylvilagus floridanus*, *Canis latrans*, *Vulpes vulpes*, *Procyon lotor*, *Taxidea taxus*.

The prairie vole (*Microtus ochrogaster*) was the dominant small mammal on the site in both trapping periods (Fig. 3). Vole density was higher on the live-trapping grid than on the snap-trapping grid, probably because of greater plant density on the former. There is evidence (Eadie 1953) that population densities of voles are directly related to density of the ground-level vegetation in which they make their characteristic runways. At Osage, density appears to be most strongly correlated with standing dead plant biomass, rather than live biomass or total aboveground biomass (Fig. 4 through 6). The extremely low small mammal densities observed in the grazed pastures to the north of the grids, and the virtual absence of *Microtus* there, also may be related to the low density of standing dead plant biomass in the grazed pasture (Fig. 4).

Osage, Oklahoma	First Period		Second Period	
	Live	Snap	Live	Snap
Microtus ochrogaster	114	110	89	19
Reithrodontomys montanus	3	2	13	3
Sigmodon hispidus	6	0	2	0
Peromyscus leucopus	0	2	0	0
Peromyscus maniculatus	0	6	0	3
Blarina brevicauda	4	5	2	2
Spermophilus tridecemlineatus	0	0	0	1
Cryptotis parva	0	0	0	1
	127	125	106	29

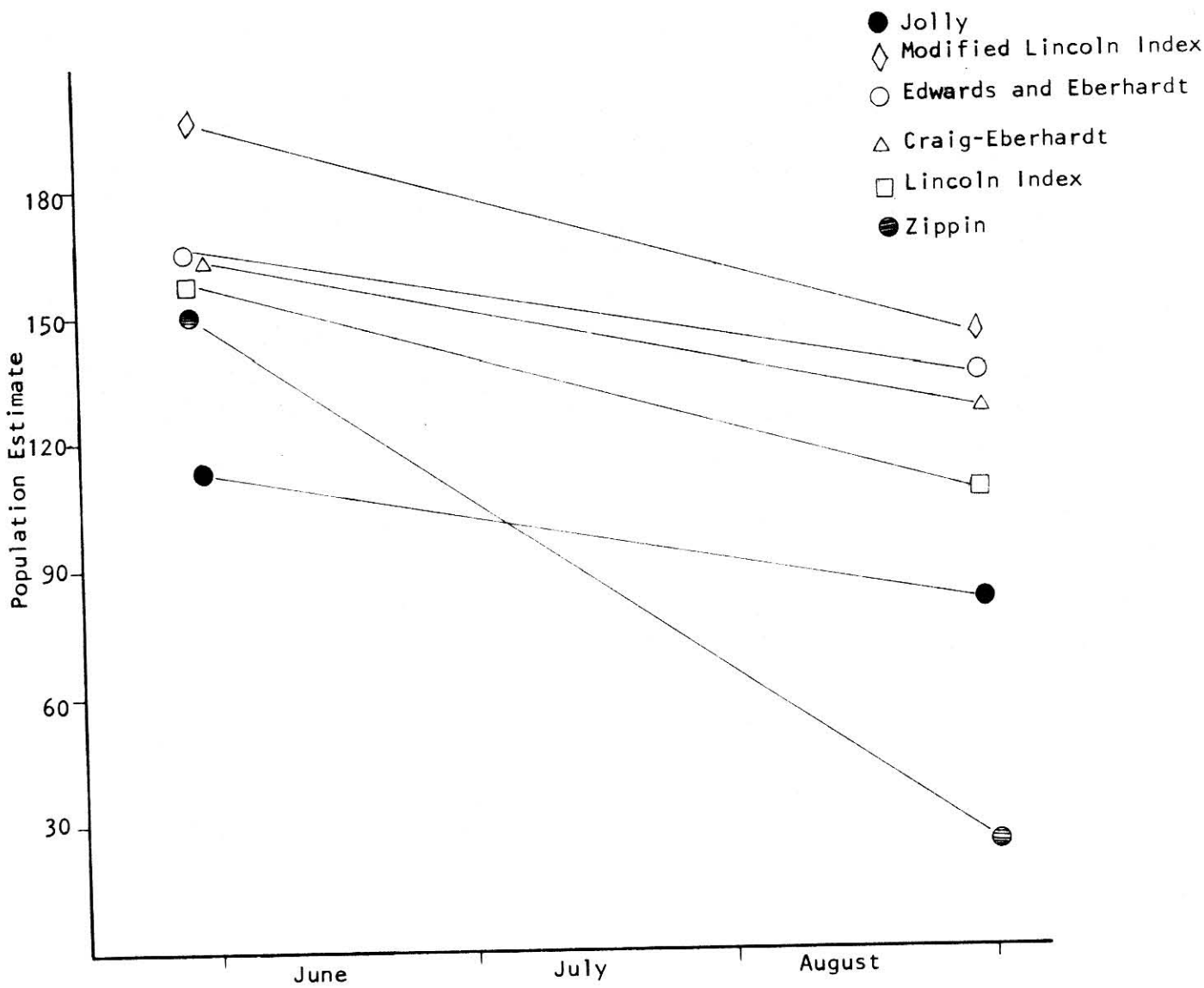

Fig. 3. Comparison of total population density estimates based on different estimating techniques, and total numbers of individual small mammals captured, by species, at OSAGE.

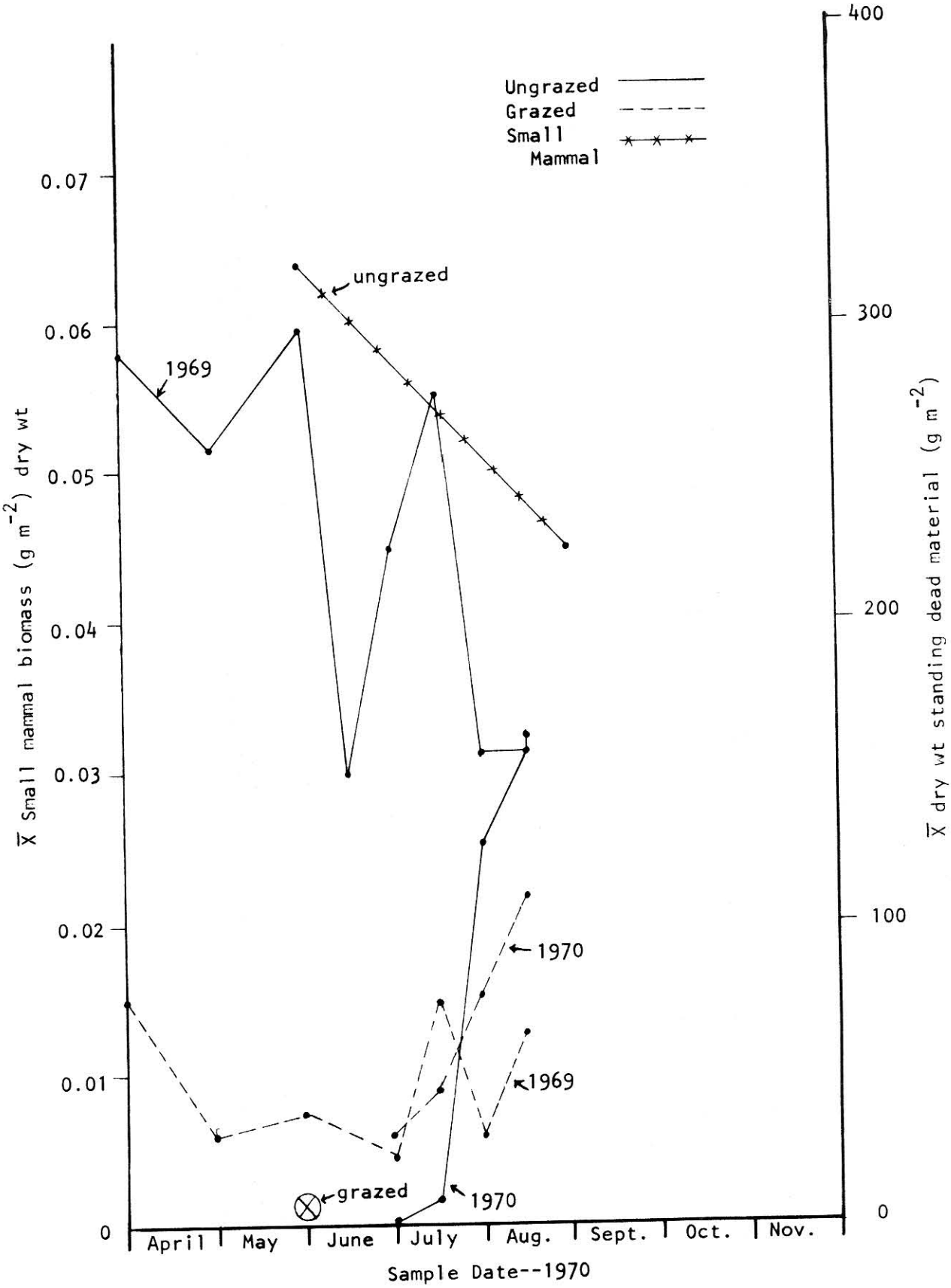

Fig. 4. Comparison of small mammal biomass with standing dead biomass of aboveground vegetation at OSAGE.

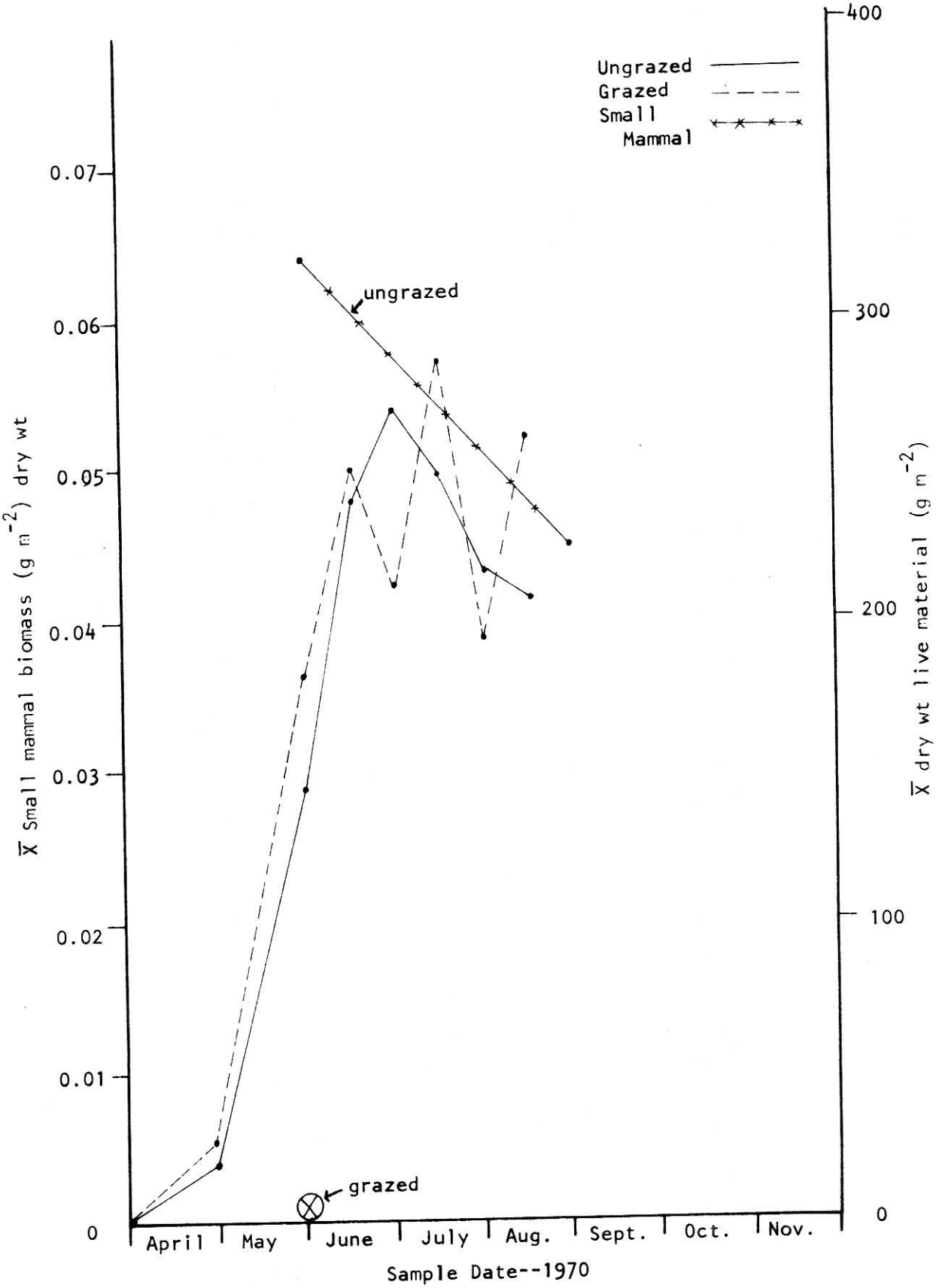

Fig. 5. Comparison of small mammal biomass with live biomass of aboveground vegetation at OSAGE.

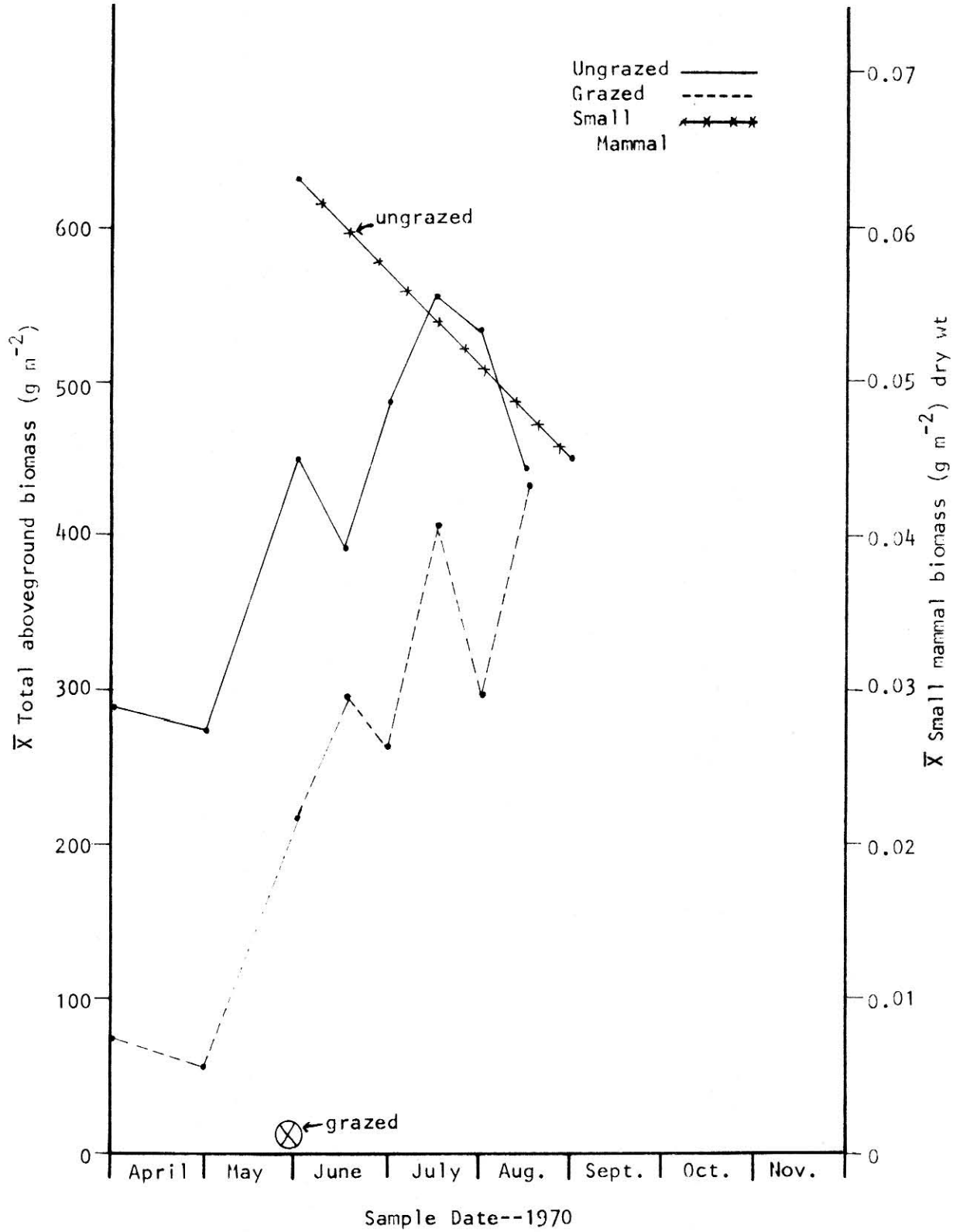

Fig. 6. Comparison of small mammal biomass with total aboveground vegetation biomass at OSAGE.

The hispid cotton rat (*Sigmodon hispidus*) is a potentially important contributer to small mammal standing crop density and biomass at the Osage Site. However, it finds its optimum habitat in early stages of ecological succession and on the grids we studied, was restricted to the southern margins of the live-trap grid in an area of dense forbs resulting from prior cultivation.

Thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) were rare at the Osage Site, and plains pocket gophers (*Geomys bursarius*) were completely absent in 1970. Both of these species, when common, may be important contributers to small mammal biomass.

The two species of *Peromyscus* on the site were restricted to the snap-trap grid. In particular, the deer mouse (*Peromyscus maniculatus*) prefers more open habitats and was taken on the northeast quadrant of the grid where vegetation was sparsest, in part as a result of intermittent winter cattle grazing. The white-footed mouse (*Peromyscus leucopus*) is typically an inhabitant of woodland and riparian shrubland. The few individuals observed on the snap-trap grid may have moved on to it from the shelter belt to the south. The only small mammals taken in the grazed pastures at Osage were *P. maniculatus* and *R. montanus*; these species prefer open habitats.

Estimates of total numbers of small mammals on both grids, and of biomass densities are given by species in Tables 1 through 4. The prairie vole is the major component of biomass density at Osage.

A marked decline in numbers occurred on the snap-trap grid between the first and second sampling periods and affected most or all of the species. Inasmuch as a moderate decline also occurred in *Microtus* and *Sigmodon* (but

Table 1. Snap-trap grid--Osage 1 (24 May through 2 June 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Hansson-Zippin	Average for Class	Total Biomass Estimate (g) Hansson-Zippin	Biomass Density (g/ha) Hansson-Zippin
Microtus ochrogaster	112.0			
♂♂ adult	35.0	40.00	1400.0	432.1
subadult	10.0	33.94	339.4	104.8
juvenile	4.0	12.82	51.3	15.8
♀♀ adult	43.0	42.45	1825.4	563.4
subadult	11.0	31.16	342.8	105.8
juvenile	9.0	12.24	110.2	34.0
Total			4069.1	1255.9
Peromyscus maniculatus	7.0			
♂♂ adult	3.0	18.15	54.5	16.8
subadult	2.0	13.90	27.8	8.6
♀♀ undetermined	2.0	14.85	29.7	9.2
Total			112.0	34.6
Peromyscus leucopus	3.0			
♂♂ adult	3.0	27.30	81.9	25.3
Blarina brevicauda	6.0			
♀♀ adult	4.0	14.63	58.5	18.0
subadult	1.0	14.20	14.2	4.4
undetermined	1.0	14.80	14.8	4.6
Total			87.5	27.0
Reithrodontomys montanus	3.0			
♂♂ adult	1.0	10.40	10.4	3.2
♀♀ adult	2.0	11.30	22.6	7.0
Total			33.0	10.2
TOTAL			4383.5	1353.0

Table 2. Snap-trap grid--Osage 2 (23 August through 1 September 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Zippin	Average for Class	Total Biomass Estimate (g) Zippin	Biomass Density (g/ha) Zippin
Microtus ochrogaster	20.0			
♂♂ adult	9.0	34.06	306.5	94.6
subadult	2.0	29.20	58.4	18.0
♀♀ adult	7.0	33.80	236.6	73.0
juvenile	2.0	12.00	24.0	7.4
Total			625.5	193.0
Peromyscus maniculatus	3.0			
♂♂ adult	2.0	17.80	35.6	11.0
♀♀ adult	1.0	17.50	17.5	5.4
Total			53.1	16.4
Reithrodontomys montanus	3.0			
♂♂ adult	1.0	6.20	6.2	1.9
subadult	1.0	7.00	7.0	2.2
♀♀ adult	1.0	10.20	10.2	3.1
Total			23.4	7.2
Spermophilus tridecemlineatus	1.0			
♀♀ subadult	1.0	59.70	59.7	18.4
Blarina brevicauda	2.0			
♀♀ adult	2.0	11.60	23.2	7.2
Cryptotis parva	1.0			
undetermined	1.0	3.00	3.0	0.9
TOTAL			787.9	243.1

Table 3. Live-trap grid--Osage 1 (26 May through 5 June 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Jolly	C-E[a/]	Average for Class	Total Biomass Estimate (g) Jolly	C-E[a/]	Biomass Density (g/ha) Jolly	C-E[a/]
Microtus ochrogaster	106.0	147.0					
♂♂ adult	34.0	47.0	40.00	1360.0	1880.0	419.7	580.3
subadult	9.0	12.0	33.94	305.5	407.3	94.3	125.7
juvenile	4.0	6.0	12.82	51.3	76.9	15.8	23.7
♀♀ adult	40.0	56.0	42.45	1698.0	2377.2	524.1	733.7
subadult	10.0	14.0	31.16	311.6	436.2	96.2	134.7
juvenile	9.0	12.0	12.24	110.2	146.9	34.0	43.3
Total				3836.5	5324.5	1184.1	1643.4
Sigmodon hispidus		8.0					
♂♂ adult		3.0	160.37		481.1		148.5
subadult		0.0					
juvenile		2.0	46.89		93.8		29.0
♀♀ adult		1.0	153.17		153.2		47.3
subadult		1.0	88.15		88.2		27.2
juvenile		1.0	47.70		47.7		14.7
Total					864.0		266.7
Reithrodontomys montanus		4.0					
♂♂ adult		2.0	10.40		20.8		6.4
♀♀ adult		1.0	11.30		11.3		3.5
subadult		1.0	7.00		7.0		2.2
Total					39.1		12.1
Blarina brevicauda		4.0					
♀♀ adult		4.0	14.63		58.5		18.1
TOTAL				4798.1	6286.1	1481.0	1940.3

[a/] Craig-Eberhardt estimate.

Table 4. Live-trap grid--Osage 2 (23 August through 1 September 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers		Average for Class	Total Biomass Estimate (g)		Biomass Density (g/ha)	
	Jolly	C-E[a/]		Jolly	C-E[a/]	Jolly	C-E[a/]
Microtus ochrogaster	79.0	111.0					
♂♂ adult	34.0	46.0	34.06	1158.0	1566.8	357.4	483.6
subadult	8.0	12.0	29.20	233.6	350.6	72.1	108.2
juvenile	0.0						
♀♀ adult	29.0	41.0	33.80	980.2	1385.8	302.5	427.7
subadult	0.0						
juvenile	8.0	12.0	12.00	96.0	144.0	29.6	44.4
Total				2468.8	3447.0	761.6	1064.9
Sigmodon hispidus		2.0					
♂♂ adult		1.0	160.37		160.4		49.5
♀♀ adult		1.0	153.17		153.2		47.3
Total					313.6		96.8
Reithrodontomys montanus		39.0					
♂♂ adult		15.0	8.50		127.5		39.4
juvenile		3.0	6.40		19.2		5.9
♀♀ adult		15.0	10.20		153.0		47.2
juvenile		6.0	6.40		38.4		11.9
Total					338.1		104.4
Blarina brevicauda		2.0					
♀♀ adult		2.0	11.60		23.2		7.2
TOTAL				3142.7	4121.9	970.0	1273.3

[a/] Craig-Eberhardt estimate.

not *Reithrodontomys*) populations on the live-trap grid, part of the decline on the snap-trap grid may be assignable to factors, probably climatic, affecting both populations. The greater portion of the decline on the snap-trap grid was, however, probably due to removal of the small mammals by trapping, and failure of the populations to recover completely during the nearly three months between sampling periods.

Summary. Our best estimate of the live weight biomass of small mammals at Osage during the first trapping period is *1591.4 g/ha*. Our best estimate of the biomass of small mammals at Osage during the second trapping period is *1121.7 g/ha*.

Jackrabbit transects. Ten one-mile transects were walked in the vicinity of the grids during the first collection period, and two were walked during the second collection period. No jackrabbits were observed on any of these transects. One *Lepus californicus* was observed along the road approximately three miles west of the grids on the evening of 25 May 1970. A specimen of *Sylvilagus floridanus* was obtained just across the road to the west of the snap-trap grid during the first collection period.

Cottonwood

Small mammals collected on the Cottonwood Site during both sampling periods include the following:

Snap-trap grid: *Spermophilus tridecemlineatus*, *Thomomys talpoides*, *Reithrodontomys montanus*, *Peromyscus leucopus*, *Peromyscus maniculatus*.

Live-trap grid: *Spermophilus tridecemlineatus*, *Peromyscus leucopus*, *Peromyscus maniculatus*, *Microtus ochrogaster*.

Off-grid collections: *Sorex cinereus*, *Spermophilus tridecemlineatus*, *Thomomys talpoides*, *Reithrodontomys megalotis*, *Reithrodontomys montanus*, *Peromyscus leucopus*, *Peromyscus maniculatus*, *Microtus ochrogaster*, *Microtus pennsylvanicus*.

Other mammals taken or obtained in the general vicinity of the site: *Myotis leibii*, *Eptesicus fuscus*, *Lepus townsendii*, *Cynomys ludovicianus*, *Ondatra zibethicus*, *Mus musculus*, *Erethizon dorsatum*, *Vulpes vulpes*, *Procyon lotor*, *Mephitis mephitis*, *Mustela frenata*, *Taxidea taxus*, *Odocoileus hemionus*.

The most striking feature of small mammal populations at the Cottonwood Site in 1970 was their extremely low densities (Fig. 7). The dominant species on both grids was the deer mouse (*Peromyscus maniculatus*), but densities ranged from only about 0.25 to 1.0/ha in the spring sample, to about 1.0 to 2.5/ha in the late summer sample. Prairie voles (*Microtus ochrogaster*) were captured only on the live-trap grid, and were scarce there, but vole sign in the form of old runways was present in local areas on both grids. Off-grid collections verified the fact that small mammal populations were at low levels in the vicinity of Cottonwood, and that *Microtus*, in particular, had been more abundant in the recent past, probably in the autumn of 1969.

The well-drained grassland of the grids did not provide suitable habitat for either the meadow vole (*Microtus pennsylvanicus*) or western harvest mouse (*Reithrodontomys megalotis*). In contrast to their congeners (*M. ochrogaster*, *R. montanus*), these species are restricted to mesic swale vegetation, and were taken in off-grid trapping of these habitats, although their numbers appeared to be low also.

As was true at Osage, thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) were only transient on the grids and rare in the general

Cottonwood, South Dakota	First Period		Second Period	
	Live	Snap	Live	Snap
Peromyscus maniculatus	2	6	7	5
Peromyscus leucopus	1	2	0	0
Microtus ochrogaster	2	0	3	0
Reithrodontomys montanus	0	1	0	0
Spermophilus tridecemlineatus	0	2	1	0
Thomomys talpoides	0	1	0	0
	5	12	11	5

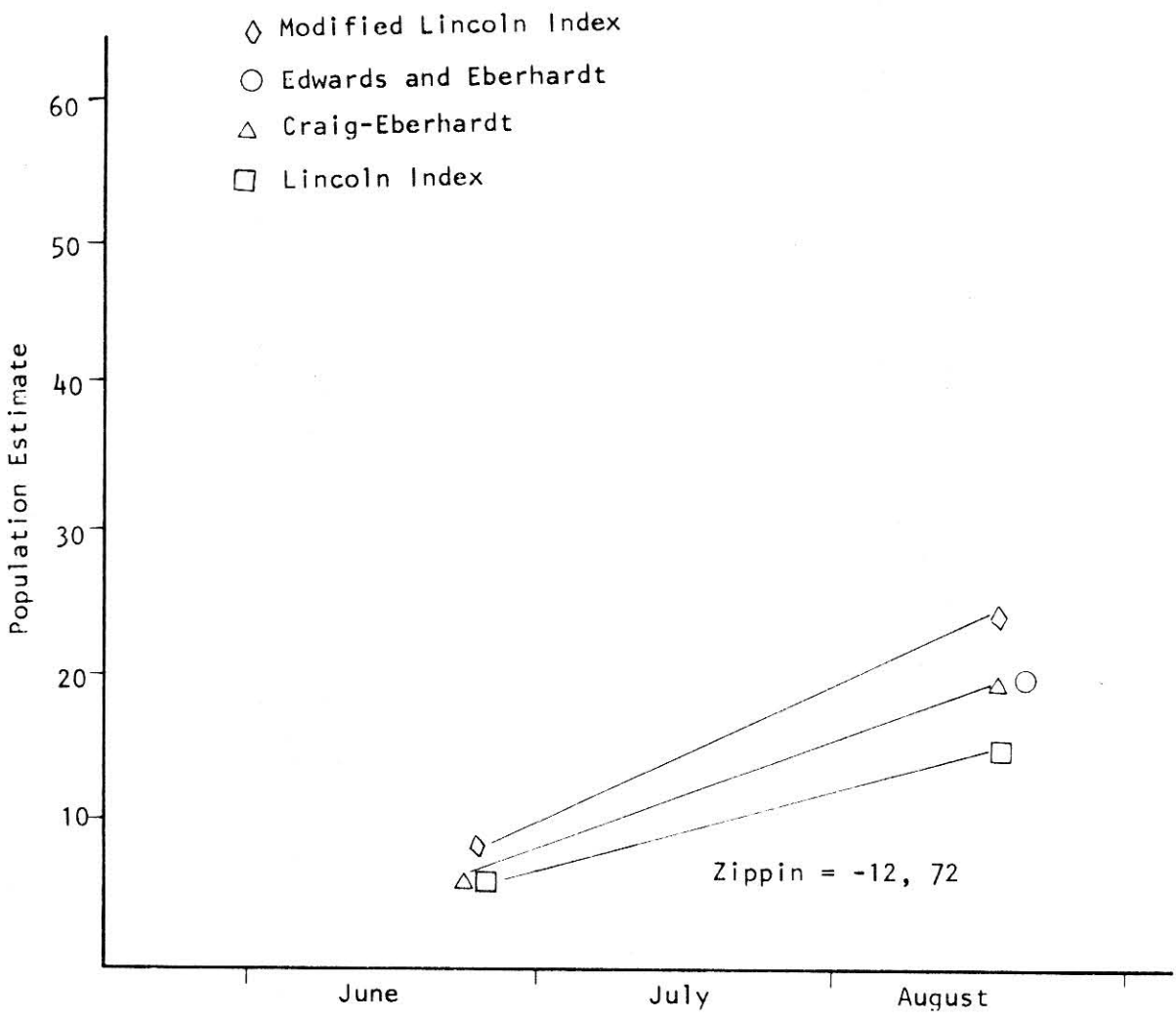

Fig. 7. Comparison of total population density estimates based on different estimating techniques, and total number of individual small mammals captured, by species, at COTTONWOOD.

area. This was also true of the northern pocket gopher (*Thomomys talpoides*); only one individual was resident on the snap-trap grid, and active gopher burrows were rare on the Cottonwood Site as a whole.

Estimates of total numbers of small mammals on both grids and of biomass densities, are given by species in Tables 5 through 8. The deer mouse and (on the live-trap grid) also the prairie vole are the principal contributors to total small mammal biomass.

Normal seasonal increases in populations of these species occurred between sampling periods and are reflected in the increase in population estimates for the live-trap grid (Fig. 7). The pattern of removal of individuals on the snap-trap grid was such that no realistic estimates of population size could be obtained, but there is no reason to think that the pattern differed from that found on the live-trap grid.

Summary. Our best estimate of the biomass of small mammals at Cottonwood during the first trapping period is *114.8 g/ha*. Our best estimate of the biomass of small mammals at Cottonwood during the second trapping period is *181.2 g/ha*.

Jackrabbit transects. Ten one-mile transects were walked during both collection periods. Three white-tailed jackrabbits, *Lepus townsendii*, were observed on these transects during the first period, giving a value of 0.3 jackrabbits per transect. No jackrabbits were observed on the transects during the second collection period.

Dickinson

Small mammals collected on the Dickinson Site during both sampling periods included the following:

Table 5. Snap-trap grid--Cottonwood 1 (13 June through 22 June 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Zippin	Average for Class	Total Biomass Estimate (g) Zippin	Biomass Density (g/ha) Zippin
Peromyscus maniculatus	6.0			
♂♂ adult	2.0	19.65	39.3	12.1
subadult	2.0	14.25	28.5	8.8
♀♀ adult	1.0	21.60	21.6	6.7
subadult	1.0	13.50	13.5	4.2
Total			102.9	31.8
Peromyscus leucopus	2.0			
♂♂ subadult	1.0	16.10	16.1	5.0
♀♀ adult	1.0	17.40	17.4	5.3
Total			33.5	10.3
Spermophilus tridecemlineatus	2.0			
♂♂ adult	2.0	177.20	354.4	109.4
Thomomys talpoides	1.0			
♂♂ subadult	1.0	60.80	60.8	18.8
Reithrodondomys montanus	1.0			
♂♂ adult	1.0	9.70	9.7	3.0
TOTAL			561.3	173.3

Table 6. Snap-trap grid--Cottonwood 2 (13 August through 22 August 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Zippin	Average for Class	Total Biomass Estimate (g) Zippin	Biomass Density (g/ha) Zippin
Peromyscus maniculatus	5.0			
♂♂ adult	1.0	20.20	20.2	6.2
juvenile	1.0	7.60	7.6	2.4
♀♀ subadult	1.0	19.20	19.2	5.9
juvenile	2.0	7.50	15.0	4.6
TOTAL			62.0	19.1

Table 7. Live-trap grid--Cottonwood 1 (14 June through 23 June 1970).

Species Sex-Age Class	Live Weight (g)			
	Estimate of Total Numbers C-E[a/]	Average for Class	Total Biomass Estimate (g) C-E[a/]	Biomass Density (g/ha) C-E[a/]
Microtus ochrogaster	3.0			
♂♂ subadult	1.0	33.94	33.9	10.5
♀♀ adult	2.0	44.80	89.6	27.6
Total			123.5	38.1
Peromyscus maniculatus	2.0			
♂♂ subadult	2.0	14.73	29.5	9.1
Peromyscus leucopus	1.0			
♂♂ adult	1.0	29.29	29.3	9.0
TOTAL			182.3	56.2

a/ Craig-Eberhardt estimate.

Table 8. Live-trap grid--Cottonwood 2 (14 August through 23 August 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers C-E[a/]	Average for Class	Total Biomass Estimate (g) C-E[a/]	Biomass Density (g/ha) C-E[a/]
Peromyscus maniculatus	12.0			
♂♂ adult	5.0	21.80	109.0	33.6
subadult	1.0	20.20	20.2	6.2
♀♀ adult	2.0	20.75	41.5	12.8
subadult	2.0	19.20	38.4	11.9
juvenile	2.0	7.50	15.0	4.6
Total			224.1	69.1
Microtus ochrogaster	6.0			
♂♂ adult	2.0	32.73	65.5	20.2
subadult	2.0	29.20	58.4	18.0
♀♀ subadult	2.0	31.16	62.3	19.2
Total			186.2	57.4
Spermophilus tridecemlineatus	1.0			
♂♂ adult	1.0	177.20	177.2	54.7
TOTAL			587.5	181.2

a/ Craig-Eberhardt estimate.

Snap-trap grid: *Spermophilus tridecemlineatus*, *Thomomys talpoides*, *Perognathus fasciatus*, *Peromyscus maniculatus*, *Onychomys leucogaster*, *Microtus pennsylvanicus*, *Zapus hudsonius*.

Live-trap grid: *Spermophilus tridecemlineatus*, *Perognathus fasciatus*, *Peromyscus maniculatus*, *Onychomys leucogaster*, *Microtus pennsylvanicus*.

Off-grid collections: *Lepus townsendii*, *Spermophilus tridecemlineatus*, *Thomomys talpoides*, *Perognathus fasciatus*, *Peromyscus maniculatus*, *Microtus pennsylvanicus*.

Other mammals taken or observed in the general vicinity of the site: *Sorex cinereus*, *Lagurus curtatus*, *Vulpes vulpes*, *Mustela frenata*, *Mephitis mephitis*.

As was true at Cottonwood, the deer mouse (*Peromyscus maniculatus*) dominated the catch at the Dickinson Site, with a species of vole (*Microtus*) also important (Fig. 8). However, on the Dickinson Site only the meadow vole (*M. pennsylvanicus*) was found; moreover, no *M. ochrogaster* populations were located in off-grid trapping operations. Given the nature of the habitats on the grids (upland grassland), one would have expected the prairie vole (*M. ochrogaster*), as was true at Cottonwood. On the other hand, in the absence of *M. ochrogaster*, *M. pennsylvanicus* may occupy a more xeric grassland habitat (Findley 1954 and Getz 1963). Further study of the Dickinson Site will be required to determine whether or not the relative frequencies of the two vole species change from year to year, and whether or not such change may affect interspecific habitat segregation. Bailey (1926) long ago noted that the subspecies occupying this portion of North Dakota (*M. p. insperatus*) differed from typical *pennsylvanicus* in utilization of a more arid habitat.

Dickinson, North Dakota	First Period		Second Period	
	Live*	Snap	Live*	Snap
Peromyscus maniculatus	7	20	8	15
Spermophilus tridecemlineatus	6	3	7	6
Perognathus fasciatus	2	4	1	2
Microtus pennsylvanicus	15	2	0	5
Onychomys leucogaster	1	1	0	1
Zapus hudsonius	0	0	0	1
Thomomys talpoides	0	0	0	1
	31	30	16	31

* Grid size, 1.1 h.

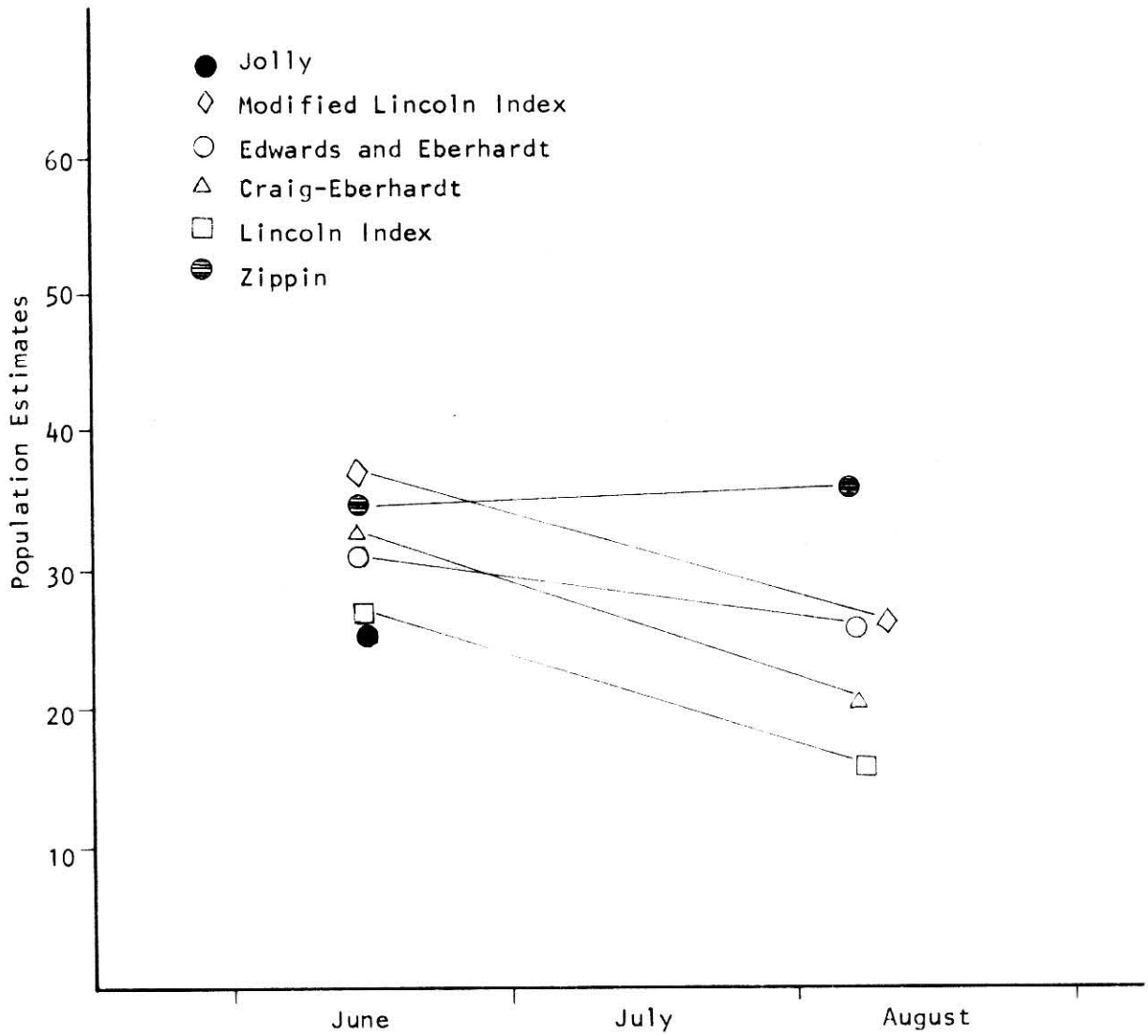

Fig. 8. Comparison of total population density estimates based on different estimating techniques, and total numbers of individual small mammals captured, by species, at DICKINSON.

The Dickinson Site was also unique in that it supported a larger population of the thirteen-lined ground squirrel (*S. tridecemlineatus*) than did the other sites we investigated. The olive-backed pocket mouse (*Perognathus fasciatus*) also occurred at Dickinson, although it was not taken at Cottonwood, which is also within the species geographic range.

Pocket gophers (*Thomomys talpoides*) were, as at Cottonwood, rare. No recent pocket gopher activity was observed on either the live-trap or snap-trap grids, although some old sign was evident on the live-trap grid. During the first collection period, one individual of *T. talpoides* was trapped near the top of the prominence between the two IBP grids, and another individual was taken in sandy soil along the road to the north of the grids. During the second trapping period, one *T. talpoides* was taken in a grid snap-trap following a rain; this trap was near the interstate right-of-way. Also, during the second trapping period, 15 *Thomomys talpoides* were removed from a vacant lot of approximately 1.5 ha at the northwestern edge of Dickinson. We crudely estimated a density of 10 *Thomomys* per hectare in disturbed grassland habitat in the vicinity of Dickinson.

Because the live-trap grid at this site was smaller (1.1 as opposed to 3.24 ha) than the standard IBP grid, and because Dickinson is a third-order site, biomass estimates based on it are not reported here in detail. The grid was located within an irregularly shaped, ungrazed exclosure of approximately four acres. Also, toward the end of the second trapping period, the live-traps were raided on several nights by a long-tailed weasel, *Mustela frenata*, which killed and ate the occupants of the traps.

Total numbers of individuals of each species taken and population estimates based on the live-trapping are shown in Fig. 8.

In the first trapping period at Dickinson, the species composition of animals taken on the live-trap grid was exactly the same as that taken on the snap-trap grid. One point of interest is that the population of *Microtus pennsylvanicus* was relatively high on the live-trap grid at the beginning of the trapping period, and thereafter, it declined until no more *Microtus* were taken on the ninth and tenth days of trapping (22 and 23 June). No *Microtus pennsylvanicus* were taken until the eighth day (23 June) of trapping on the snap-trap grid when the only two individuals were caught.

In the second trapping period at Dickinson, four species of small rodents were taken on the snap-trap grid that were not recorded from the live-trap grid. Species trapped on the snap-trap grid, but not on the live-trap grid, were *Microtus pennsylvanicus* (five specimens taken), *Thomomys talpoides* (one), *Zapus hudsonius* (one), and *Onychomys leucogaster* (one).

Estimates of total numbers of small mammals on the snap-trap grid, and of biomass densities, are given by species in Tables 9 and 10. Because of its relatively large body size, *S. tridecemlineatus* is the greatest single contributer to small mammal biomass density, with *P. maniculatus* next. A relatively high population of ground squirrels was present on the live-trap grid, and total biomass density was estimated as 2,464 g/ha in the first, and 975.7 g/ha in the second sampling period.

Seasonal changes are difficult to interpret; little change between sampling periods was apparent on the snap-trap grid, and the apparent decrease on the live-trap grid in the second sample may be attributable to the activities of the trap-robbing weasel (see above).

Summary. Our best estimate of the biomass of small mammals at Dickinson during the first trapping period is *295.0 g/ha*. Our best estimate of the

Table 9. Snap-trap grid--Dickinson 1 (16 June through 25 June 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Zippin	Average for Class	Total Biomass Estimate (g) Zippin	Biomass Density (g/ha) Zippin
Peromyscus maniculatus	22.0			
♂♂ adult	7.0	19.93	139.5	43.1
subadult	5.0	14.45	72.3	22.3
juvenile	4.0	8.25	33.0	10.2
♀♀ adult	2.0	19.40	38.8	12.0
juvenile	4.0	8.27	33.1	10.2
Total			316.7	97.8
Spermophilus tridecemlineatus	4.0			
♂♂ adult	3.0	122.90	368.7	113.8
♀♀ adult	1.0	128.20	128.2	39.6
Total			496.9	153.4
Perognathus fasciatus	8.0			
♂♂ adult	2.0	12.50	25.0	7.7
♀♀ adult	2.0	9.70	19.4	6.0
subadult	4.0	6.90	27.6	8.5
Total			72.0	22.2
Microtus pennsylvanicus	2.0			
♂♂ adult	1.0	32.90	32.9	10.2
♀♀ subadult	1.0	21.10	21.1	6.5
Total			54.0	16.7
Onychomys leucogaster	1.0			
♀♀ adult	1.0	16.00	16.0	4.9
TOTAL			955.6	295.0

Table 10. Snap-trap grid--Dickinson 2 (2 August through 11 August 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Zippin	Average for Class	Total Biomass Estimate (g) Zippin	Biomass Density (g/ha) Zippin
Peromyscus maniculatus	17.0			
♂♂ adult	2.0	15.80	31.6	9.7
subadult	11.0	14.87	163.6	50.5
♀♀ adult	1.0	19.00	19.0	5.9
subadult	2.0	17.00	34.0	10.5
juvenile	1.0	8.27	8.3	2.6
Total			256.5	79.2
Spermophilus tridecemlineatus	8.0			
♂♂ adult	6.0	87.60	525.6	162.2
♀♀ subadult	2.0	78.90	78.9	24.4
Total			604.5	186.6
Microtus pennsylvanicus	5.0			
♂♂ adult	3.0	29.80	89.4	27.6
juvenile	1.0	10.50	10.5	3.2
♀♀ juvenile	1.0	12.80	12.8	4.0
Total			112.7	34.8
Thomomys talpoides	2.0			
♀♀ juvenile	2.0	84.40	168.8	52.1
Perognathus fasciatus	2.0			
♀♀ adult	1.0	11.40	11.4	3.5
juvenile	1.0	6.00	6.0	1.9
Total			17.4	5.4
Zapus hudsonius	1.0			
♂♂ subadult	1.0	13.70	13.7	4.2
Onychomys leucogaster	1.0			
♂♂ subadult	1.0	22.80	22.8	7.0
TOTAL			1196.4	369.3

biomass of small mammals at Dickinson during the second trapping period is *369.3 g/ha*. On the exclosure, where *Spermophilus* were more abundant, total biomass was considerably higher.

Jackrabbit transects. Ten one-mile transects were walked in the vicinity of the grids during the first collection period, but none was walked during the second period. No jackrabbits were observed on any of the transects. Three *Lepus townsendii* were observed in the general area of the Dickinson Site; one was approximately two miles north of the grids on 11 June 1970, another was found dead on the road one mile north of the grids on the evening of 18 June 1970, and the third was seen dead on the road just north of the IBP grids on the morning of 20 June 1970.

Bridger

Small mammals collected on the Bridger Site during the single mid-season sample there included the following:

Snap-trap grid: *Sorex cinereus*, *Thomomys talpoides*, *Microtus montanus*.

Live-trap grid: *Thomomys talpoides*, *Clethrionomys gapperi*, *Microtus montanus*, *Zapus princeps*.

Off-grid collections: *Thomomys talpoides*, *Peromyscus maniculatus*, *Microtus montanus*.

Other mammals taken or observed in the general vicinity of the site: *Lasionycteris noctivagans*, *Lepus americanus*, *Eutamias amoenus*, *Tamiasciurus hudsonicus*, *Neotoma cinerea*, *Ursus americanus*.

Small mammal populations of the Bridger Site differed drastically from those of Osage, Cottonwood, and Dickinson in that they were typical of montane meadows, rather than of the Great Plains. On the relatively

undisturbed live-trap grid, the montane vole (*Microtus montanus*) was the dominant species, and northern pocket gophers, while present, were not common (Fig. 9). In contrast, on the more heavily grazed and disturbed snap-trap grid, pocket gophers were much more abundant (Table 11 and 12), although montane voles were about as common as on the live-trap grid.

Summary. Our minimal estimate of the biomass of small mammals in undisturbed grassland at Bridger during the mid-season trapping period is *358.1 g/ha*; our best guess is that biomass density was about *800 g/ha*.

On more disturbed grassland, where gopher populations were high, our minimal estimate is *2375.8 g/ha*; our best guess is that biomass density was about *3000 g/ha*.

Jackrabbit transects. No transects were run at this site because jackrabbits are not known to occur here, and because of the difficult circumstances involved with operations at the site. Five specimens of snowshoe hare (*Lepus americanus*) were collected in forested areas in the general vicinity of the grids.

Pocket gopher census. Extensive pocket gopher activity was noted on the snap-trap grid at Bridger. Thirty-nine individuals, many of them immature, were trapped aboveground in the snap-traps used in the regular grid census. An attempt was made using Macabee gopher traps to catch all individuals between rows one and five. This effort resulted in the capture of 40 specimens. Finally, a fresh mound and plug count was made 48 hours after a rain. The following are the results of the mound census: number of mounds between rows 1 and 2, 15; 2 and 3, 16; 3 and 4, 8; 4 and 5, 27; 5 and 6, 43; 6 and 7, 47; 7 and 8, 32; 8 and 9, 40; 9 and 10, 36; 10 and 11, 32;

Bridger, Montana	Live	Snap
Microtus montanus	24	43
Thomomys talpoides	4	39
Clethrionomys gapperi	2	0
Zapus princeps	1	0
Sorex cinereus	0	1
	31	83

Bison, Montana	Snap
Microtus montanus	47
Thomomys talpoides	2

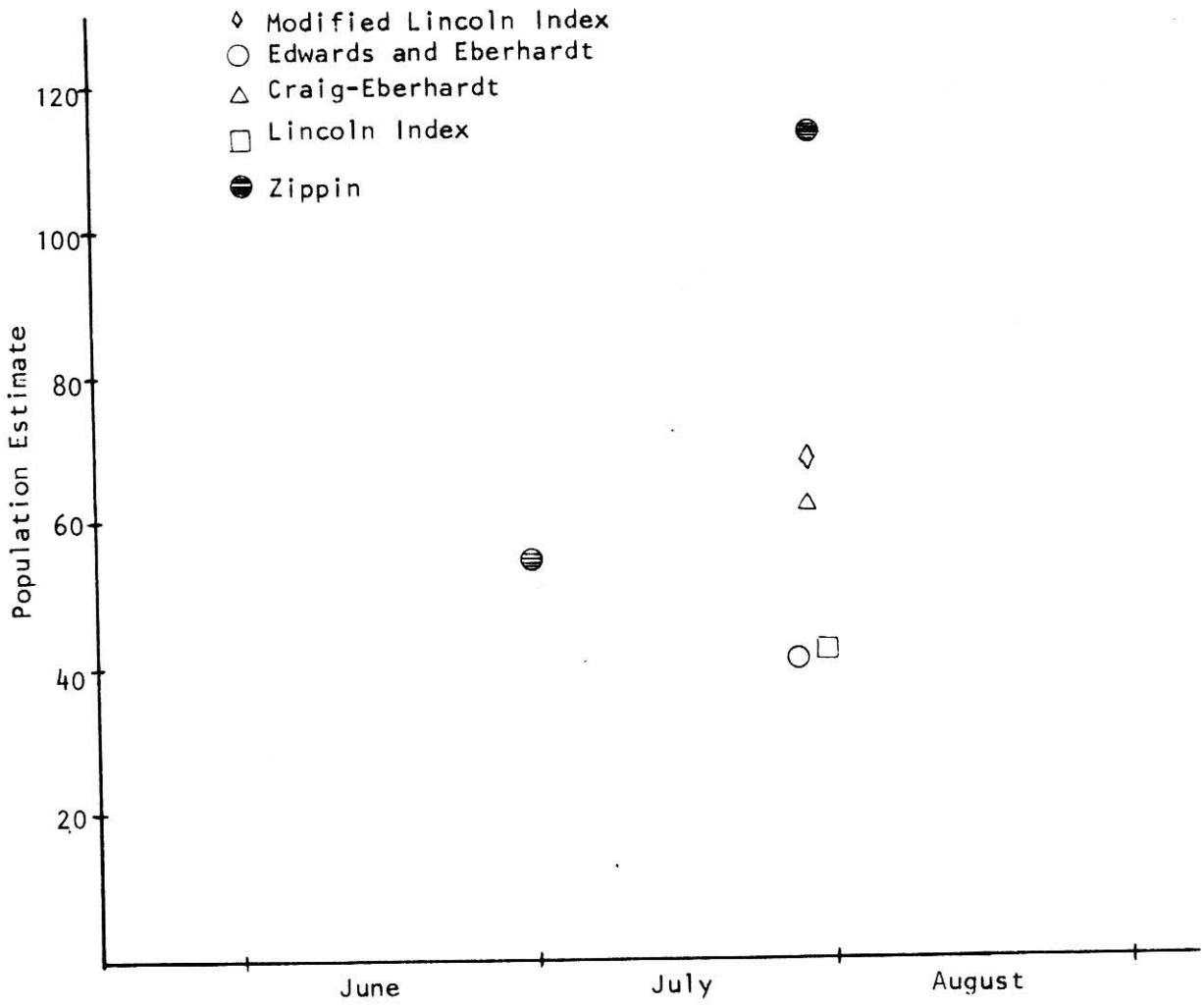

Fig. 9. Comparison of total population density estimates based on different estimating techniques, and total number of individual small mammals captured, by species, at BRIDGER and BISON.

Table 11. Snap-trap grid--Bridger (15 July through 26 July 1970).

Species Sex-Age Class	Estimate Total Numbers Zippin	Live Weight (g) Average for Class	Live Weight (g) Total Biomass Estimate (g) Zippin	Biomass Density (g/ha) Zippin
Thomomys talpoides	120.0[a/]			
♂♂ adult	18.0	83.60	1504.8	464.4
subadult	24.0	47.07	1129.7	348.7
juvenile	6.0	43.20	259.2	80.0
♀♀ adult	29.0	69.80	2024.2	624.7
subadult	37.0	42.44	1570.3	484.7
juvenile	6.0	34.40	206.4	63.7
Total			6694.6	2066.2
Microtus montanus	49.0			
♂♂ adult	7.0	39.57	277.0	85.5
subadult	9.0	14.62	131.6	40.6
juvenile	10.0	10.48	104.5	32.3
♀♀ adult	11.0	30.37	334.1	103.1
subadult	6.0	14.96	89.8	27.7
juvenile	6.0	10.40	62.4	19.3
Total			999.4	308.5
Sorex cinereus	1.0			
♀♀ adult	1.0	3.60	3.6	1.1
TOTAL			7697.6	2375.8

[a/] Estimate based upon total number caught plus mound counting census described by Reid, Hansen, and Ward (1966). This estimate is probably low and could be as high as 175, with a corresponding biomass density of 3013.5 g/ha for the gopher population. This in turn would increase the total small mammal biomass density to 3323.1 g/ha.

Table 12. Live-trap grid--Bridger (15 June through 26 July 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Biomass C-E[a/]	Average for Class	Total Biomass Estimate (g) C-E[a/]	Biomass Density (g/ha) C-E[a/]
Microtus montanus	43.0			
♂♂ adult	7.0	39.57	277.0	85.5
subadult	8.0	14.62	117.0	36.1
juvenile	9.0	10.48	94.3	29.1
♀♀ adult	9.0	30.37	273.3	84.4
subadult	5.0	14.96	74.8	23.1
juvenile	5.0	10.40	52.0	16.0
Total			888.4	274.2
Thomomys talpoides	4.0[b/]			
♂♂ subadult	1.0	47.07	47.1	14.5
♀♀ adult	1.0	69.80	69.8	21.6
subadult	1.0	42.44	42.4	13.1
juvenile	1.0	34.40	34.4	10.6
Total			193.7	59.8
Clethrionomys gapperi	2.0			
♂♂ subadult	1.0	21.00	21.0	6.5
♀♀ subadult	1.0	21.00	21.0	6.5
Total			42.0	13.0
Zapus princeps	1.0			
♂♂ adult	1.0	36.00	36.0	11.1
TOTAL			1160.1	358.1

a/ Craig-Eberhardt estimate.

b/ Estimate based only on gophers entering live-traps. This estimate is surely low, and could be as high as 20 to 40 with a corresponding biomass density of 299.0 to 598.0 g/ha. This in turn would increase the total small mammal biomass density to 597.3 to 896.3 g/ha.

11 and 12, 43. Using the conversion of 8.2 signs per pocket gopher (Reid, Hanson, and Ward 1966) an estimate of 41 gophers remaining on the grid is obtained. Adding these estimates together, a result of 120 pocket gophers is obtained for the IBP grid. However, the estimate of only 41 gophers remaining on the grid appears somewhat low because this many animals were taken between rows one and five.

If the mound-count technique is used only for the data available from between rows one and five, an estimate of eight individuals still remaining in this area is obtained, giving an overall figure of 48 (not counting those individuals taken in snap-traps). If this area is representative of the remainder of the grid, an estimate of 84 individuals is obtained for the area from rows 5 to 12. Using these latter estimates plus the 39 individuals taken in snap-traps, an estimate of 171 pocket gophers living on the grid is obtained.

Bison

Small mammals collected on the Bison Site during the single mid-season sample there included the following:

Snap-trap grid: *Thomomys talpoides*, *Microtus montanus*.

Off-grid collection: *Peromyscus maniculatus*.

Other mammals taken or observed in the general vicinity of the site: *Sorex vagrans*, *Sylvilagus nuttallii*, *Microtus pennsylvanicus*, *Canis latrans*, *Taxidea taxus*, *Mustela erminea*.

Herds of several species of large herbivores are maintained on the National Bison Range: *Cervus canadensis*, *Odocoileus virginianus*, *Odocoileus hemionus*, *Antilocapra americana*, *Bison bison*, *Ovis canadensis*.

Because Bison is a third-order site, no live-trap grid was set up there. As at the Bridger Site, the montane vole (*M. montanus*) is the principal species in the undisturbed Palouse grassland of this intermontane valley area, with *T. talpoides* also present (Fig. 9, Table 13).

Several gopher mounds were observed on the snap-trap grid at the beginning of the trapping period. Trapping with Macabee traps resulted in the removal of two *Thomomys talpoides*, after which no fresh pocket gopher activity was noted on the grid. It is therefore assumed that these gophers represented the resident population on the grid.

Summary. Our best estimate of the biomass of small mammals at Bison is *397.4 g/ha*.

Jackrabbit transects. Six one-mile transects were walked at this site, but no jackrabbits were observed. Several specimens of the mountain cottontail, *Sylvilagus nuttallii*, were observed at night along the roads on the Bison Range.

DISCUSSION AND CONCLUSIONS

Numerical and Biomass Density

A great range of small mammal population densities was encountered at the various sites, from a maximum which probably approached 3000 g/ha (disturbed grassland, Bridger) to a minimum of 114.8 g/ha (lightly grazed grassland, Cottonwood), a 30-fold difference.

High densities were associated with a dominance of a single abundant species, either pocket gopher (*Thomomys*), ground squirrel (*Spermophilus*), or vole (*Microtus*). Such high densities occurred on either ungrazed, undisturbed sites (Osage, Dickinson), or on grazed, disturbed sites (snap-trap grid,

Table 13. Snap-trap grid--Bison (27 June through 7 July 1970).

Species Sex-Age Class	Live Weight (g) Estimate of Total Numbers Zippin	Average for Class	Total Biomass Estimate (g) Zippin	Biomass Density (g/ha) Zippin
Microtus montanus	55.0			
♂♂ adult	7.0	28.07	196.5	60.6
subadult	19.0	16.89	320.9	99.0
♀♀ adult	12.0	29.29	351.5	108.5
subadult	15.0	16.58	248.7	76.8
juvenile	2.0	13.05	26.1	8.1
Total			1143.7	353.0
Thomomys talpoides	2.0			
♂♂ adult	1.0	85.60	85.6	26.4
♀♀ adult	1.0	58.20	58.2	18.0
Total			143.8	44.4
TOTAL			1287.5	397.4

Bridger) (Table 14). This suggests that annual changes in population density may greatly influence small mammal standing crop biomass. Vole populations are known to fluctuate greatly ("cycle") from year to year in many places (Hoffman 1958), and there was field evidence (see above) that voles in the vicinity of Cottonwood, and perhaps Dickinson, had been abundant a short time earlier; this was also true in southeastern Montana, at a non-IBP site in Carter County. The high density of voles at Osage may also be interpreted as a "cyclic" peak, and the decline observed there between the first and second sampling periods may continue.

Pocket gophers and thirteen-lined ground squirrel densities also may change markedly in the course of several years, in response to vegetational succession or land use patterns, and it would be unsafe to assume that the densities observed at the various sites in 1970 are typical and stable.

Regardless of these variables, small mammal standing crop biomass density on the Comprehensive Network Sites studied probably never exceeded 0.1 g/m^2 dry weight, and in most cases was much less (Table 15). This represents a small proportion, compared to producer biomass at the sites, although it is of the same order of magnitude as other classes of consumer organisms in the grasslands.

Effect of Shifting Traps on Capture

In no case did shifting of traps after five days appear to have any influence on captures. We conclude that shifting traps did not expose any new animals to capture, probably because the magnitude of the shift in location was small relative to the daily range of movements of individual small mammals.

Table 14. Species contribution to biomass density (arranged in descending order from greatest to least total density).

Site, Grid, Sample	Total	Biomass Density, g/ha, and % of Total			
		Thomomys	*Microtus*	*Spermophilus*	Other
Dickinson, live, 1	2464.0[a/]	----	405.0(16%)	1863.0(76%)	196.0 (8%; 3 species)
Bridger, snap	2375.8[b/]	2066.2(87%)	308.5(13%)	----	1.1(<1%; 1 species)
Osage, live, 1	1940.3	----	1643.4(85%)	----	296.9(15%; 3 species)
Osage, snap, 1	1353.0	----	1255.9(93%)	----	97.1 (7%; 4 species)
Osage, live, 2	1273.3	----	1064.9(84%)	----	208.4(16%; 3 species)
Dickinson, live, 2	975.7[a/]	----	----	831.2(85%)	144.5(15%; 2 species)
Bridger, live	~800	~500 (63%)	274.2(34%)	----	24.1 (3%; 2 species)
Bison, snap	397.4	44.4(11%)	353.0(89%)	----	----
Dickinson, snap, 2	369.3	52.1(14%)	34.8 (9%)	186.6(51%)	95.8(26%; 4 species)
Dickinson, snap, 1	295.0	----	16.7 (6%)	153.4(52%)	124.9(42%; 3 species)
Osage, snap, 2	243.1	----	193.0(79%)	18.4 (8%)	31.7(13%; 4 species)
Cottonwood, live, 2	181.2	----	57.4(32%)	54.7(30%)	69.1(38%; 1 species)
Cottonwood, snap, 1	173.3	18.8(11%)	----	109.4(63%)	45.1(26%; 3 species)
Cottonwood, live, 1	56.2	----	38.1(68%)	----	18.1(32%; 2 species)
Cottonwood, snap, 2	19.1	----	----	----	19.1(100%; 1 species)

[a/] Based on irregular grid; see text.
[b/] Minimum estimate; see text.

Table 15. Average small mammal standing crop biomass density by site and date.

Site	Date	Wet Weight g/ha	Dry Weight g/ha	Dry Weight g/m^2
Osage	May 24-June 5	1591.4	477.4	0.048
Osage	August 23-September 1	1121.7	336.5	0.034
Cottonwood	June 13-June 23	114.8	34.4	0.003
Cottonwood	August 14-August 23	181.2	54.4	0.005
Dickinson	June 16-June 25	295.0	88.5	0.009
Dickinson	August 2-August 11	369.3	110.8	0.011
Bridger snap-trap grid	July 15-July 26	2375.8[a/]	712.7	0.071
Bridger live-trap grid	July 15-July 26	358.1[a/]	107.4	0.011
Bison	June 27-July 7	397.4	119.2	0.012

[a/] Minimal estimate; see text.

Effect of Grazing on Small Mammal Populations

Due to manpower and time limitations, it was not possible to sample both heavily-grazed and lightly-grazed (or ungrazed) treatments at the sites, and we decided to concentrate on the latter treatment. However, observations and limited trapping indicate that on most sites small mammal populations are at much lower densities on grazed areas, compared to ungrazed or lightly-grazed areas. The only exception to this may occur when grazing results in vegetational changes that favor pocket gophers or ground squirrels.

Species Diversity

The use of uniform live- and snap-trap grids at the various Comprehensive Network Sites from Jornada, in the south, to Dickinson and Bison in the north, provided an opportunity to examine latitudinal variation in species diversity within the Grassland Biome. Species diversity indices were calculated from the approximation of the Shannon formula proposed by Lloyd, Zar, and Karr (1968): $H' \approx \frac{c}{N}(N\log_{10}N - \Sigma n_i \log_{10} n_i)$, where c = 3.3219, so that the diversity index is expressed in bits per individual. In addition to the Comprehensive Network Sites, data from two other areas were included. These include a site in the Long Pine Hills, 5 miles north and 3.5 miles west of Camp Crook, *in* Carter County, Montana, and Llano de las Flores, Oaxaca, Mexico. Both were sampled by IBP-type grid trapping, and the results are thus comparable to the Comprehensive Network Sites.

A great deal of variation is apparent in the diversity indices calculated for various live- and snap-trap grids (Fig. 10), but two points may be made. The first is that diversity indices for grassland small mammals are low, with a range from zero (one species only) to 2.64 (11 species).

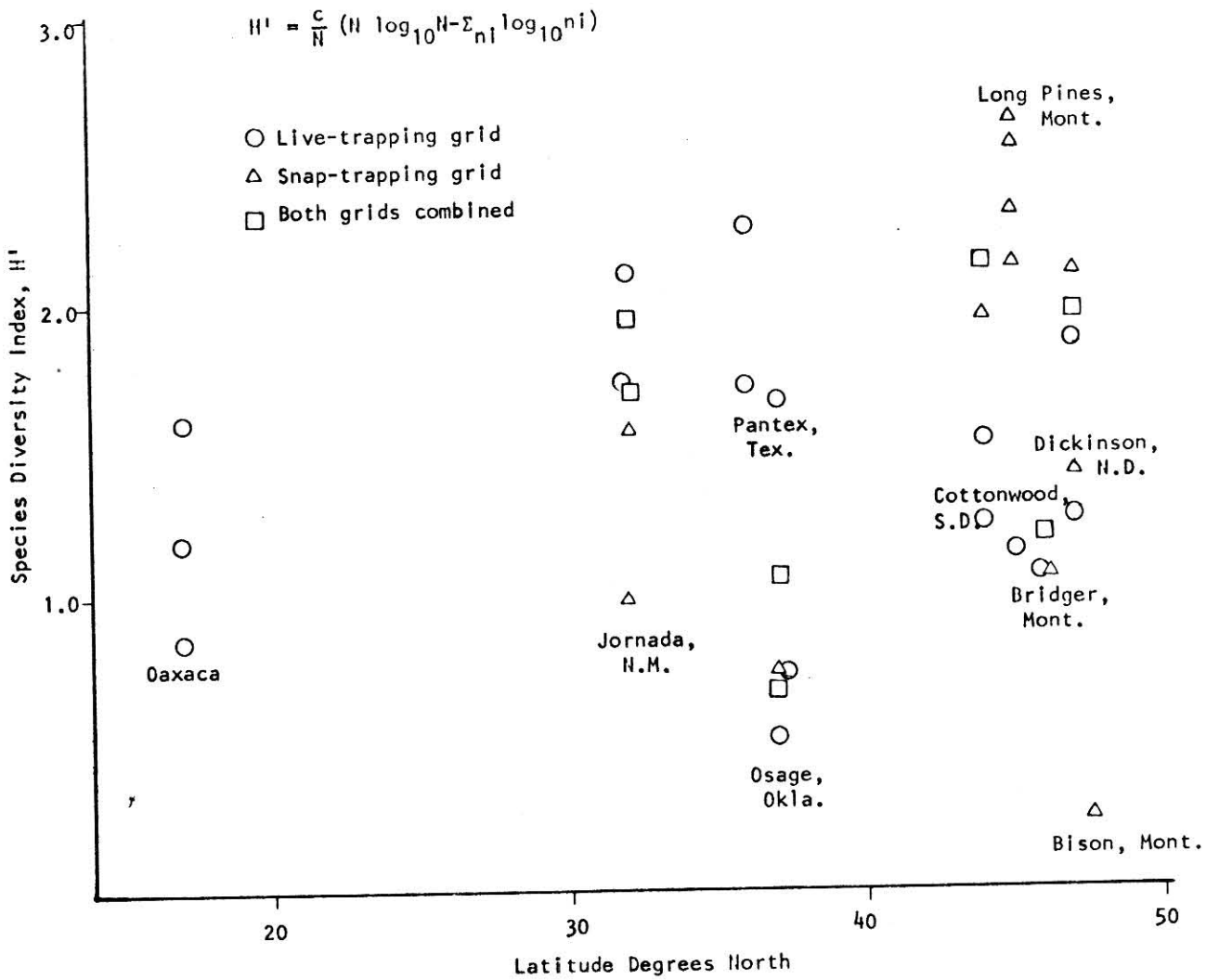

Fig. 10. Species diversity indices for small mammal populations at IBP Grassland Biome Sites (and other sites) plotted against latitude.

They are similar, however, to those for grassland birds (Tramer 1969). Secondly, there is no indication of a trend of increasing species diversity towards lower latitudes, as has often been reported for various groups (Udvardy 1969). In terms of the correlation between diversity and complexity or spatial heterogeneity of habitat, this is understandable; the grassland habitat occupied by small mammals is essentially two-dimensional and of much the same structural complexity regardless of latitude. Additional attention to species diversity in all of the various groups inhabiting the Comprehensive Network Sites ought to prove of interest.

The effect of high density of a single species at a site is also of interest. As noted above, high numerical and biomass densities at Osage, Bridger, and Dickinson were associated with dominance of a single species (vole, gopher, ground squirrel). Such single species dominance reduces the species diversity index for the sample, as shown in Fig. 11.

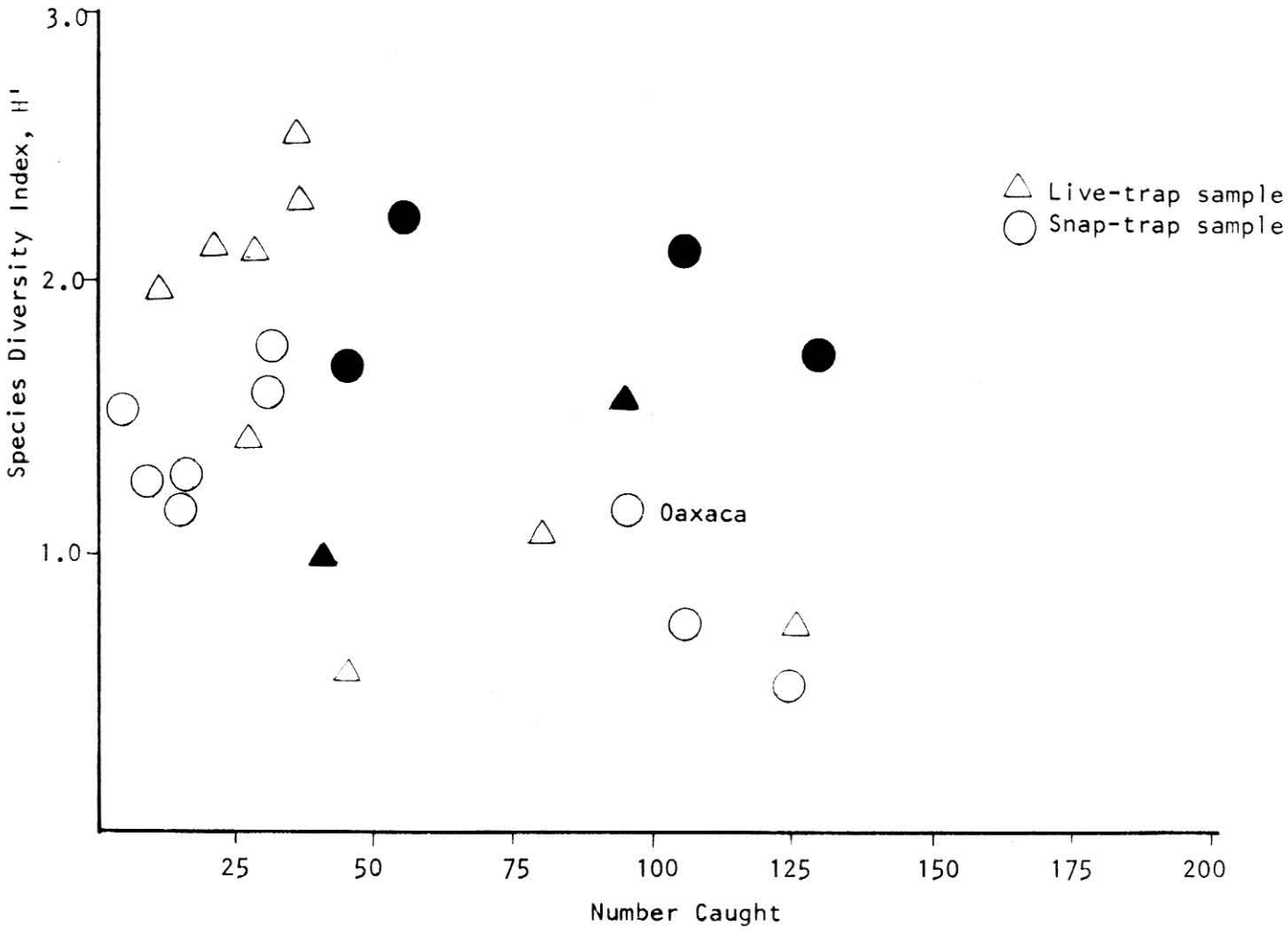

Fig. 11. Species diversity indices for small mammal populations at IBP Grassland Biome sites (and other sites) plotted against total numbers of small mammals captured at each site. Solid symbols indicate sites where heteromyid rodents predominated (Pantex and Jornada).

LITERATURE CITED

Bailey, V. 1926. A biological survey of North Dakota. I. Physiography and life zones. II. The mammals. North Amer. Fauna 49:(6):1-226.

Collins, D. 1970. Comprehensive Network Site description, BRIDGER. U.S. IBP Grassland Biome Tech. Rep. No. 38. Colorado State Univ., Fort Collins. 10 p.

Eadie, W. R. 1953. Response of *Microtus* to vegetation cover. J. Mammal. 34:263-264.

Eberhardt, L. L. 1969. Population estimates from recapture frequencies. J. Wildlife Manage. 33:28-39.

Findley, J. S. 1954. Competition as a possible limiting factor in the distribution of *Microtus*. Ecology 35:418-420.

French, N. R. 1971. Small mammal studies in the U.S. IBP Grassland Biome. Ann. Zool. Fennici 8:48-53.

Getz, L. L. 1963. A comparison of the water balance of the prairie and meadow voles. Ecology 44:202-207.

Golley, F. B. 1960. Energy dynamics of a food chain in an old-field community. Ecol. Monogr. 30:187-206.

Hansson, L. 1969. Home range, population structure and density estimates at removal catches with edge effect. Acta Theriologica 14(11):153-160.

Hoffman, R. S. 1958. The role of reproduction and mortality in population fluctuations of voles (*Microtus*). Ecol. Monogr. 28:79-109.

Jolly, G. M. 1965. Explicit estimates from capture-recapture data with both death and immigration--stochastic model. Biometrika 52:225-247.

Lewis, J. K. 1970. Comprehensive Network Site description, COTTONWOOD. U.S. IBP Grassland Biome Tech. Rep. No. 39. Colorado State Univ., Fort Collins. 26 p.

Lloyd, M., J. H. Zar, and J. R. Karr. 1968. On the calculation of information-theoretical measures of diversity. Amer. Midland Natur. 79:257-272.

Morris, M. S. 1970. Comprehensive Network Site description, BISON. U.S. IBP Grassland Biome Tech. Rep. No. 37. Colorado State Univ., Fort Collins. 23 p.

Reid, V. H., R. M. Hansen, and A. L. Ward. 1966. Counting mounds and earth plugs to census mountain pocket gophers. J. Wildlife Manage. 30:327-334.

Risser, P. G. 1970. Comprehensive Network Site description, OSAGE. U.S. IBP Grassland Biome Tech. Rep. No. 44. Colorado State Univ., Fort Collins. 5 p.

Tramer, E. J. 1969. Bird species diversity: components of Shannon's formula. Ecology 50:927-929.

Udvardy, M. D. F. 1969. Dynamic zoogeography with special reference to land animals. Vol. 18. Van Nostrand Reinhold Co., New York. 445 p.

Whitman, W. C. 1970. Comprehensive Network Site description, DICKINSON. U.S. IBP Grassland Biome Tech. Rep. No. 40. Colorado State Univ., Fort Collins. 15 p.

Zippin, C. 1956. On evaluation of the removal method of estimating animal populations. Biometrika 12:163-189.

APPENDIX I

AMPHIBIANS AND REPTILES COLLECTED ON OR NEAR IBP GRASSLAND COMPREHENSIVE NETWORK SITES IN SUMMER 1970

Osage

ECB 1736	*Rana pipiens* (Leopard Frog)
ECB 1740	*Bufo cognatus* (Plains Toad)
ECB 1670	*Eumeces obsoletus* (Sonoran Skink)
ECB 1741	*Lampropeltis gegulus holbrooki* (Speckled King Snake)
ECB 1702	*Sistrurus catenatus tergeminus* (Massasagua)
ECB 1735	*Sistrurus catenatus tergeminus* (Massasagua)
AC 921	*Sistrurus catenatus tergeminus* (Massasagua)
ECB 1667	*Thamnophis sirtalis parietalis* (Red-sided Garter Snake)
ECB 1671	*Terrapene ornata ornata* (Ornate Box Turtle)
RWT 1795	*Terrapene ornata ornata* (Ornate Box Turtle)

Cottonwood

RWT 2053	*Thamnophis radix haydeni* (Plains Garter Snake)

Dickinson

AC 702	*Ambystoma tigrinum melanostictum* (Tiger Salamander)
AC 916	*Pseudacris triseriata maculata* (Western Striped Frog)
JRC 1363	*Rana pipiens* (Leopard Frog)
JRC 1364	*Rana pipiens* (Leopard Frog)
JRC 1365	*Rana pipiens* (Leopard Frog)
AC 913	*Scaphiopus bombifrons* (Plains Spadefoot Toad)
AC 914	*Scaphiopus bombifrons* (Plains Spadefoot Toad)
AC 915	*Scaphiopus bombifrons* (Plains Spadefoot Toad)

Bison

HHG 1773	*Ambystoma macrodactylum columbianum* (Long-tailed Salamander)
HHG 1753	*Thamnophis sirtalis parietalis* (Red-sided Garter Snake)
HHG 1754	*Crotalus viridis viridis* (Prairie Rattlesnake)
HHG 1772	*Crotalus viridis viridis* (Prairie Rattlesnake)

APPENDIX II

Field Data Sheets

Live-Trap Data

Small mammal live-trapping data were collected in 1970 at the Bridger, Cottonwood, Dickinson, and Osage Sites. These data are stored as Grassland Biome data sets A2U1003, A2U1004, A2U1005, and A2U1009. Data were collected on Form NREL-10. A sample data form and an example of the data follow.

+++ EXAMPLE OF DATA +++

```
        1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890

1005AC 1306701      PEMA  0 1 0001    9        0 01 07
                    MIPE  3 1       2         6 01 06
                    PEFA  0 1 0002    3       0 01 05
                    MIPE  3 1         3       0 04 02
                    MIPE  0 1 0003 3          0 04 02
                    SPTR  0 1 0004    0       0 07 05
                    MIPE  3 1         9       6 08 04
                    MIPE  0 1 0010 6          0 08 02
                    SPTR  0 1 0020    6       0 08 02
                    PEMA  0 1 0030 3          0 09 01
                    MIPE  2 1 0040    2       0 09 02
                    MIPE  0 1 0011 3          3 09 02
                    MIPE  0 1 0012 2          0 09 03
                    MIPE  0 1 0013    9       3 09 04
1005AC 1406701      PEMA  0 3 0001    9       0 01 07
                    SPTR  0 1 0014    6       0 02 01
                    PEMA  0 3 0030 3          0 04 01
                    MIPE  3 3 0010 6          0 08 02
                    SPTR  0 1 0021 0          0 08 02
                    MIPE  0 3 0040    2       0 09 02
                    MIPE  3 3 0003 6          0 08 04
                    MIPE  0 3 0013    3       3 09 04
1005HHG1606701      PEMA  0 3 0001    0       0 07 07
                    PEMA  0 3 0020 6          0 01 07
                    SPTR  0 3 0021 3          0 04 07
                    MIPE  0 3 0013    3       3 02 04
                    MIPE  0 1 0022    2       0 09 02
1005HHG1706701      MIPE  0 1 0023    2       0 01 08
                    PEMA  0 3 0001    3       0 01 07
                    MIPE  3 1       2         0 01 06
                    MIPE  3 1       2         0 01 06
                    PEFA  0 3 0002    6       0 01 05
                    ONLE  0 1 0024 6          0 03 04
                    MIPE  0 3 0040    1       0 03 05
                    MIPE  0 3 0013    3       0 04 04
                    MIPE  0 1 0031    7       0 07 03
                    SPTR  0 3 0011 3          0 09 04
```

1005AC 1806701	PEMA	0	3	0001		3	0	01	08
	PEMA	0	3	0030	3		0	01	07
	PEMA	0	1	0032	1		2	03	04
	MIPE	3	1		2		6	03	05
	PEMA	0	1	0033	1		0	04	05
	MIPE	0	3	0013		3	0	08	01
1005AC 1906701	PEMA	0	3	0001		3	0	01	07
	PEMA	0	3	0032	1		2	02	04
	MIPE	0	3	0040		1	2	03	05
	MIPE	0	3	0023	1		0	03	05
	SPTR	0	3	0021	3		0	08	05
1005AC 2006701	MIPE	0	3	0013		3	0	01	08
	PEMA	0	3	0001		3	0	01	07
	MIPE	0	3	0040		4	2	01	06
	PEMA	0	1	0034	2		0	02	01
	PEMA	0	3	0032	2		2	02	04
	PEMA	0	3	0033	2		0	04	06
	MIPE	0	3	0031		4	0	07	02
1005AC 2106701	PEMA	0	3	0001		3	0	01	07
	MIPE	0	3	0040		4	2	01	06
	PEMA	0	3	0034	2		0	03	01
	PEMA	0	3	0032	2		1	02	03
	PEMA	0	3	0033	2		0	04	04
1005AC 2206701	PEMA	0	3	0001		3	0	01	07
	PEMA	0	1	0041	2		6	01	02
	PEMA	0	3	0033	2		0	02	01
	SPTR	0	1	0042		6	0	03	01
	PEMA	0	3	0032	2		6	04	02
	PEMA	0	3	0034	2		0	04	01
	SPTR	0	3	0004		6	0	06	06
	PEMA	0	1	0043	2		1	08	03
1005AC 2306701	PEMA	0	3	0001		3	0	01	08
	PEMA	0	3	0034	2		0	02	02
	SPTR	0	1	0044		6	0	02	08
	PEMA	0	3	0033	2		0	03	01
	PEMA	0	3	0032	2		1	04	01
	SPTR	0	3	0004		6	0	04	07
	SPTR	0	3	0014		6	0	06	02
	PEFA	0	1	0100		1	0	08	04

Snap-Trap Grid Data

Small mammal snap-trap grid data were collected in 1970 at the Bison, Bridger, Cottonwood, Dickinson, and Osage Sites. These data are stored as Grassland Biome data sets A2U1012, A2U1013, A2U1014, A2U1015, and A2U1019. 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 Day	DATE Mo.	DATE Yr.	TREATMENT	REPLICATE	PLOT SIZE	TRAP DAY	HOUR	GRID TRAP Row	GRID TRAP Col	GENUS	SPECIES	SUBSPECIES	SPECIMEN NUMBER	MARK	LENGTH	TAIL	FOOT	EAR	WEIGHT	MOLT	PARASITES	STOMACH WEIGHT	FOOD	EYE LENS	SPECIMEN	MAP REFERENCE TWN	MAP REFERENCE RNG	MAP REFERENCE S
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	20-22	23-26	27-28	29-30	31-32	33-34	35	36-42	43	44-47	48-50	51-53	54-56	57-61	62	63	64-66	67	68	69	70-72	73-75	76-77

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 Day	DATE Mo.	DATE Yr.	TREATMENT	REPLICATE	PLOT SIZE	TRAP DAY	HOUR	GRID TRAP Row	GRID TRAP Col	GENUS	SPECIES	SUBSPECIES	SPECIMEN NUMBER	MALE EXTERNAL	MALE TESTES LN	MALE TESTES WD	MALE EPIDID	MALE SEM VES	FEMALE EXTERNAL	FEMALE MAMMARY	FEMALE PUBIC SEM	FEMALE NORMAL EMBRYOS L	FEMALE NORMAL EMBRYOS R	FEMALE EMBRYO LENGTH	FEMALE RESORB L	FEMALE RESORB R	FEMALE SCARS NEW L	FEMALE SCARS NEW R	FEMALE SCARS OLD L	FEMALE SCARS OLD R	FEMALE CORPORA LUTEA L	FEMALE CORPORA LUTEA R	FEMALE TRACT WEIGHT	FEMALE CORP ALB	FEMALE SPEC SOURCE
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-1[illegible]	[illegible]-22	23-26	27-28	29-30	31-32	33-34	35	36-42	44	45-47	48-49	50	51	52	53	54	55	56	57-59	60	61	62	63	64	65	66	67	68-72	71	72

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-Respirqtion

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 +++

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890123456789
1304RWT1308702 2.76 2300
1304RWT1308702 2.76 2300
1304RWT1308702 2.76 2300 2  2                                    2
1304RWT1308702 2.76 2300    2
1304RWT1308702 2.76 2300    2
1304RWT1308702 2.76 2300
1304RWT1308702 2.76 2300
1304RWT1308702 2.76 2300
1304RWT1308702 2.76 2300                          2
1304RWT1308702 2.76 2300                                      2
1304RWT1308702 2.76 2300
1304RWT1408702 2.76 0630                        2
1304RWT1408702 2.76 0630                        2
1304RWT1408702 2.76 0630                     2                2
1304RWT1408702 2.76 0630          2
1304RWT1408702 2.76 0630
1304RWT1408702 2.76 0630
1304RWT1408702 2.76 0630    2
 304RWT1408702 2.76 0630
,304RWT1408702 2.76 0630
1304RWT1408702 2.76 0630 22
1304RWT1408702 2.76 0630                     2
1304RWT1408702 2.76 0630             2
1304RWT1408702 2.76 2300
1304RWT1408702 2.76 2300
1304RWT1408702 2.76 2300                                 2
1304RWT1408702 2.76 2300          2
1304RWT1408702 2.76 2300           2
1304RWT1408702 2.76 2300
1304RWT1408702 2.76 2300
1304RWT1408702 2.76 2300                        2
1304RWT1408702 2.76 2300                     2  2  2
1304RWT1408702 2.76 2300
1304RWT1408702 2.76 2300
1304RWT1408702 2.76 2300                                    22  2
1304RWT1508702 2.76 0830
1304RWT1508702 2.76 0830
1304RWT1508702 2.76 0830                  2                 2
1304RWT1508702 2.76 0830
1304RWT1508702 2.76 0830                        2
1304RWT1508702 2.76 0830          2                                2
1304RWT1508702 2.76 0830
1304RWT1508702 2.76 0830          2
 304RWT1508702 2.76 0830                     2
1304RWT1508702 2.76 0830                  2
1304RWT1508702 2.76 0830                        1
```

```
 304RJC1508702 2.76  20830081 2PEMA RJC01851 139 56 19 17 20.7100.511301S19E21
1404RJC1508702 2.76 02083008 12PEMA RJC0185 4 090622                          1
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330        2
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330                2
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330
1304RWT1508702 2.76 2330
1304RWT1608702 2.76 0900
1304RWT1608702 2.76 0900
1304RWT1608702 2.76 0900
1304RWT1608702 2.76 0900
1304RWT1608702 2.76 0900                                    2
1304RWT1608702 2.76 0900
1304RWT1608702 2.76 0900    2         2
1304RWT1608702 2.76 0900  2                   2
1304RWT1608702 2.76 0900  2       2     2     2       2
1304RWT1608702 2.76 0900
1304RWT1608702 2.76 0900        2     2  2
1304RWT1608702 2.76 0900           2
1304RWT1608702 2.76 2245
1304RWT1608702 2.76 2245     2
1304RWT1608702 2.76 2245    2                                 2
1304RWT1608702 2.76 2245        2                                 2
1304RWT1608702 2.76 2245                              2
1304RWT1608702 2.76 2245
1304RWT1608702 2.76 2245
1304RWT1608702 2.76 2245        2
1304RWT1608702 2.76 2245
1304RWT1608702 2.76 2245
1304RWT1608702 2.76 2245
1304RJC1708702 2.76 0815 1  2  2     2
1304RJC1708702 2.76 0815                  2
1304RJC1708702 2.76 0815                  2                       2
1304RJC1708702 2.76 0815           2  2  2                             2
1304RJC1708702 2.76 0815           2  2                    2  2
1304RJC1708702 2.76 0815    2                             2
1304RJC1708702 2.76 0815 2                2     2  2
1304RJC1708702 2.76 0815 2                2  2     2  22
1304RJC1708702 2.76 0815 2     22 22 2     2        2
1304RJC1708702 2.76 0815 2        2  2  2  2     2  2  2
1304RJC1708702 2.76 0815        2         2        2
1304RJC1708702 2.76 0815     22    2  2              2
```

```
1204RWT1708702 2.76 0408150101PEMA RJC01881 124 52 18 14  8.9101.411301S19E21
  04RWT1708702 2.76 0408150101PEMA RJC0188          21100   00000000   01
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300      2
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300                                  2
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300                                2
1304RWT1708702 2.76 2300
1304RWT1708702 2.76 2300
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800                              2
1304RWT1808702 2.76 0800                                 22
1304RWT1808702 2.76 0800                             2
1304RWT1808702 2.76 0800
1304RWT1808702 2.76 0800
 304RWT1808702 2.76 2330                             1
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1808702 2.76 2330
1304RWT1908702 2.76 0830                             2
1304RWT1908702 2.76 0830
1304RWT1908702 2.76 0830
1304RWT1908702 2.76 0830
1304RWT1908702 2.76 0830                                 2
1304RWT1908702 2.76 0830                             2
1304RWT1908702 2.76 0830                          2
1304RWT1908702 2.76 0830                          2
1304RWT1908702 2.76 0830                             22
1304RWT1908702 2.76 0830                                2
1304RWT1908702 2.76 0830  2  2    2
1204RWT1808702 2.76 0623300801PEMA RJC01891 162 58 17 18 20.9011.711301S19E21
1404RWT1808702 2.76 0623300801PEMA RJC0189          41100   00000000   01
 304RWT1908702 2.76 2300                                      2
1304RWT1908702 2.76 2300
1304RWT1908702 2.76 2300
1304RWT1908702 2.76 2300
```

```
 04RWT1908702 2.76 2300
1304RWT1908702 2.76 2300        2
1304RWT1908702 2.76 2300
1304RWT1908702 2.76 2300
1304RWT1908702 2.76 2300
1304RWT1908702 2.76 2300
1304RWT1908702 2.76 2300
1304RWT1908702 2.76 2300
1304RWT2008702 2.76 0830                    2                2
1304RWT2008702 2.76 0830
1304RWT2008702 2.76 0830
1304RWT2008702 2.76 0830
1304RWT2008702 2.76 0830
1304RWT2008702 2.76 0830
1304RWT2008702 2.76 0830 2  2                    2
1304RWT2008702 2.76 0830 2
1304RWT2008702 2.76 0830                    2          2
1304RWT2008702 2.76 0830                 2                    2
1304RWT2008702 2.76 0830
1304RWT2008702 2.76 0830              2  2
1304RWT2008702 2.76 2245
1304RWT2008702 2.76 2245        2
1304RWT2008702 2.76 2245
1304RWT2008702 2.76 2245 2       2
1304RWT2008702 2.76 2245
1304RWT2008702 2.76 2245     22
1304RWT2008702 2.76 2245
1304RWT2008702 2.76 2245 2                        2
1304RWT2008702 2.76 2245
1304RWT2008702 2.76 2245
1304RWT2008702 2.76 2245
1304RWT2008702 2.76 2245
1304RWT2108702 2.76 0815                 2                    1
1304RWT2108702 2.76 0815     2                        2        2
1304RWT2108702 2.76 0815              2      22
1304RWT2108702 2.76 0815 2
1304RWT2108702 2.76 0815
1304RWT2108702 2.76 0815     2
1304RWT2108702 2.76 0815                 2
1304RWT2108702 2.76 0815              2
1304RWT2108702 2.76 0815      2 2                    2
1304RWT2108702 2.76 0815                       2     2
1304RWT2108702 2.76 0815         22            2 2
1304RWT2108702 2.76 0815         2
1204RJC2108702 2.76 080815110lPEMA RJC01991 122 51 18 13  8.9011.311301S19E21
1404RJC2108702 2.76  80815110lPEMA RJC0199 2  2 110                                1
1304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300                                  2
1304RWT2108702 2.76 2300
```

```
 304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300                                                22
1304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300
1304RWT2108702 2.76 2300
1304RJC2208702 2.76 0800          2
1304RJC2208702 2.76 0800
1304RJC2208702 2.76 0800
1304RJC2208702 2.76 0800              2
1304RJC2208702 2.76 0800
1304RJC2208702 2.76 0800
1304RJC2208702 2.76 0800      2       2           2  2       2
1304RJC2208702 2.76 0800                          2
1304RJC2208702 2.76 0800      2
1304RJC2208702 2.76 0800
1304RJC2208702 2.76 0800          2           2       2           2
1304RJC2208702 2.76 0800
1304RWT2208702 2.76 2300
1304RWT2208702 2.76 2300            2
1304RWT2208702 2.76 2300
1304RWT2208702 2.76 2300      2                                       2
1304RWT2208702 2.76 2300                                          2
1304RWT2208702 2.76 2300    2                     2               22
 304RWT2208702 2.76 2300                                            2
1304RWT2208702 2.76 2300                      2                   2
1304RWT2208702 2.76 2300                            2     22      22
1304RWT2208702 2.76 2300                                  2   2
1304RWT2208702 2.76 2300                                    2
1304RWT2208702 2.76 2300    2                               22 22 22
1304RWT2308702 2.76 0700    2
1304RWT2308702 2.76 0700
1304RWT2308702 2.76 0700
1304RWT2308702 2.76 0700                    2
1304RWT2308702 2.76 0700                        2
1304RWT2308702 2.76 0700                                2
1304RWT2308702 2.76 0700
1304RWT2308702 2.76 0700            2           2
1304RWT2308702 2.76 0700
1304RWT2308702 2.76 0700    2       1
1304RWT2308702 2.76 0700
1304RWT2308702 2.76 0700
1204RWT2308702 2.76 1007001003PEMA RWT20733 125 54 18 18 11.900    00201S19E21
1404RWT2308702 2.76 1007001003PEMA RWT2073          21100    00000000    02
```

Miscellaneous Trapping

Small mammal miscellaneous trapping data were collected in 1970 at the Bridger, Cottonwood, Dickinson, and Osage Sites. These data are stored as Grassland Biome data sets A2U1023, A2U1024, A2U1025, and A2U1029. Data were collected on Forms NREL-12A and NREL-14. An example of the data follows.

+++ EXAMPLE OF DATA +++

```
         1         2         3         4         5         6         7
1234567890123456789012345678901234567890123456789012345678901234567890123456789
1209RPL2008701 2.76   17000709MIOC RPL00934 129 35 19 12 32.700   00202900833
1209RPL2008701 2.76   17000107MIOC RPL00944 127 33 19 10 32.800   00202900833
1209AC 2608701 2.76  407301001MIOC RPL01034 110 31 20 12 28.2213.511302900833
1209AC 2608701 2.76   1030     BLBR RPL01055 102 22 12  7 11.0000.811302900833
1209AC 2608701 2.76   1030     BLBR AC 09325 115 18 14  4 13.5010.511302900833
1209RJC2808701 2.76            MIOC RJC02045 131 28 21  8 21.2610.411302900833
1209RJC2808701 2.76            MIOC RJC02055 153 28 20 12 38.0611.011302900833
1209RJC2808701 2.76            MIOC RJC02065 164 32 20 14 47.0614.711302900833
1209RJC2808701 2.76            MIOC RJC02075 143 30 20 13 31.6611.111302900833
1209RJC2908701 2.76  709000909MIOC RJC02084 132 28 19 10 26.040   01302900833
1209RJC2908701 2.76  709001211MIOC RJC02094 160 32 19 12 34.900   01302900833
1209RJC2908701 2.76  709001212MIOC RJC02104 128 32 20 10 23.700   01302900833
1209RJC2908701 2.76  709001210MIOC RJC02113 135 37 21 10 26.400   01302900833
1209RJC2908701 2.76  709000608MIOC AC 09334 147 32 19 13 35.800   01302900833
1209RJC2908701 2.76  709000608MIOC AC 09344 147 29 20 12 30.000   01302900833
1209RJC2908701 2.76  709001205MIOC AC 09353 141 30 19 12 32.500   01302900833
1209RJC2908701 2.76  709000909MIOC AC 09364 169 33 20 14 34.500   01302900833
1209RJC3008701 2.76            MIOC RJC02145 132 31 16 14 27.901    1302900833
1209RJC3008701 2.76            MIOC RJC02155 151 31 18 16 44.951    1302900833
1209RJC3008701 2.76            MIOC RJC02165 148 31 18 13 37.901    1302900833
1209RJC3008701 2.76            MIOC RJC02175 129 32 18 10 23.361    1302900833
1409RPL2008701 2.76   17000709MIOC RPL0093 6  8 511                          2
1409RPL2008701 2.76   17001107MIOC RPL0094          61200   00000000   02
1409AC 2608701 2.76  407301001MIOC RPL0103          11100   00000000   02
1409AC 2608701 2.76   1030     BLBR RPL0105          01100   00000026   03
1409AC 2608701 2.76   1030     BLBR AC 0932 6 090533                       3
1409RJC2808701 2.76            MIOC RJC0204          41100   00000000   03
1409RJC2808701 2.76            MIOC RJC0205 5        61200   00110021   03
1409RJC2808701 2.76            MIOC RJC0206 3 12 833                       3
1409RJC2808701 2.76            MIOC RJC0207          31200   00000000   03
1409RJC2908701 2.76  709000909MIOC RJC0208          61200   00000012   12
1409RJC2908701 2.76  709001211MIOC RJC0209          31200   00332233   12
1409RJC2908701 2.76  709001212MIOC RJC0210          31100   00000010   02
1409RJC2908701 2.76  709001210MIOC RJC0211          31200   00000022   02
1409RJC2908701 2.76  709000608MIOC AC 0933          31300   00003311   12
1409RJC2908701 2.76  709000608MIOC AC 0934          61300   00001200   12
1409RJC2908701 2.76  709001205MIOC AC 0935          31100   00000000   02
1409RJC2908701 2.76  709000909MIOC AC 0936          61300   00003300   12
1409RJC3008701 2.76            MIOC RJC0214 6  9 622                       4
1409RJC3008701 2.76            MIOC RJC0215          61200   00003300   14
1409RJC3008701 2.76            MIOC RJC0216          31100   00002203   14
1409RJC3008701 2.76            MIOC RJC0217 1  4 311                       4
```