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COMPARISONS OF SMALL MAMMAL BIOMASS AT EIGHT U.S. IBP GRASSLAND BIOME RESEARCH SITES 1970 SEASON

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TABLE OF CONTENTS

ABSTRACT

Small mammal population density estimates are made for Bison, Bridger, Cottonwood, Dickinson, Jornada, Osage, Pantex, and Pawnee sites based on 1970 field data. Small mammal biomass at these sites is quantitatively compared by means of a similarity index and cluster analysis.

INTRODUCTION

This report presents a comparison of small mammal biomass at eight U.S. IBP Grassland Biome research sites. The comparison is based on live and snap trap data collected in 1970 at the following Comprehensive Network Sites: Bison, Bridger, Cottonwood, Dickinson, Jornada, Osage, and Pantex. There were no comparable 1970 data available from Pawnee Site; Pawnee data were extracted from Flake (1971) and represent 1969 and 1970 sampling efforts. A description of the sampling procedure for Bison, Bridger, Cottonwood, Dickinson, and Osage can be found in IBP Grassland Biome Technical Report No. 109 (Hoffman, Jones, and Genoways 1971) and for Jornada and Pantex in IBP Grassland Biome Technical Report No. 114 (Packard 1971). In general, the sampling schemes (except at Pawnee) followed the standardized field data collection procedures described in IBP Grassland Biome Technical Report No. 35 (French 1970).

POPULATION ESTIMATES

Population estimates were calculated separately for each species at each site. This was necessary because a correction factor which differed among species and also between sites for the same species was employed to arrive at an estimate of the effective area sampled for each species, as will be explained below. Wherever possible, the Jolly stochastic model (Jolly 1965) was used to estimate the population based on live trap data, while the Hansson method (Hansson 1969) was used to estimate the population based on snap trap data as recommended by French (1971). When data were insufficient to yield an estimate by the Jolly or Hansson procedures, either the Lincoln or Modified Lincoln Index was used on the live trap data and the Zippin regression estimator (Zippin 1956) on the snap trap data. All estimates were based on 1970 field data.

EFFECTIVE AREA SAMPLED

It is well known that the area from which trapped animals are taken is usually larger than the area of the trap grid itself (French 1971 and others). The area from which animals are drawn, or the effective area sampled by the grid, depends upon the range of activity of the animals being trapped (Hansson 1969). This activity range is different for different species; and therefore, separate corrections for the effective area sampled should be made for each species. The Hansson method makes such corrections by taking into account the observed "edge effect" in the trapping grid and calculating a density estimate from the animals captured and an estimated area based on the edge effect. The Hansson procedure (individuals/ha) was used for our Grassland Biome data from removal trapping without further modification where the data were such that an edge effect was evident. (If the data show no edge effect, as described by Hansson (1969), this estimator is not valid.) The Jolly stochastic model, when applied to live-trapping data, makes corrections for both death and immigration so that the population estimates (number of individuals) from this estimator should apply only to the actual grid area (3.24 ha). This is the area enclosed by a line 7.5 m (one-half the distance between trap stations in the grid) beyond the outermost trap lines. The Jolly estimates were therefore divided by 3.24 to yield density figures in individuals/ha. The Lincoln, Modified Lincoln, and Zippin methods provide an estimate of the number of individuals present on an undefined area (presumably an area somewhat larger than the trap grid).

For our data these estimates were corrected for the effective area sampled for each species at each site, as explained below.

French (1971) has conducted a small mammal trapping study on two circular, nine-hectare, rodent-proof enclosures in the Nevada desert. Based on data collected from his live-trapping enclosure, he concluded that the effective area sampled by the standard 12 x 12 IBP grid (which covers 3.24 ha) was between six and seven hectares for the pocket mouse, *Perognathus formosus*, and greater than nine hectares (the size of the enclosure) for the kangaroo rat, *Dipodomys microps*. Also, from his live-trapping data it is possible to plot all the grid positions where an individual animal was captured and to measure the greatest distance between any two of these positions. This was done for each animal, and the distances were averaged for members of the same species to give a mean maximum movement (MMM) for each species. The MMMs for *Perognathus formosus* and *Dipodomys microps* were 27.2 m and 73.0 m, respectively. Let us now assume that the effective area sampled for a nearly immobile population (MMM < 7.5 m) is the actual area of the trapping grid (in this case 3.24 ha), that the effective area sampled for *Perognathus formosus* in this study is 6.5 ha (recall that French estimated between 6 and 7 ha), and that the effective area sampled for *Dipodomys microps* is 12 ha (French estimated > 9 ha), all of which seem to be in line with French's findings. Based on the above, there appears to be a linear relationship between the effective area sampled and the MMM for a given species (Fig. 1): effective area sampled (in ha) = 3.24 + 0.12 x MMM (in m).

Where adequate data were available a MMM was calculated for each small mammal species at each IBP site for each collection date in 1970 by the method described above. These values were then averaged across all collection

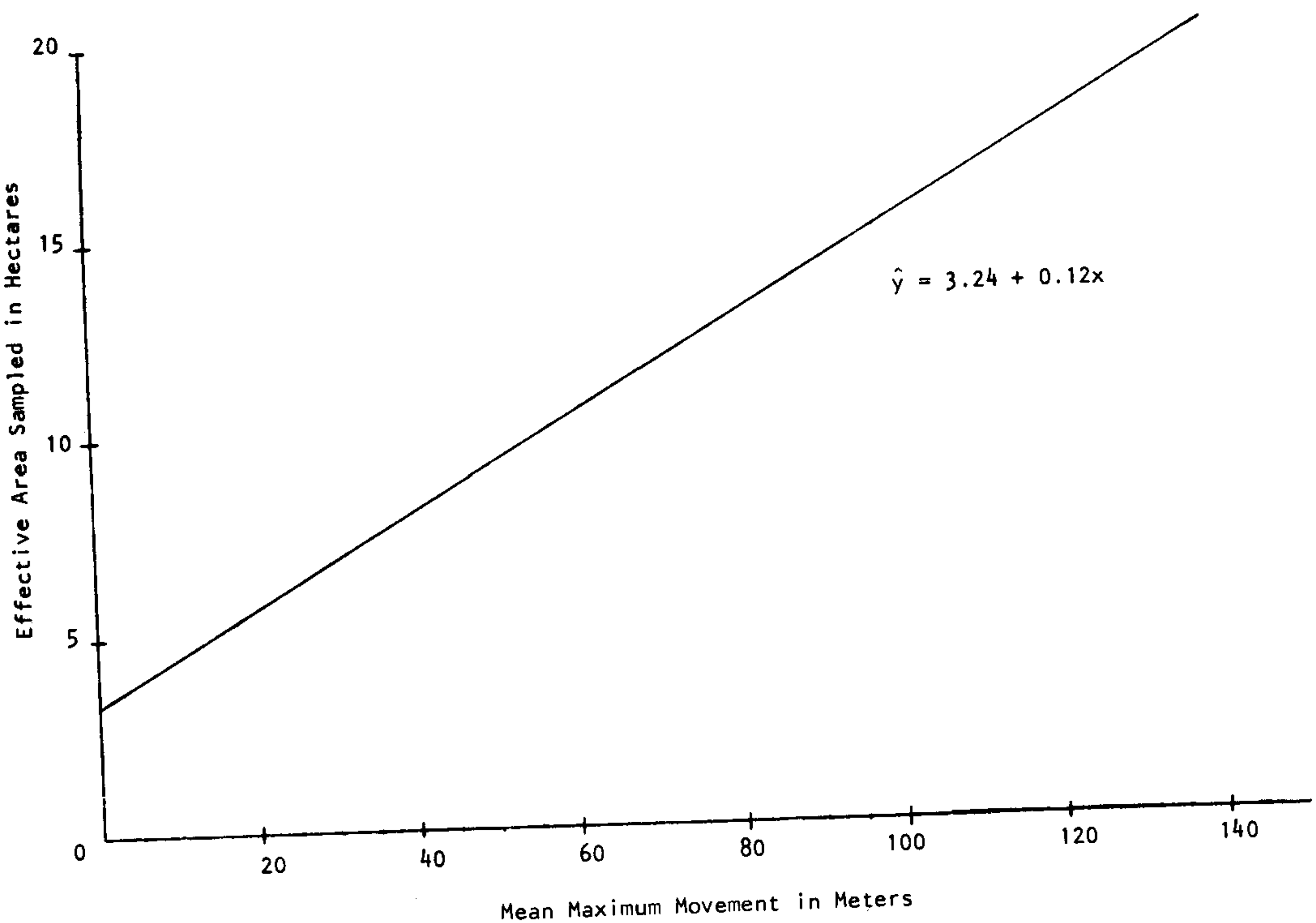

Fig. 1. Relationship between MMM and effective area sampled.

dates for that site. The effective area sampled was then calculated for each species by means of the regression equation (Table 1). (It appears that there may be significant differences in movement at different dates in some of the species studied, although this requires further investigation). An important exception to this procedure concerned the pocket gopher at Bridger where there was insufficient field data to determine a MMM. In this case a MMM of 10 m was assumed based on work done by Hansen and Remmenga (1961). The population estimate obtained from either the Lincoln, Modified Lincoln, or Zippin method for a given species was then divided by the calculated effective area sampled for that species at that site to yield a density estimate in individuals per hectare.

BIOMASS ESTIMATES

Mean weights for all the species collected at the eight sites in 1970 were determined from field data taken from sacrificed animals. Where field data proved insufficient, weights were taken from "The Mammals of North America" (Hall and Kelson 1959). The mean weight for each species was multiplied by the derived density estimate (individuals/ha) to yield a biomass density estimate (g/ha). Estimates of individuals/ha, mean weight/individual, g/ha, and percent of the total small mammal biomass contributed by the various species at each site were then tabulated (Table 2). It will be noted that Osage and Jornada had by far the highest small mammal biomass in 1970 (Fig. 2). At each of these sites there is one dominant species; at Osage the meadow vole (*Microtus ochrogaster*) comprises 88.5%, and the kangaroo rat (*Dipodomys ordii*) at Jornada comprises 59.4%. At Bison, which has the third highest small mammal biomass, virtually 100% of the biomass is composed of the montane vole (*Microtus montanus*). At Bridger the pocket gopher

Table 1. Mean maximum movement and the estimated effective area sampled calculated from 1970 field data for small mammal species at eight U.S. IBP Grassland Biome research sites. Calculations are based on the regression equation EAS = 3.24 + 0.12 × MMM.

Site and Date	Species	Mean Maximum Movement (MMM) (in m)	Effective Area Sampled (EAS) (in ha)
Bison, July	*Microtus montanus*	<8	3.2
Bridger, July	*Microtus montanus*	39	7.9
	Thomomys talpoides	10	4.4
Cottonwood, June	*Microtus ochrogaster*	25	6.2
Cottonwood, Aug.	*Microtus ochrogaster*	<8	3.2
	Peromyscus maniculatus	105	15.8
	Spermophilus tridecemlineatus	34	7.3
Dickinson, June	*Microtus pennsylvanicus*	73	12.0
	Perognathus fasciatus	<8	3.2
	Peromyscus maniculatis	86	13.5
	Spermohpilus tridecemlineatus	65	11.0
Dickinson, Aug.	*Peromyscus maniculatus*	59	10.3
	Spermophilus tridecemlineatus	45	8.6
Jornada, April	*Dipodomys ordii*	48	9.0
	Dipodomys spectabilis	36	7.5
	Onychomys leucogaster	43	8.4
	Perognathus flavus	60	10.4
	Spermophilus spilosoma	114	17.0
Jornada, July	*Dipodomys ordii*	42	8.3
	Dipodomys spectabilis	53	9.5
	Neotoma micropus	60	10.4
	Onychomys leucogaster	74	12.1
	Perognathus penicillatus	15	5.0
	Spermophilus spilosoma	111	16.6
Jornada, Nov.	*Dipodomys ordii*	41	8.1
	Dipodomys spectabilis	73	12.0
	Onychomys leucogaster	88	13.9
	Spermohpilus spilosoma	81	12.9

Table 1. Continued.

Site and Date	Species	Mean Maximum Movement (MMM) (in m)	Effective Area Sampled (EAS) (in ha)
Osage, May	*Blanaria brevicauda*	15	5.0
	Microtus ochrogaster	33	7.2
	Reithrodontomys montanus	38	7.7
	Sigmodon hispidus	21	5.8
Osage, Aug.	*Microtus ochrogaster*	47	8.9
	Reithrodontomys montanus	33	7.1
	Sigmodon hispidus	107	16.1
Pantex, May	*Perognathus flavescens*	21	5.8
	Peromyscus maniculatus	59	9.1
	Reithrodontomys montanus	32	7.1
Pantex, Aug.	*Onychomys leucogaster*	<8	3.2
	Perognathus flavescens	15	5.0
	Perognathus hispidus	49	9.1
	Peromyscus maniculatus	38	7.7
	Reithrodontomys montanus	19	5.5
	Spermophilus tridecemlineatus	81	12.9
Pantex, Oct.	*Onychomys leucogaster*	60	10.4
	Peromyscus maniculatus	46	8.7
	Reithrodontomys montanus	18	5.4
	Sigmodon hispidus	38	7.7

Table 2. Mean summer numbers and biomass of small mammal species at eight U.S. IBP Grassland Biome research sites in 1970.

Site	Species	Population Estimation Method	Individual/ha	Mean Weight/ Individual (in g)	g/ha	Proportional Species Composition
Bison	*Microtus montanus*	Zippin	17.0	21.74	370	1.00
	TOTAL	--	17.0	--	370	1.00
Bridger	*Thomomys talpoides*	Hoffman	4.5	46.95	211	.60
	Microtus montanus	Jolly	6.8	20.82	142	.40
	Sorex vagrans	Zippin	0.3	4.30	1	<.01
	TOTAL	--	11.6	--	354	1.00
Cottonwood	*Spermophilus tridecemlineatus*	Lincoln	0.2	148.25	30	.30
	Microtus ochrogaster	Lincoln	0.7	40.56	28	.28
	Peromyscus leucopus	Zippin	0.9	17.35	16	.16
	Peromyscus maniculatus	Lincoln	0.6	19.22	12	.12
	Thomomys talpoides	Zippin	0.2	59.70	12	.12
	Reithrodontomys montanus	Zippin	0.3	8.05	2	.02
	TOTAL	--	2.9	--	100	1.00
Dickinson	*Spermophilus tridecemlineatus*	Hansson	1.0	103.24	103	.57
	Microtus pennsylvanicus	Lincoln	1.0	23.42	23	.13
	Thomomys talpoides	Zippin	0.2	88.20	18	.10
	Peromyscus maniculatus	Lincoln	0.9	17.84	16	.09
	Perognathus fasciatus	Zippin	0.9	10.70	10	.06
	Onychomys leucogaster	Zippin	0.3	21.90	6	.03
	Zapus hudsonius	Zippin	0.2	14.40	3	.02
	TOTAL	--	4.5	--	179	1.00

Table 2. Continued.

Site	Species	Population Estimation Method	Individual/ha	Mean Weight/ Individual (in g)	g/ha	Proportional Species Composition
Jornada	*Dipodomys ordii*	Jolly	14.4	45.76	659	.60
	Dipodomys spectabilis	Hansson	2.8	95.17	266	.24
	Spermophilus spilosoma	Lincoln	0.8	94.02	75	.07
	Neotoma micropus	Lincoln	0.2	283.50	57	.05
	Onychomys leucogaster	Lincoln	0.8	30.75	25	.02
	Perognathus flavus	Hansson	2.1	6.59	14	.01
	Perognathus penicillatus	Lincoln	0.4	24.00	10	.01
	TOTAL	--	21.5	--	1106	1.00
Osage	*Microtus ochrogaster*	Jolly	28.6	34.40	984	.89
	Sigmodon hispidus	Lincoln	0.6	63.30	38	.03
	Reithrodontomys montanus	Lincoln	3.0	11.32	34	.03
	Peromyscus maniculatus	Zippin	1.4	18.18	25	.02
	Spermophilus tridecemlineatus	Zippin	0.2	64.20	13	.01
	Blanaria brevicauda	Zippin	0.6	14.50	9	.01
	Peromyscus leucopus	Zippin	0.3	24.80	7	.01
	Cryptotis parva	Zippin	0.2	5.67	1	<.01
	TOTAL	--	34.9	--	1111	1.00
Pantex	*Perognathus flavescens*	Lincoln	7.0	18.40	129	.48
	Peromyscus maniculatus	Jolly	3.4	17.38	59	.22
	Reithrodontomys montanus	Lincoln	5.4	9.92	54	.20
	Spermophilus tridecemlineatus	Lincoln	0.2	86.60	17	.06
	Perognathus hispidus	Lincoln	0.1	54.50	5	.02
	Onychomys leucogaster	Lincoln	0.1	31.57	3	.01
	Perognathus merriami	Zippin	0.1	7.20	1	<.01
	Sigmodon hispidus	Zippin	<0.1	63.30	0	<.01
	TOTAL	--	16.3	--	268	1.00

Table 2. Continued.

Site	Species	Population Estimation Method	Individual/ha	Mean Weight/ Individual (in g)	g/ha	Proportional Species Composition
Pawnee	*Spermophilus tridecemlineatus*	Flake	1.2	130.00	156	.64
	Onychomys leucogaster	Flake	1.8	28.00	50	.21
	Peromyscus maniculatus	Flake	1.2	19.00	23	.09
	Dipodomys ordii	Flake	0.3	45.00	14	.06
	TOTAL	--	4.5	--	243	1.00

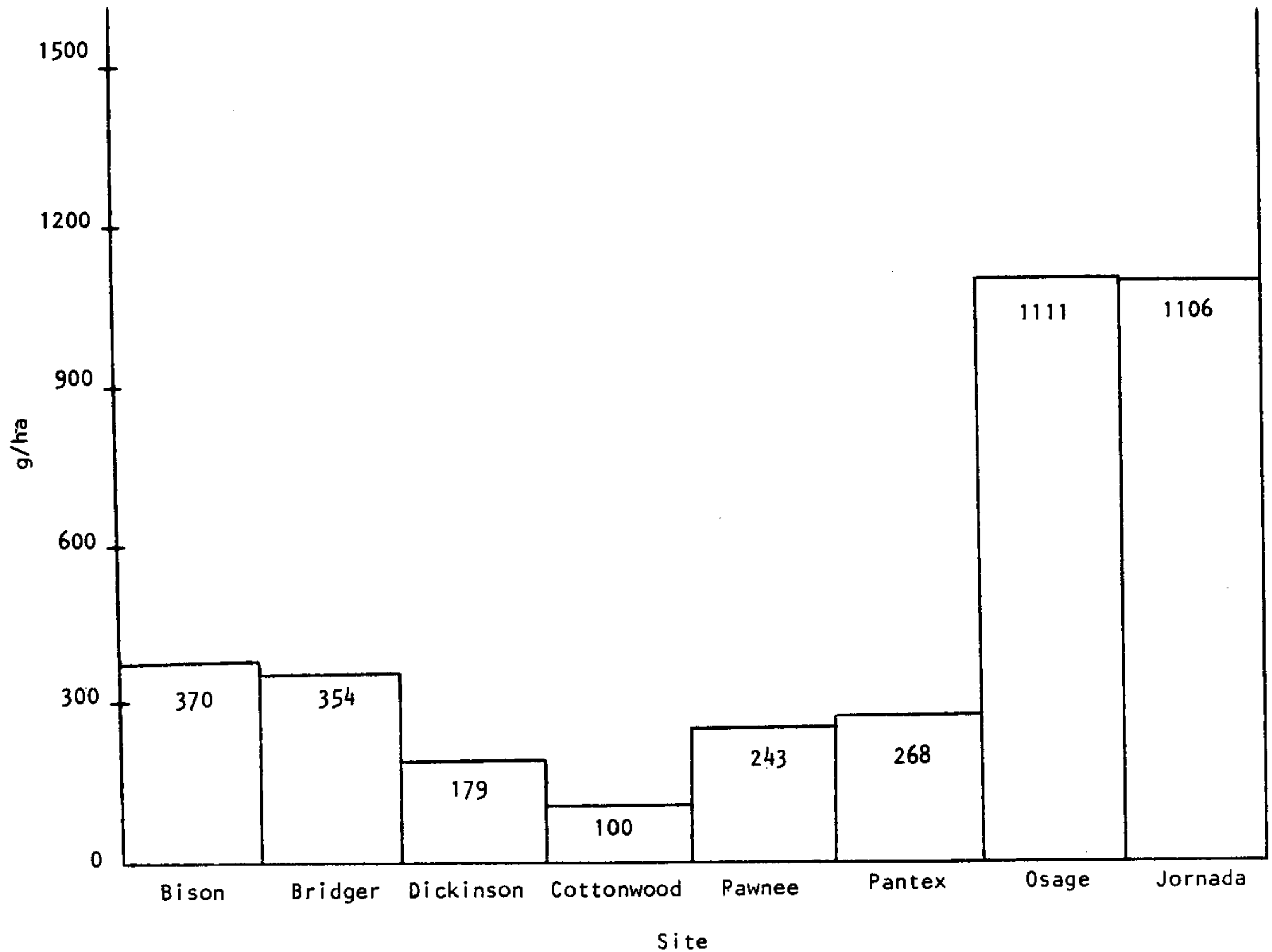

Fig. 2. A comparison of small mammal biomass at eight U.S. IBP Grassland Biome research sites.

(*Thomomys talpoides*) comprises 59.6% of the total biomass. Both Pawnee and Dickinson sites are dominated by the 13-lined ground squirrel (*Spermophilus tridecemlineatus*) which comprises 64.2% and 57.5% of the total biomass, respectively, while Cottonwood and Pantex are not so strongly dominated by a single species (Table 3).

SIMILARITY COMPARISONS BETWEEN SITES

Biomass data, in the form of the percent of total biomass contributed by the different species at each site, were used to make faunistic comparisons between the eight sites. The following information equation derived by Horn (1966) was used to make these comparisons:

$$R_o = \frac{\Sigma(x_i + y_i)\ \ln\ (x_i + y_i) - \Sigma x_i\ \ln\ x_i - \Sigma y_i\ \ln\ y_i}{(X + Y)\ \ln\ (X + Y) - X\ln X - Y\ln Y}$$

where x_i and y_i represent the fractions of the samples X and Y composed of species i. When the data are expressed as proportions, as is the case in these calculations, the denominator becomes the constant 1.3863 (= 2 ln 2). The value of R_o can vary from 0 to 1, with a value of 1 representing complete similarity with respect to proportional species composition by weight, and a value of 0 representing a completely distinct small mammal fauna (no species in common).

Dickinson and Pawnee were the most similar with respect to small mammal composition (R_o = .77), followed by Dickinson and Cottonwood (R_o = .62), Bison and Bridger (R_o = .60), Cottonwood and Osage (R_o = .59), and Cottonwood and Pawnee (R_o = .53) (Table 4). These values were then subjected to the weighted pair-group method of cluster analysis as described by Sokal and

Table 3. Dominant small mammal species at eight U.S. IBP Grassland Biome sites.

Site	Grassland Type	Species	g/ha	Percent of Total Biomass
Bison	Bunch	*Microtus montanus*	370	100
Bridger	Mountain	*Thomomys talpoides*	211	60
Cottonwood	Mixed	*Microtus ochrogaster* *Spermophilus tridecomlineatus*	28 30	28 30
Dickinson	Mixed	*Spermophilus tridecemlineatus*	103	58
Jornada	Desert	*Dipodomys ordii*	659	59
Osage	Tallgrass	*Microtus ochrogaster*	984	88
Pantex	Shortgrass	*Perognathus flavescens* *Peromyscus maniculatus*	129 59	48 22
Pawnee	Shortgrass	*Spermophilus tridecemlineatus*	156	64

Table 4. R_o similarity values comparing small mammal biomass (based on percentage species composition) at eight U.S. IBP Grassland Biome research sites.

Bison							
.60	Bridger						
.00	.21	Dickinson					
.00	.23	.62	Cottonwood				
.00	.00	.77	.53	Pawnee			
.00	.00	.30	.33	.32	Pantex		
.00	.00	.08	.59	.08	.14	Osage	
.00	.00	.03	.00	.19	.02	.00	Jornada

Sneath (1963) (Fig. 3). The high similarity between Dickinson, Cottonwood, and Pawnee is due primarily to the abundance of 13-lined ground squirrels (*Spermophilus tridecemlineatus*) at these three sites. The high similarity between Bison and Bridger is the result of the large proportion of the biomass at these sites contributed by the montane vole (*Microtus montanus*). Cottonwood and Osage are very similar because of the presence of meadow voles (*Microtus ochrogaster*) and to a lesser extent to the presence of deer mice (*Peromyscus maniculatus*) and plains harvest mice (*Reithrodontomys montanus*) at both sites.

Welch (1970) has compared the small mammal fauna (including lagomorphs) at these same eight U.S. IBP Grassland Biome Sites by means of Jaccard's Coefficient of Community (CC) index as explained by Udvardy (1969). This index does not consider density or biomass, but counts species as being either present or absent from an area. Using this method of comparison Osage and Pantex are the most similar (CC = 36), followed by Dickinson and Cottonwood (CC = 34), Cottonwood and Pawnee (CC = 29), Dickinson and Pawnee (CC = 27), Cottonwood and Osage (CC = 26), Pawnee and Jornada (CC = 26), Pantex and Jornada (CC = 25), and Bison and Bridger (CC = 25). (The remaining CC values are listed in Fig. 3 of Welch's paper.) Welch also ran a cluster analysis based on these CC values resulting in a dendrogram which appears as Fig. 4 in his paper and is reproduced here (Fig. 4) for comparison with Fig. 3.

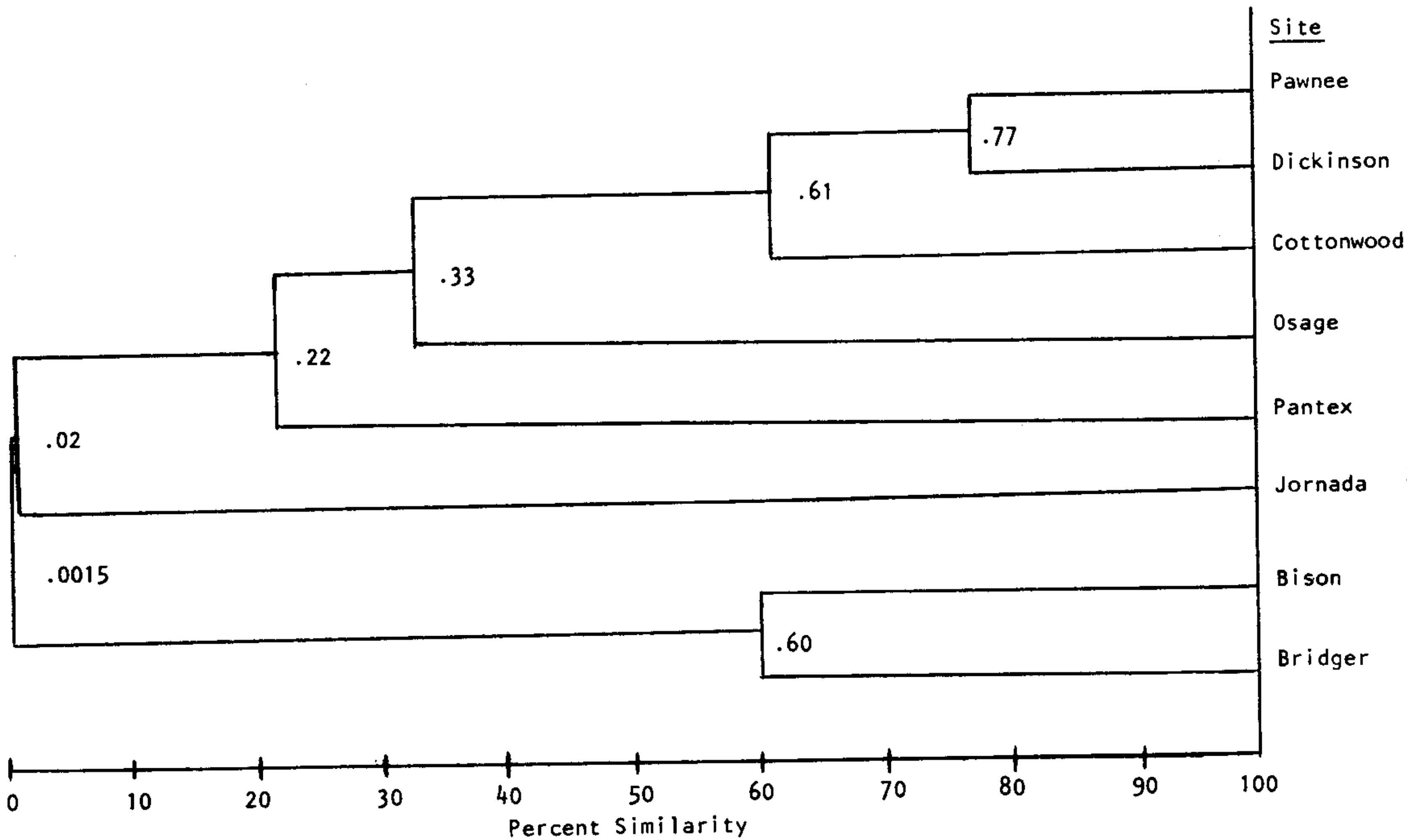

Fig. 3. Similarity levels of small mammal biomass resulting from cluster analysis of eight U.S. IBP Grassland Biome research sites based on R_o values.

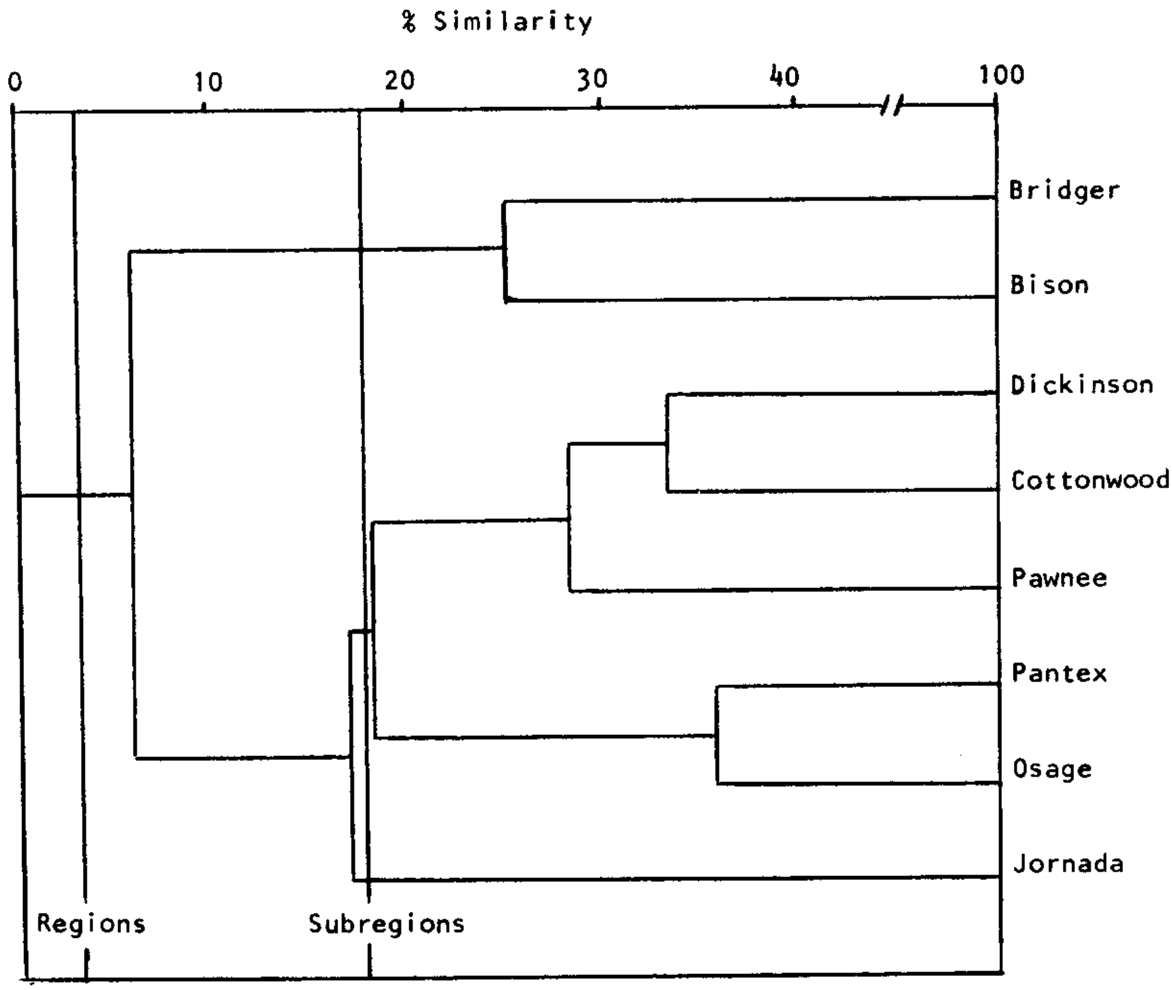

Fig. 4. Dendrogram depicting affinities among the eight sites resulting from cluster analysis. Coefficients of Community are represented by percent similarity. (From Welch, 1970)

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