DRAFT
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preliminary report

SOUTH BOULDER OPEN SPACE INVERTEBRATE SURVEY PITFALL TRAPPING 1993: Summary of Jr. Ranger Collections

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INTRODUCTION

A pitfall collection of surface-active invertebrates was initiated as part of the Boulder Open Space Jr. Ranger program in summer 1993. This report summarizes results and trends observed from data collected over five collection periods. Discussion is limited to total invertebrates, trophic groups, and selected families of invertebrates. Collections have been deposited with Dr. Deane Bowers, curator of terrestrial invertebrates at the CU Natural History Museum.

METHODS

Details of procedures, collection dates, and data documentation are reported in "Invertebrate Trapping Procedures" (unpublished Open Space Report). Details of procedures and data collection are reported therein. Here, collections from two consecutive days have been averaged into single collection estimate per pitfall, resulting in five collection dates. Statistical comparisons of results from the 20 collections in each treatment were made using an analysis of variance, examining for numerical differences attributed to grazing effects, effects of collection date, or the interaction between these variables. All statistical tests were conducted after first employing a log-transformation of numbers ($y = \ln(x+1)$) in an attempt homogenize variances between treatments and dates.

The experimental design, which consisted of 20 replicates within the exclosure vs 20 replicates in the historically grazed area is actually pseudoreplicated. We sampled only one pasture that had been grazed frequently over the last seven years and compared results to an adjacent pasture that had had cattle excluded during that time interval. In essence this means that we cannot truly discern treatment effects from site effects. Statements about "grazing effects" must therefore be considered preliminary at best. At the same time, however, soil invertebrates tend to key on microhabitat characteristics that we cannot, apriori, determine.

As such, the two adjacent sites do appear to be random samples from grazed and ungrazed sites. Thus, while the results lack maximum statistical rigor, I believe (but cannot prove) that these results would have been similar had we been able to conduct a true, replicated sample of grazed and ungrazed habitats in this particular area.

Tropic status can only be guessed at for some of the invertebrates collected here. Many organisms, such as ants, function as omnivores, i.e., may be herbivores (seed collectors), predators of other invertebrates, and carrion feeders. Omnivores have been included within the detritivore group. Other detritivores included the pillbugs, bristletails, dermapterans, millipedes, dipterans, earthworms, and crickets. Predators consisted of spiders, beetles, opiliones, true bugs (Hemiptera), odonates and the velvet mites (Family Trombidiidae), herbivores consisted of the lepidopterans, misc. larvae, grubs, homopterans (mostly leafhoppers and froghoppers) and trichopterans. There are some obvious oversimplifications here that contribute errors to the trophic level analyses. Given these limitations at trophic status, "the best" data are probably those including families where trophic status is absolutely known. Here, such groups include the Homoptera (herbivores) spiders and mites (predators), and pillbugs and bristletails (detritivores).

RESULTS

1. Effects Attributed to Grazing

Total numbers were not different between treatments (Table 1). Herbivores were, on average, more abundant within the exclosure, and, in particular, the Homoptera were more dominant in the ungrazed area (Figure 1). Beetles were more abundant in grazed areas; however the seasonal pattern in beetle abundance also differed between treatments. Ants were also more abundant on grazed areas. Among the detritivores, pillbugs were more common on ungrazed areas, but bristletails were more common on the grazed areas (Figures 2).

2. Seasonal Patterns

The various groups exhibited a variety of patterns in seasonal abundance. Some, such as the ants, were most abundant earliest in the season and appeared to decline throughout the summer (Table 2). Others, such as the leafhoppers and frog hoppers (Homoptera), exhibited a a midseason peak in abundance (Figure 1), while a few such as the pillbugs appeared most abundant late in the season (Figure 3). Finally, certain groups such as the crickets exhibited no seasonal patterns in abundance.

3. Interactions between grazing and seasonal abundance.

The analysis of variance procedure indicated a number of groups whose seasonal patterns were different for the two treatments. These included the detritivores, the beetles, and the crickets (Figures 4-6). Neither the detritivore group as a whole or the crickets showed any treatment response; however, the beetle group was by far the "most sensitive invertebrate group" based on the analysis of variance. That group showed significant treatment and seasonal patterns in addition to the treatment - seasonal pattern interaction (Figure 6).

Discussion

Pitfall traps measure both population densities and activities of these populations. Differences in numbers may therefore not accurately reflect population differences. An analysis of temperatures during the time of collections can assist in interpretations. Unusually cold or wet weather may reduce movements of some groups, explaining ephermeral declines in seasonal trends. Analyses presented here (e.g., Table 2), suggest that no single climatic factor dominated seasonal patterns, at least, the individual groups exhibited unique and occassionally inverse patterns in capture data.

Treatment effects include both changes in the resource base and the microclimate. Patterns attributed to treatment or time of year therefore cannot be linked with specific mechanisms responsible for these differences. Ungrazed sites produced higher captures of herbivores, including homopterans, suggesting that the resource base on the ungrazed sites might be superior to that of the grazed sites. From the ants' perspective, however, the grazed site was preferred. Certainly, the absence of an established canopy and litter layer resulted in greater soil temperatures on the grazed area. This may have affected overall activity rates, but, in particular, improved foraging efficiencies for these species. In all cases where seasonality of captures differed between treatments, greater captures on the grazed area were found early in the season. This suggests that grazing affects at least the phenology of invertebrate activity, if not (or in addition to) the densities of the invertebrates.

Future studies might focus on abundant groups showing strong treatment effects. The Homoptera, Coleoptera (beetles), Isoptera (pillbugs or sowbugs) and Thysanura (bristletails) would appear to be good candidates for such studies.

Table 1. Average invertebrate numbers collected in pitfall traps on recently grazed and ungrazed (exclosed) areas, South Boulder Open Space 1993.[1]

GROUP	UNGRAZED	GRAZED
Total Invertebrates	20.33 (1.04)	20.95 (1.02)
Herbivores	1.73 (0.18)*	0.77 (0.08)
Homopterans	1.50 (0.17)*	0.62 (0.07)
Predators	4.85 (0.45)	5.37 (0.42)
Spiders	1.53 (0.24)	1.48 (0.30)
Mites	2.25 (0.34)	2.44 (0.27)
Beetles	0.93 (0.09)	1.45 (0.14)*
Detritivores	13.65 (0.93)	14.80 (0.94)
Ants	8.36 (0.78)	11.96 (0.84)*
Pillbugs	4.10 (0.54)*	0.62 (0.12)
Bristletails	0.19 (0.05)	0.92 (0.12)*
Crickets	0.22 (0.03)	0.28 (0.05)

1. Values are means and standard errors of the average daily capture per pitfall, n=100 for each treatment. Statistically higher means of the two treatments (based on log-transformed data) are followed by an asterisk.

Table 2. Average invertebrate numbers collected in pitfall traps across five collection dates, South Boulder Open Space 1993.[1]

GROUP	DATE 6/24	7/8	7/23	8/6	8/18
Total Invertebrates	25.3 A	21.5 A	21.9 A	16.2 B	18.3 B
Herbivores	1.3 B	2.4 A	1.6 B	0.6 C	0.4 C
Homopterans	1.1 B	2.0 A	1.3 B	0.5 C	0.3 C
Predators	6.0 AB	7.4 A	5.0 BC	2.3 D	4.8 C
Spiders	1.4 AB	1.2 AB	1.4 AB	0.9 B	2.6 A
Mites	3.1 AB	4.4 A	2.2 B	0.9 C	1.2 C
Beetles	1.4 AB	1.7 A	1.3 AB	0.5 C	1.0 B
Detritivores	17.8 A	11.7 B	15.4 AB	13.3 B	13.1 B
Ants	13.4 A	8.1 B	11.3 AB	9.7 B	8.2 B
Pillbugs	1.1 B	2.3 A	2.2 AB	2.4 AB	3.7 A
Bristletails	0.9 A	0.4 BC	0.6 BC	0.2 C	0.7 A
Crickets	0.3 A	0.3 A	0.2 A	0.1 A	0.3 A

1. Values are means of the average daily capture per pitfall, n=40 per date. Statistically different means (based on log-transformed data) are followed by different letters (Duncan's Multiple Range Test, $p<.05$).

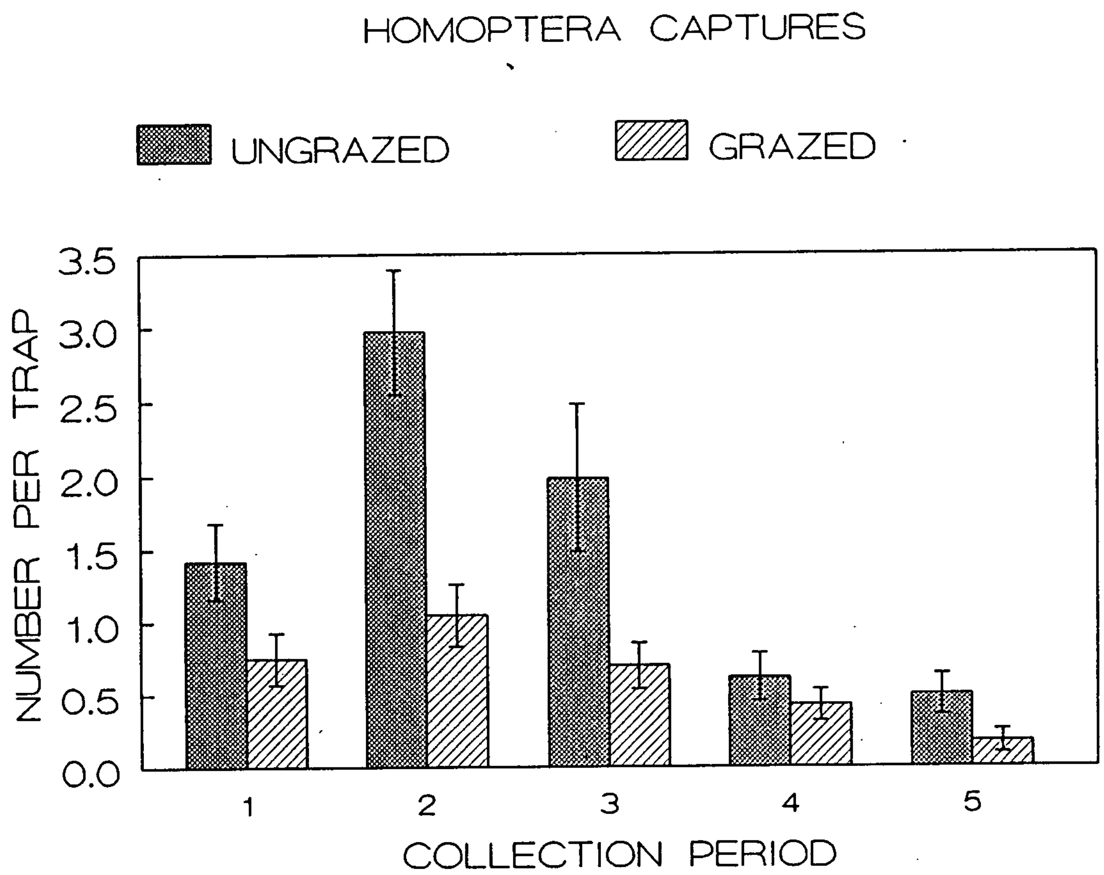

HOMOPTERA CAPTURES
UNGRAZED
GRAZED
NUMBER PER TRAP
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
COLLECTION PERIOD

Fig 1

Fig 2

PILLBUG AND BRISTLETAIL CAPTURES

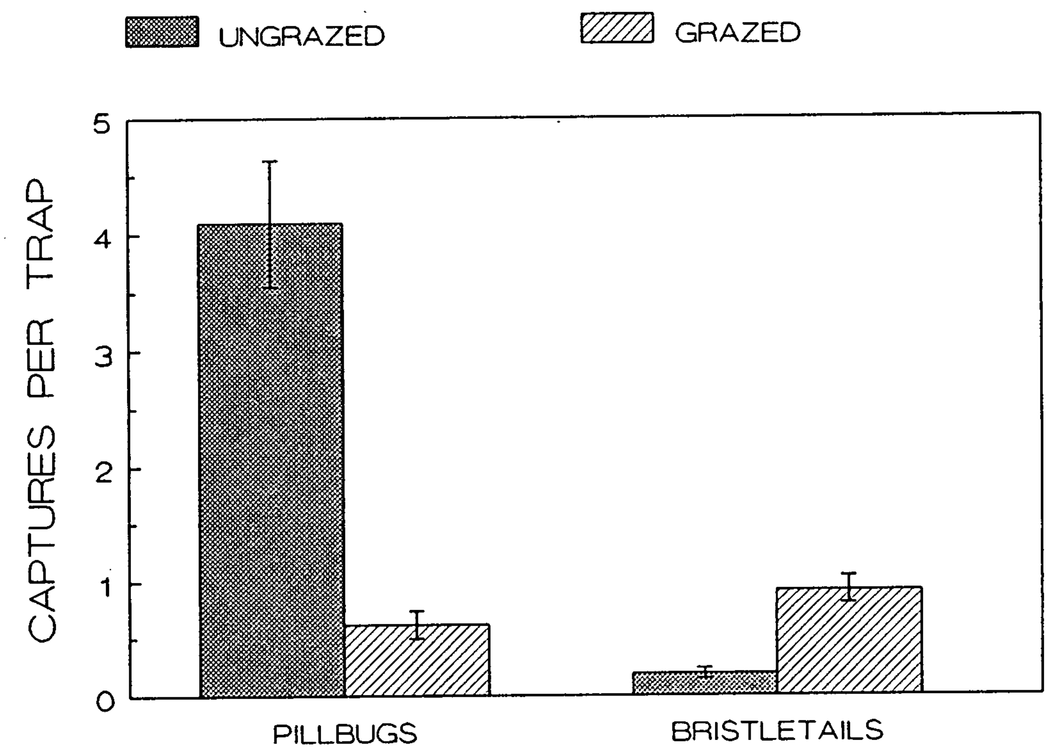


Fig 3

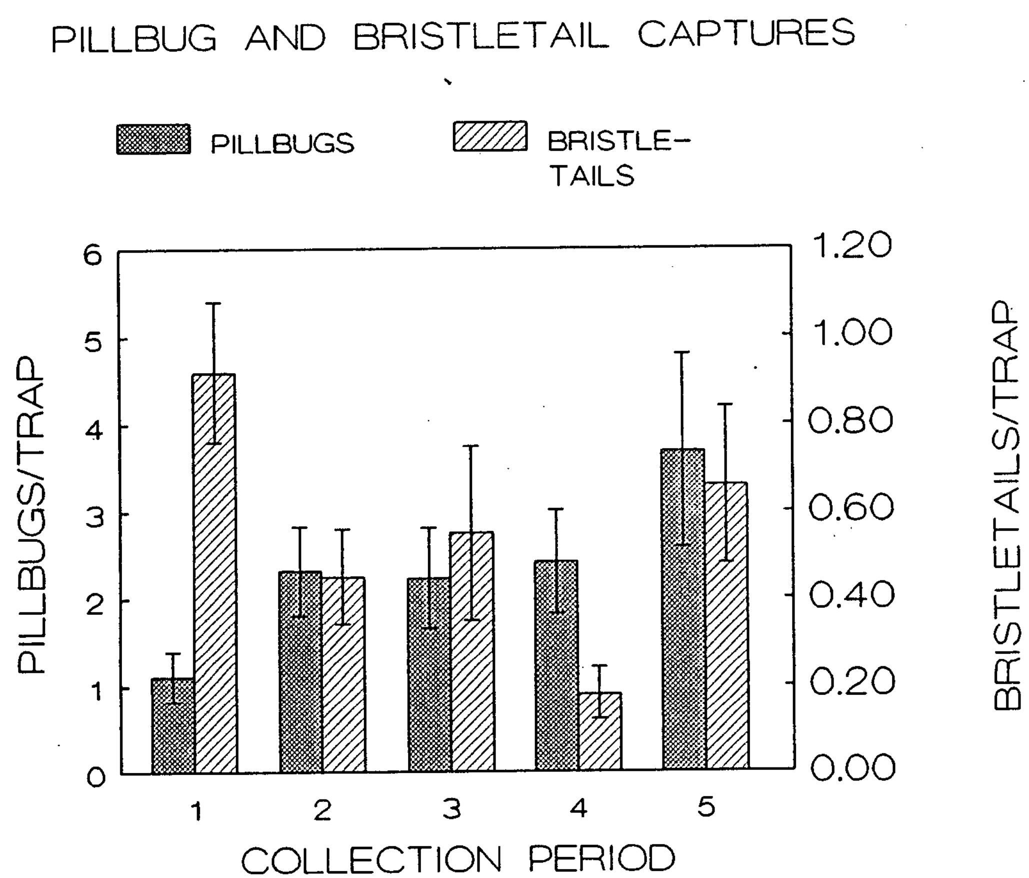
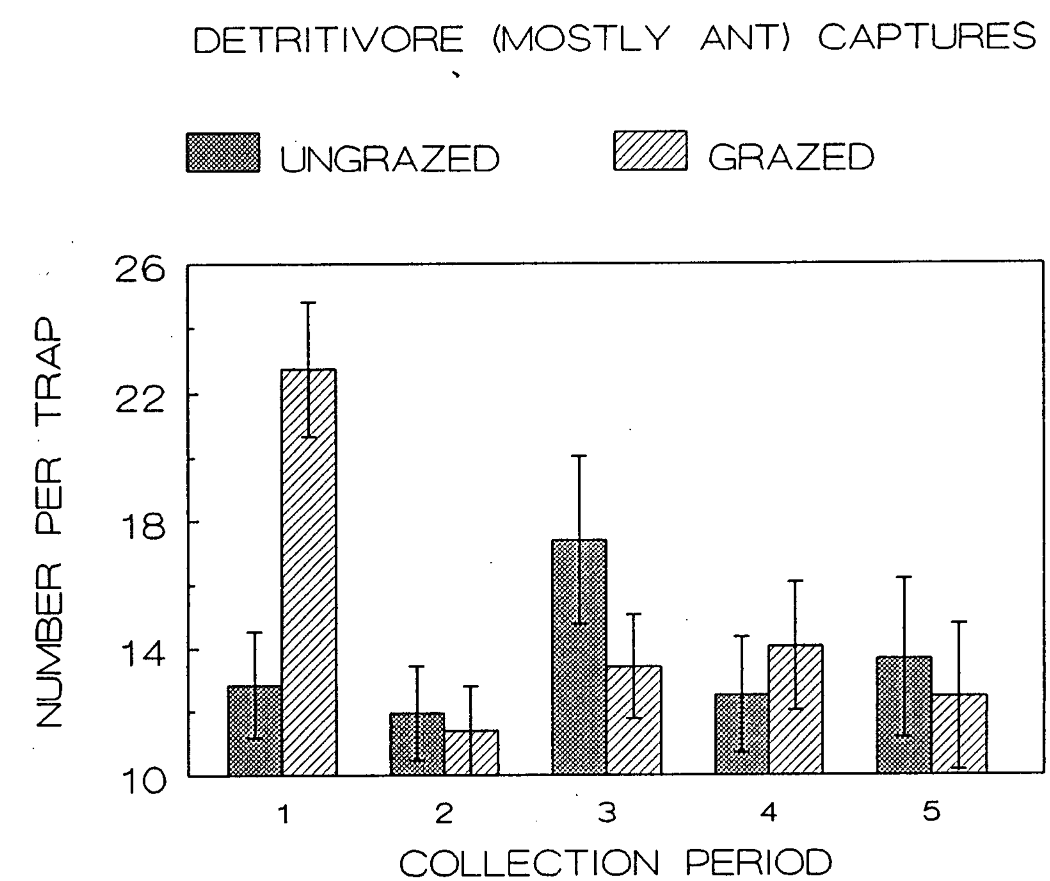

PILLBUG AND BRISTLETAIL CAPTURES
PILLBUGS
BRISTLE-
TAILS
PILLBUGS/TRAP
BRISTLETAILS/TRAP
COLLECTION PERIOD
0
1
2
3
4
5
6
0.00
0.20
0.40
0.60
0.80
1.00
1.20

Fig 4


DETRITIVORE (MOSTLY ANT) CAPTURES
UNGRAZED
GRAZED
NUMBER PER TRAP
26
22
18
14
10
1
2
3
4
5
COLLECTION PERIOD

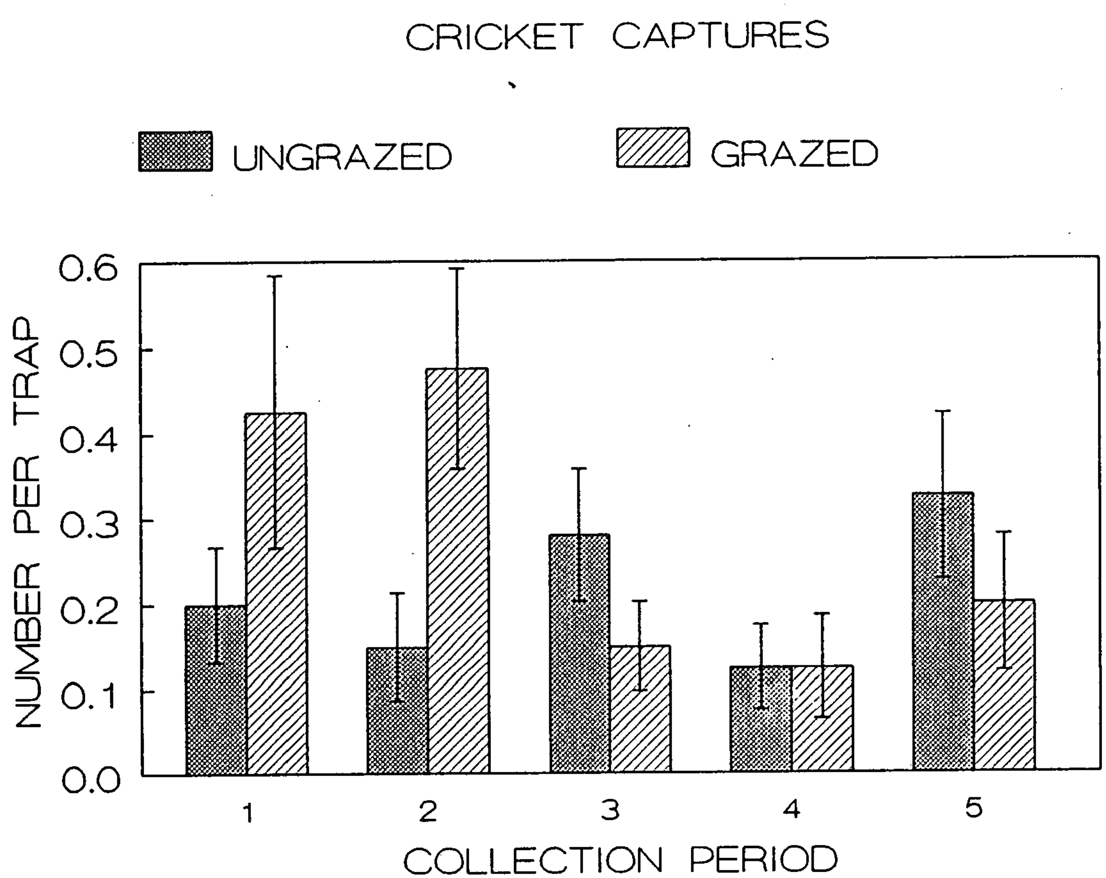

CRICKET CAPTURES
UNGRAZED
GRAZED
NUMBER PER TRAP
0.0
0.1
0.2
0.3
0.4
0.5
0.6
1
2
3
4
5
COLLECTION PERIOD

Fig 5

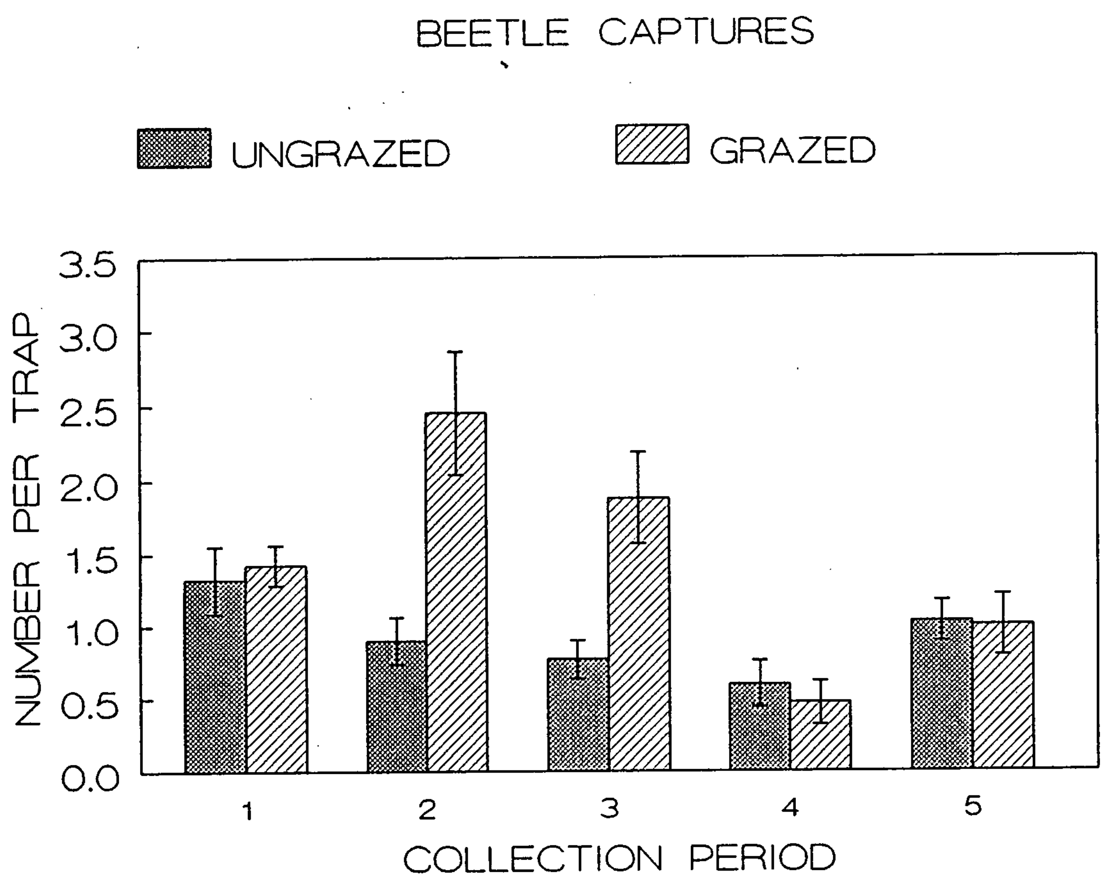

BEETLE CAPTURES
UNGRAZED
GRAZED
NUMBER PER TRAP
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1
2
3
4
5
COLLECTION PERIOD

Fig 6