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Curlew Valley Validation Site Report

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1974 PROGRESS REPORT

CURLEW VALLEY VALIDATION SITE REPORT

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ABSTRACT

The Curlew Valley Validation Site continued essentially the same data collection procedures as in 1973. Minor changes were implemented in the pitfall trapping arrangement for insect samples.

Abiotic measurements included air and soil temperatures, soil water, precipitation, solar radiation, relative humidity, wind speed and evaporation. Air temperatures were maximum in July and minimum in January, with subfreezing temperatures being recorded 9.5 months of the year. Soil temperatures decreased with depth in the summer and increased with depth in the winter, the surface experiencing the greatest temperature fluctuations. Throughout the year, soil temperatures at every depth were approximately 3 C cooler under plant cover than within interspaces. Soil water potential decreased as summer progressed, reaching less than —50 bars in July, August and September. Snow comprised 87.3% of the total precipitation, the greatest amount falling in January. Sporadic rain events occurred throughout spring, summer and fall. As compared to the two previous years, the 1974 calendar year received the least amount of rain, 106 mm less than in 1972, and 64 mm less than in 1973. Total incoming solar radiation was greatest in June and July. Relative humidity was least in June and July and greatest in December and January. Wind speed, which increased with height, was greatest in spring. The greatest amount of evaporation occurred in July, the same time of year mean air temperature peaked and precipitation declined, thus exposing the environment to potential water stress.

Plant studies in 1974 were conducted in two vegetation types at the southern validation sites; the *Artemisia-Atriplex-Sitanion* type and the *Agropyron* type. The 1974 investigations of vegetation associations dominated by annual species were made by Klikoff and Freeman as in 1973. Frequent harvest net primary production studies were conducted in the *Artemisia-Atriplex-Sitanion* community in 1973 and 1974. Summary and synthesis of the 1973 investigation, conducted in a favorable growing season, showed that above-ground production of *A. tridentata* and *A. confertifolia* was 41 and 66 g/m^2, respectively. Below-ground production was 1350 g/m^2. Root production estimates are thought to have an upwards bias. Absolute production of the community was 1500 g/m^2. Net assimilation was 18.75. Relative productivity was 0.5. Production in terms of energy was 5000 $kcal/m^2$, constituting an absolute energy efficiency of 1.20%. The nitrogen content of the new growth was 11 g/m^2, yielding a 0.23 turnover rate for both above- and below-ground components. Compared to the prior year, 1974 was a relatively dry growing season and the net primary productivity of the community was significantly less than in 1973. *A. tridentata* produced 16 g/m^2 above-ground, *A. confertifolia* 26 g/m^2 and *S. hystrix* 21 g/m^2. Estimated below-ground production was 552 g/m^2. For 1974, absolute productivity was about 600 g/m^2 with an energy content of 2400 $kcal/m^2$. Experimental exclosure studies of herbivory on *A. confertifolia* showed that if any herbivory occurred at all in 1974, consumption amounted to less than 10% of the available new growth during the growing season. In the *A. desertorum* community, 1974 standing crops of above-ground, below-ground and litter components were estimated along with above-ground production as in 1971, 1972 and 1973. Values for all four years are presented. Equations are shown predicting above-ground biomass per *A. desertorum* plant given plant volume, and above-ground standing crop (kg/ha) given growing-season precipitation. Nutrient contents of *A. desertorum* biomass components were investigated. Findings showed that calories, ash and fats fluctuated with biomass from year to year, while nitrogen fluctuated somewhat independently of biomass.

Rodents were sampled on the southern shrub and grass sites in August 1974, and trapping data from 1971 through 1974 were combined for analysis. Population levels were calculated by eight different estimators. The minimum biomass and density estimate, based on the number of animals actually captured, was selected as the most realistic estimator of small mammal populations. Mean home range, calculated from all trapping records, was used as a standard home range for *Peromyscus maniculatus*, *Perognathus parvus* and *Eutamias minimus*. These three species remain the dominant rodents in Curlew Valley. *Eutamias* populations have been stable since 1971, while *Peromyscus* peaked in 1972 and *Perognathus* in 1973. There was no correlation between mammal densities and changes in precipitation. Changes in numbers of these three species in the HAL-ART and ANNUALS sites seem to indicate a seasonal shifting of rodents among vegetation types. Jackrabbits were censused on the south shrub site in October 1974, and their numbers continued to decline. As in the previous year, no attempt was made to sample birds, reptiles or amphibians. The paucity of individuals in each of these groups and the lack of data to suggest they are functionally important remain persuasive criteria for this decision.

Emergent traps, D-Vac and pitfall sampling methods were employed over an eight-month field season in three vegetation types. Vacuum results show that the ANNUALS type had highest seasonal biomass (g/m^3 plant canopy), whereas the shrub type (ART-ATR-SIT) had the highest seasonal density ($\#/m^3$ plant canopy)

of invertebrates. Peak density periods (months) for eight vacuumed plants are as follows: *Agropyron desertorum* (September, 35.9); *Artemisia tridentata* (August, 52.9); *Sitanion hystrix* (July, 172.7); *Chrysothamnus viscidiflorus* (September, 46.0); *Atriplex confertifolia* (July, 127.3); *Bassia hyssopifolia* (July, 111.6); *Halogeton glomeratus* (July, 99.8); *Descurainia pinnata* (April, 174.4). *Atriplex confertifolia* had consistently higher invertebrate densities than any of the other seven vacuumed plants. Pitfall results indicated that *Nysius ericae* (Lygaeidae) had the highest density in the ANNUALS type; Formicidae (Hymenoptera) in the ART-ATR-SIT type; and Lycosidae (Araneida) in the AGRDES type. Carabid beetles also had high densities in all three vegetation types. Taxonomic composition analysis showed that Hymenoptera comprised 39% of the total species recorded at Curlew Valley. Hymenoptera, Diptera and Coleoptera make up 79% of the total insect fauna. Breakdown of trophic level components indicates that 59% of the adult insects are herbivorous and 34% carnivorous. Immature forms consist of 40% herbivorous and 44% carnivorous.

ACKNOWLEDGMENTS

Individuals contributing to the Curlew Valley Validation Site work in 1974 are listed below:

Category	Assistance in laboratory or field	Authorship in report
Abiotic	R. D. Anderson, M. J. Perlmutter, R. S. Shinn	M. Merritt
Plants	R. D. Anderson, M. J. Perlmutter, R. S. Shinn	R. S. Shinn
Invertebrates	C. Gist, W. Osborne, R. Schwarze, N. Unhanand, P. Sferra, N. Bohart	W. Osborne
Vertebrates	R. D. Anderson, R. S. Shinn	R. D. Anderson
Data processing	K. Marshall, C. Romesburg	

DATA COLLECTION DESIGN

System Component	Parameters Measured	DSCODE	North Shrub 1973	North Shrub 1974	North Grass 1973	North Grass 1974	South Shrub 1973	South Shrub 1974	South Grass 1973	South Grass 1974	Reported on Page
Meteorological	Weather	BJM2,4									
	Air Temperature					end Sept.			X	X	9
	Relative Humidity					end Sept.			X	X	
	Wind Speed (2 meters)					end Sept.			X	X	
	Wind Speed (.5 meters)					end Sept.			X	X	
	Precipitation (recording gauge, rain)					end Sept.			X	X	
	Precipitation (overflow cans, snow)					end Sept.			X	X	
	Soil Surface Temperature					end July			end July	X	
	Soil Temperature (7 depths at weather station)								X	X	
	Evaporation Rate (recording meter)							X			
	Temperature Profile										
	Air Temperature Profile (recording thermographs; several heights; shaded, plant canopy, interspaces, 9 locations)							X			
	Soil Temperature Profile (recording thermo graphs; 4 depths)							X			
Soils	Soil Temperature and Water Potential (thermocouple psychrometers)	BJP5					X	X		X	9
	Two Vegetation Types, shaded and interspace, 4 depths						X				
	Four Vegetation Types, shaded and interspace, 4 depths							X		X	
Vegetation Above Ground	Biomass (off-site)	BJC1-4					X		X		14-21
	Species						X		X		
	Size (cm)						X		X		
	Cover (cm^2)						X		X		
	Basal Area (cm^2)						X		X		
	Phenology						X		X		
	Sex						X		X		
	Dry Weight						X		X		
	Biomass Dynamics of Shrub Components	BJS3	X				X	X			14-21
	Species (ARTTRI and ATRCON)		X				X	X			
	Actual Size (cm)		X				X	X			
	Basal Area (cm^2)		X				X	X			
	Dry Weight Woody Stems (g)		X				X	X			
	Dry Weight Young Stems (g)		X				X	X			
	Dry Weight Leaves (g)		X				X	X			
	Dry Weight Inflorescence (g)		X				X	X			
	Dry Weight Seeds (g)		X				X	X			
	Dry Weight Deadwood (g)		X				X	X			
	Total Dry Weight (g)		X				X	X			
	Estimated Age (yrs) (ARTTRI only)		X				X	X			
	Biomass Dynamics of Grass Components	BJY4							X	X	14-21
	Species								X	X	
	Dry Weight New Growth								X	X	
	Dry Weight Old Growth								X	X	
	No. Seed Heads								X	X	
Litter	Necromass Dynamics of Litter Components	BJD3-4					X	X	X	X	14-21
	Dry Weight Wood (g)						X	X	X	X	
	Dry Weight > 2mm (g)						X	X	X	X	
	Dry Weight < 2mm (g)						X	X	X	X	
	Dry Weight Fecal Litter (g)						X	X	X	X	
	Total Dry Weight						X	X	X	X	
Below Ground	Dynamics of Root Biomass	BJE3-4					X	X	X	X	14-21
	Species						X	X	X	X	
	Type						X	X	X	X	
	Dry Weight 0-20 cm (g)						X	X	X	X	
	Dry Weight 21-40 cm (g)						X	X	X	X	
	Dry Weight 41-60 cm (g)						X	X	X	X	

Data Collection Design, continued

System Component	Parameters Measured	DSCODE	North Shrub 1973	North Shrub 1974	North Grass 1973	North Grass 1974	South Shrub 1973	South Shrub 1974	South Grass 1973	South Grass 1974	Reported on Page
		MM01					X	X	X	X	14-21
Nutrient Analysis	For each plant part by species:										
	Calories/g Dry Weight						X	X	X	X	
	Ash Content %						X	X	X	X	
	Ash Free Calories/(g)						X	X	X	X	
	% Protein						X	X	X	X	
	% Carbohydrates						X	X	X	X	
	% Fat						X	X	X	X	
		MM2A,B					X	X	X	X	
Chemical Analysis	For each plant part by species:										
	Phosphorous %						X	X	X	X	
	Potassium %						X	X	X	X	
	Calcium %						X	X	X	X	
	Magnesium %						X	X	X	X	
	Silicon %						X	X	X	X	
	Zinc %						X	X	X	X	
	Copper ppm						X	X	X	X	
	Iron ppm						X	X	X	X	
	Manganese ppm						X	X	X	X	
	Boron ppm						X	X	X	X	
	Aluminum ppm						X	X	X	X	
	Titanium ppm						X	X	X	X	
	Cobalt ppm						X	X	X	X	
	Molybdenum ppm						X	X	X	X	
	Strontium ppm						X	X	X	X	
	Barium ppm						X	X	X	X	
	Lead ppm						X	X	X	X	
	Sodium ppm						X	X	X	X	
	Sodium %						X	X	X	X	
	Plant, Root, and Litter	BJC5					X		X		
	Plot Synthesis Biomass gm/m^2						X		X		
Invertebrates	Biomass - Soil (2500 cc sample, bi-weekly)	BJX1,2,3					X		X		23
	Invertebrate Taxa						X		X		
	Number						X		X		
	Stage						X		X		
	Feeding Type						X		X		
	Dry Weight						X		X		
	Vegetation Species						X		X		
	Soil Surface Temperature, °C						X		X		
	Air Temperature @10 cm, °C						X		X		
	Relative Humidity @10 cm						X		X		
	Time of Day						X		X		
	Biomass - Surface (Pit-fall sample, weekly)	BJZ1,2,3					X		X		24
	Invertebrate Taxa						X		X		
	Number						X		X		
	Stage						X		X		
	Feeding Type						X		X		
	Dry Weight						X		X		
	Vegetation Species						X		X		
	Cover %						X		X		
	Biomass - Above Ground (D-Vac sample, bi-weekly)	BJX1,2,3					X		X		23
	Invertebrate Taxa						X		X		
	Number						X		X		
	Stage						X		X		
	Feeding Type						X		X		
	Dry Weight						X		X		
	Vegetation Species						X		X		
	Plant Height						X		X		
	width, 2 heights						X		X		
	length, 2 heights						X		X		
	cover %						X		X		
	Soil Surface Temperature °C						X		X		
	Air Temperature @ 10 cm, °C						X		X		
	Relative Humidity @10 cm						X		X		
	Time of Day						X		X		
	Insect Emergence (weekly)	BJX5,6,7					X		X		24
	Invertebrate Taxa						X		X		
	Number						X		X		
	Stage						X		X		
	Feeding Type						X		X		
	Dry Weight						X		X		
	Vegetation Species						X		X		
	Height						X		X		
	Cover %						X		X		

Data Collection Design, continued

System Component	Parameters Measured	DSCODE	North Shrub 1973	North Shrub 1974	North Grass 1973	North Grass 1974	South Shrub 1973	South Shrub 1974	South Grass 1973	South Grass 1974	Reported on Page
	Biomass - Soil (2500 cc							X		X	
	sample, biweekly)										
	Invertebrate taxa							X		X	
	Number							X		X	
	Stage							X		X	
	Feeding type							X		X	
	Dry weight							X		X	
	Vegetation Species							X		X	
	Relative Humidity										
	@ 10 cm							X		X	
	Time of Day							X		X	
	Biomass - Surface										
	(pit-fall traps,										
	3 days per week)							X		X	
	Invertebrate taxa							X		X	
	Number							X		X	
	Stage							X		X	
	Feeding type							X		X	
	Dry weight							X		X	
	Vegetation Species							X		X	
	Time of Day							X		X	
	Biomass - Above Ground										
	(D-Vac sample, weekly)							X		X	
	Invertebrate taxa							X		X	
	Number							X		X	
	Stage							X		X	
	Feeding type							X		X	
	Dry weight							X		X	
	Vegetation Species							X		X	
	Plant height							X		X	
	width @ 2 heights							X		X	
	length @ 2 heights							X		X	
	cover %										
	Phenology							X		X	
	Relative Humidity										
	@ 10 cm							X		X	
	Time of Day							X		X	
	Insect Emergence										
	(sampled bi-weekly)							X		X	
	Invertebrate taxa							X		X	
	Number							X		X	
	Stage							X		X	
	Feeding type							X		X	
	Dry weight							X		X	
	Vegetation Species							X		X	
	% cover							X		X	
	Time of Day							X		X	
Vertebrates											
Rodents	Biomass - on site	BJH1-4	X		X		X	X	X	X	48
	Periodic samples (April,										
	June, August)		X		X		X	August only	X	August only	
	Species		X		X		X	X	X	X	
	Sex		X		X		X	X	X	X	
	Age		X		X		X	X	X	X	
	Nipple Condition		X		X		X	X	X	X	
	Vaginal Condition		X		X		X	X	X	X	
	Testical Condition		X		X		X	X	X	X	
	Weight		X		X		X	X	X	X	
	Density		X		X		X	X	X	X	
Lagomorphs	Jackrabbit Biomass	BJI1					X	X			52
	Density (drive count)						X	X			

FINDINGS

ABIOTIC

M. Merritt

Air Temperature

Bihourly hygrothermograph readings were recorded continuously and entered in the data bank (DSCODE A3UBDM2). Biweekly minima, maxima and mean temperatures are shown in Table 1. Note that below-freezing temperatures were recorded 9.5 months of the year. December, January and February mean temperatures were subfreezing, the spring thaw beginning in March. July and August mean temperatures were maximal for the year.

Precipitation

A weighing, recording rain gauge continuously measured rainfall events, duration and the amount of precipitation. Snow was captured in a 20-cm diameter can and weighed weekly. Table 2 shows monthly total rain events, total precipitation (rain and snow), mean rainfall rate and mean snow depth. The greatest amount of rain fell in the spring and fall, but July and August experienced some rain as well. Snow covered the ground for nearly four months, with the greatest amount present in January.

Figure 1 compares the total yearly and mean monthly precipitation between 1972, 1973 and 1974. The total amount of precipitation steadily decreased over the three-year span, demonstrating nearly a 100-mm difference between 1972 and 1974.

Solar Radiation

A star pyrometer was used to integrate voltage received and record values in millivolts hourly. Values entered in the data bank are converted into total langleys per day. In Figure 2, a two-variable cubic regression ($r^2 = .84$) indicates that total incoming solar radiation is greatest in June and July.

Relative Humidity

A hygrothermograph continuously records bihourly readings approximating percent relative humidity. In Figure 3 a two-variable parabolic regression ($r^2 = .82$) indicates that relative humidity is least in June and July and greatest in December and January.

Wind Speed

Totalizing anemometers which record wind speed were read weekly. In Figure 4, a cubic regression of values taken at .5 m ($r^2 = .51$) and 2 m ($r^2 = .57$) indicates that speeds are highest in spring and lowest in winter. Wind speed is greater at 2 m than at .5 m.

Soil Temperature

Thermocouples installed just below the surface, at 5, 15 and 30 cm, both in interspaces and under plant cover, record temperatures bihourly. Temperatures per depth were averaged per month and are illustrated in Figures 5 and 6. In both exposed and covered conditions, temperatures decreased with depth in the summer and increased with depth in the winter. Thus, the surface experienced the greatest temperature fluctuations while temperatures at 30 cm fluctuated the least. Thermocouples under plant cover registered temperatures approximately 3 C cooler in nearly every instance.

Soil Water

Thermocouple psychrometers were installed in four vegetation types in both interspaces and under plant cover at depths of 5, 15, 30 and 50 cm. Readings were taken weekly for six months. Figure 7 shows that, as summer progressed, the more shallow depths experienced a decrease in soil water potential, finally exceeding —50 bars in July, August and September.

Evaporation

A weather measure (E-801) recording evaporimeter, located in the shade at 30 cm above ground level, records evaporation bihourly. Data were averaged per month for six months. As Figure 8 shows, the greatest amount of evaporation occurred at the same time mean air temperature peaked. During the interval of high evaporation and air temperatures, precipitation was minimal, thus exposing the environment to a potential situation of water stress.

Table 1. Biweekly air temperature (° C)

Month	Minimum	Maximum	Mean
1	-21.7	1.1	-11.2
	-10.6	8.3	- 2.5
2	-17.8	4.4	- 6.6
	-13.3	7.8	- 2.8
3	- 6.7	13.9	2.0
	-10.0	16.7	3.5
4	- 6.1	14.4	4.7
	- 6.1	23.9	6.0
5	- 3.9	24.4	11.0
	- 1.1	29.4	10.1
6	- 1.7	34.4	14.7
	5.6	37.2	12.4
7	4.4	37.8	24.0
	8.9	36.1	23.4
8	3.9	33.3	23.9
	2.8	35.0	19.3
9	- .6	33.9	20.1
	- 5.6	30.6	16.4
10	- 2.8	26.1	14.8
	- 3.9	25.6	9.1
11	- 4.4	15.6	4.8
	- 6.1	11.7	3.1
12	- 8.9	8.3	- .2
	-14.4	6.1	- 1.9

Table 2. Monthly precipitation (mm)

MONTH	NO. RAIN EVENTS	RATE RAINFALL (mm/hr)	PRECIP AS RAIN (mm)	PRECIP AS SNOW (mm)	$\bar{X}$ SNOW DEPTH (mm)
1	--	--	--	61.9	138.2
2	--	--	--	29.7	98.5
3	--	--	--	2.8	Trace
4	5	23.4	2.0	--	--
5	1	5.0	.5	--	--
6	--	--	--	--	--
7	2	6.4	6.4	--	--
8	3	7.6	3.8	--	--
9	--	--	--	--	--
10	11	25.7	2.1	--	--
11	2	18.5	.8	--	--
12	--	--	--	27.9	35.6

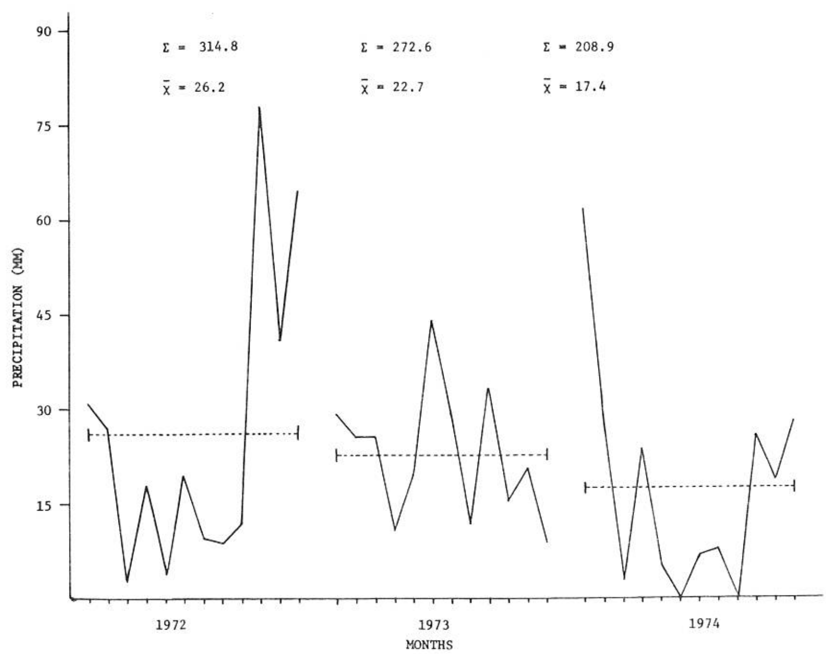

Figure 1. Monthly precipitation (mm) for 1972, 1973 and 1974.

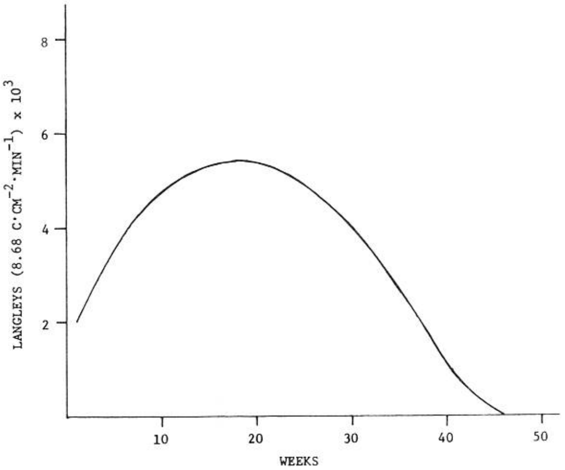

Figure 2. Two-variable cubic regression of solar radiation (langleys) at Snowville, Utah (r^2 = .84).

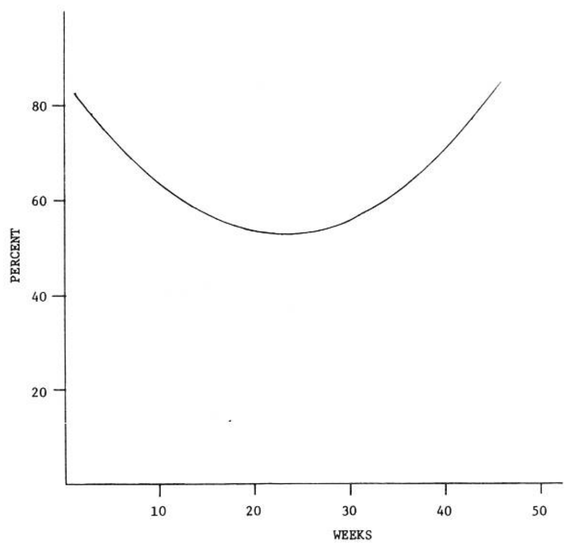

Figure 3. Two-variable parabolic regression of percent relative humidity (r^2 = .82).

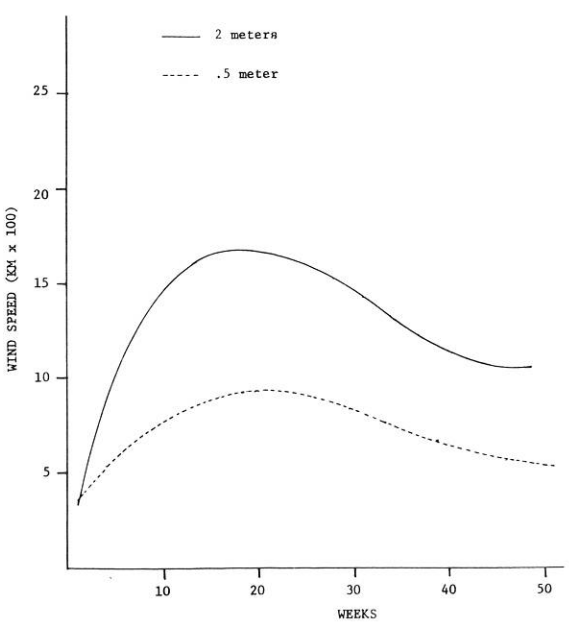

Figure 4. Two-variable cubic regression of wind speed (km) at .5 m (r^2 = .51) and 2 m (r^2 = .57).

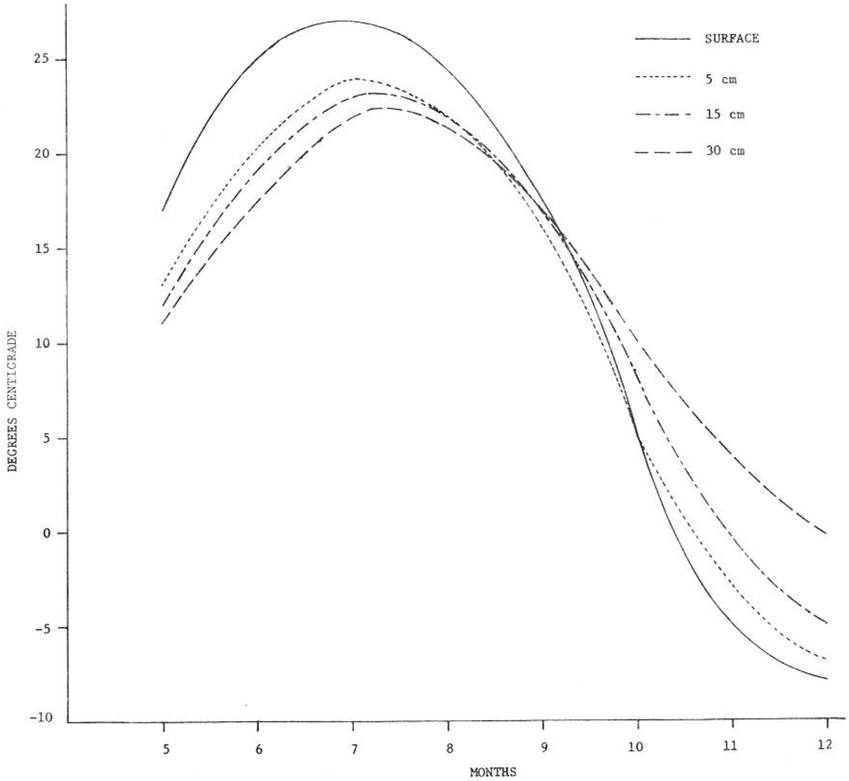

Figure 5. Soil temperatures (° C) at the surface, 5, 15 and 30 cm in plant interspaces.

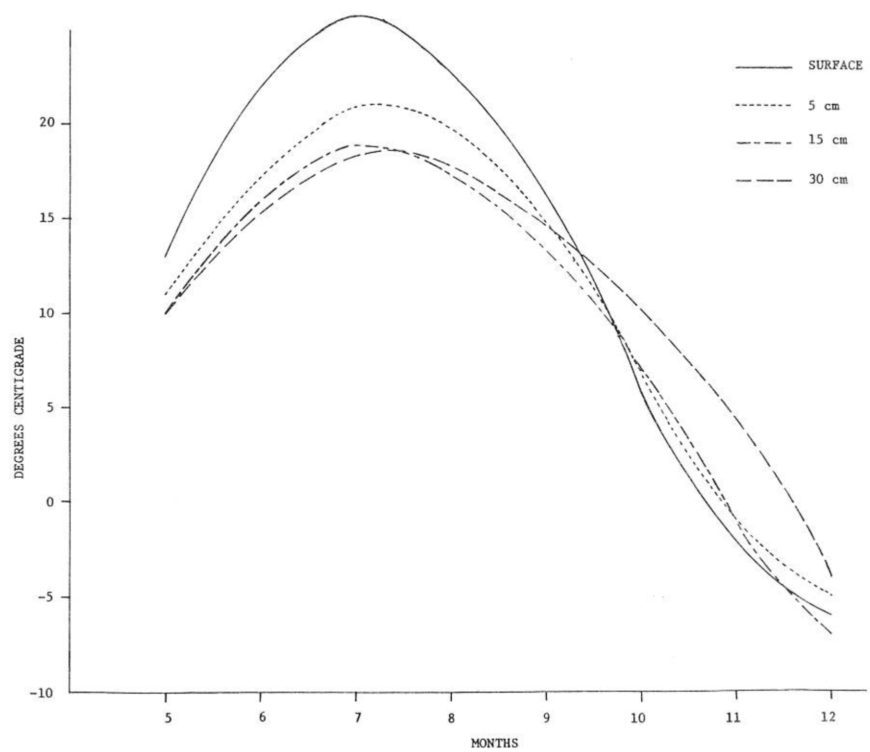

Figure 6. Soil temperatures (° C) at the surface, 5, 15 and 30 cm under plant cover.

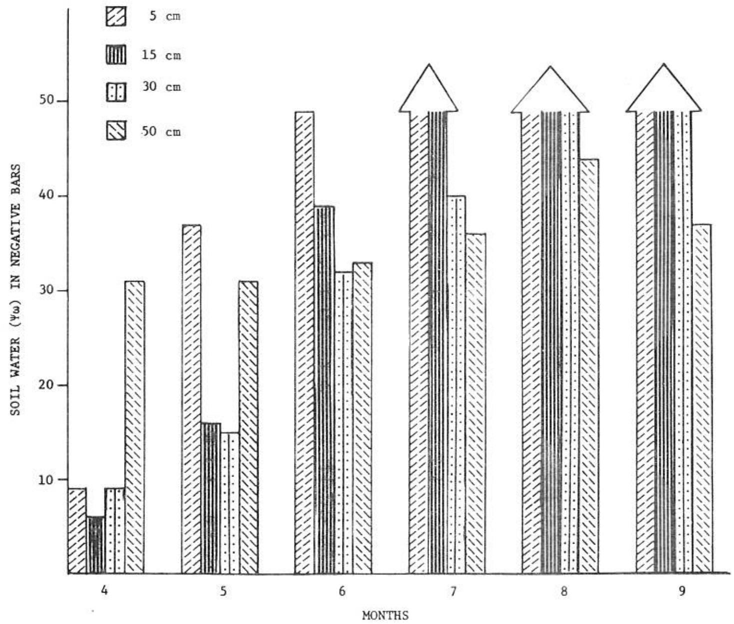

Figure 7. Soil water (negative bars) at 5, 15, 30 and 50 cm.

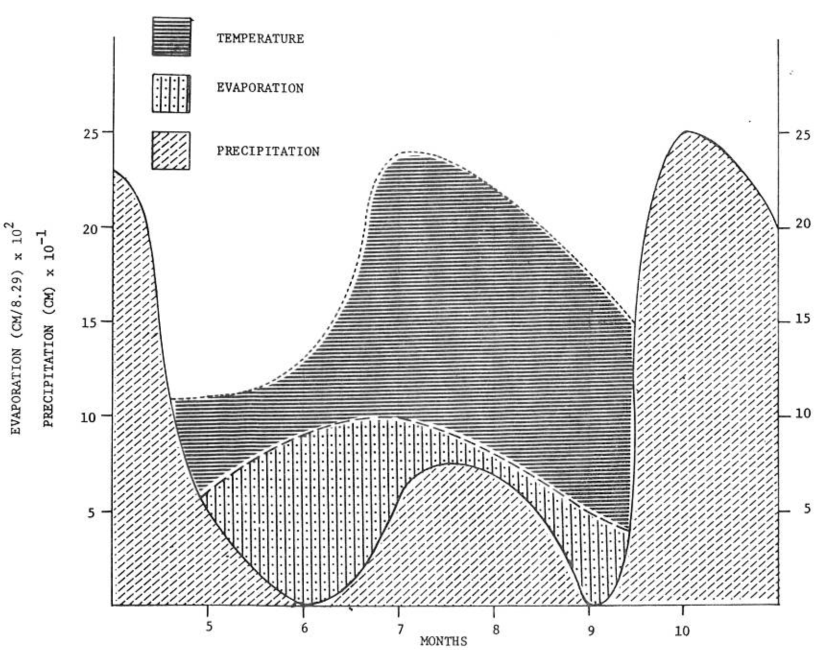

Figure 8. Evaporation (cm/8.29) x 10^2, correlated with precipitation (cm) x 10^{-1} and air temperature (°C).

PLANTS

R. S. Shinn

Plant validation studies for 1974 in Curlew Valley were conducted in two vegetation types: the *Artemisia-Atriplex-Sitanion* type and the *Agropyron* type. The 1974 investigations of vegetation associations dominated by annual species were investigated by Klikoff and Freeman (1974) as in 1973.

Artemisia-Atriplex-Sitanion

In 1974, two types of studies were conducted in the ART-ATR-SIT vegetation association. The frequent harvest method was used in a continuation of investigations begun in 1973 on net primary production of shrubs, *Artemisia tridentata* and *Atriplex confertifolia*. These investigations were expanded in 1974 to include squirrel-tail grass (*Sitanion hystrix*). The second set of studies were field experiments designed to determine the extent and sources of herbivory suffered by a field population of *A. confertifolia*.

The ART-ATR-SIT vegetation association comprises 60 ha of the 200 ha south of the Curlew Valley Validation Site. The structure of this community was quantitatively documented in 1971 and 1972 and reported in Balph et al. (1974).

The ART-ATR-SIT association is dominated by three plot species; the shrubs *Artemisia tridentata* and *Atriplex confertifolia*, and the grass *Sitanion hystrix*. Plant densities average one, two and seven plants per m^2, respectively. Above-ground spring biomasses are about 300, 150 and 15 g per m^2, respectively. Spring root mass for the community is an estimated 3000 g/m^2. The spring root:shoot ratio is therefore about 6:1. Accumulated litter necromass is about 625 g/m^2.

Following satisfactory documentation of community structure in 1971 and 1972, investigations into community function were begun in 1973 and continued in 1974. The objectives of this work were quantification of primary production, energy flow and nutrient cycling in *A. tridentata*, *A. confertifolia* and *S. hystrix*.

The frequent harvest method (Odum 1960) was used to estimate above-ground production. Below-ground production was estimated by using frequent core-sampling techniques (Dahlman and Kucera 1965). Litter dynamics were followed, using accumulated ground-litter samples in conjunction with litter-traps (Medwecka-Kornas 1971). Harvest dates were spaced regularly through the growing season. Following harvest, plant parts were analyzed for energy and nutrient content.

Results on 1973 primary productivity of *A. confertifolia* and *A. tridentata* were given by Shinn in Tables 16 and 17 in the Plants Section of the report of 1973 progress (Balph et al. 1974). In 1973, above-ground production was estimated to be 41 g/m^2 for *A. tridentata* and 66 g/m^2 for *A. confertifolia*, yielding a total of 107 g/m^2 above-ground production. Production of the community root system was estimated at about 1350 g/m^2. This figure seems excessive and may be biased by the sampling method. Further studies on root concentration and distribution patterns under shrubs are underway to clarify this matter. During the growing season, the root:shoot ratio changed from 6.4:1 in the spring to 8.3:1 at the peak of production. This implies that there was 13 times as much production below ground as above. It is expected these root production figures will be adjusted downward as more information on root dynamics is gathered.

Using the 1973 data as is, however, the absolute productivity of this shrub-type was 1500 g/m^2. The net assimilation was 1500 g/m^2 production per 80 g/m^2 leaves. The relative productivity was 1500 g/m^2 produced per 3000 g/m^2 of spring biomass. These figures indicate that the primary production of this shrub-steppe community, in a very favorable season like 1973, was as great as average production in temperate grassland ecosystems (Coupland 1975).

Energy and nitrogen analyses were recently completed on the 1973 productivity and biomass data for *A. tridentata* and *A. confertifolia* presented in Tables 16 and 17 of the Plants Section of the 1973 progress report (Balph et al. 1974).

Figures 9-14 are time-series graphs showing how biomass, nitrogen and calories of above-ground, below-ground and litter components of both species fluctuated through the growing season. In general, biomass and kcal fluctuated together, whereas nitrogen apparently fluctuated somewhat independently of the other two. In *A. confertifolia*, nitrogen content often goes down as biomass is increasing. This cannot yet be explained and may be due to random variation or error. Hopefully, logical patterns will emerge by the completion of the four-year study.

In terms of energy, productivity was about 5000 $kcal/m^2$. Making the assumption that only one half of the total incoming radiation is available for photosynthesis (Rabinowitch 1945), the absolute energy efficiency was 1.20%. This is close to the 1.21% reported by Kucera et al. (1967) for a Missouri tallgrass prairie.

The nitrogen content of the spring biomass was 36 g/m^2 and the nitrogen content of the production was 11 g/m^2. Therefore, the nitrogen turnover rate for combined above- and below-ground components was .23.

A similar study, expanded to include *S. hystrix*, was conducted in 1974. Because 1974 was a dry year, the productivity of the plant community was lower than in 1973. *A. tridentata* produced about 16 g/plant of new above-ground material and showed a below-ground increment of only 1.27 g/sample. Compare this with 41 g/plant above-ground production and a 6.08 g/sample increment below-ground for 1973. Similarly, in 1974, *A.*

confertifolia produced about 13 g/plant above-ground with a 4.25 g/sample increment below-ground compared to 33 g/plant above-ground and 5.69 g/sample below-ground in 1973. For 1974, *S. hystrix* produced 2.8 g/plant of leaves, .9 g/plant of seeds and .5 g/plant of new root crown. The 1974 energy and nutrient analyses are not yet completed.

Studies on productivity, energy flow and nutrient cycling will continue through 1976. By then, with a four-year data base and more information on root distribution, resource availability and usage, it should be possible to propose sound models for these functions.

In 1974 another functional investigation was begun on *A. confertifolia.* Its objectives were to quantify the productivity and component biomass responses of *A. confertifolia* to herbivorous activity by two classes of herbivores.

In April 1974, 60 *A. confertifolia* were selected and marked for their dimensional uniformity. Twenty of these plants served as controls and were subject to natural herbivory by rodents and insects. Twenty plants were surrounded by exclosures constructed of metal-builders flashing embedded about 5 cm in the soil. Within each exclosure, several museum special snap-traps were set and maintained throughout the experiment. These plants were kept free of rodent influences but were vulnerable to insect herbivory. A third group of 20 plants was surrounded by similar exclosures. These exclosures were coated with Tac Trap, a sticky terrestrial insect inhibitor, and the area within was treated with a systemic pesticide, Temic, every month. Thus, these plants were kept free of all rodent and insect herbivory. All 60 plants were harvested at the end of the growing season. Each plant was broken down into its component parts, dried and weighed. Analysis of variance and least significant difference tests were used to test for differences among components within treatments.

The results of this investigation yielded no significant differences among any components or any treatment (a = .10). No effects of herbivory could be shown, even though the experimental design was sensitive enough to detect 10% differences in mean weight of the components. Laboratory and field tests of the herbicide were conducted to affirm its effectiveness. Assuming that all insects on the plants and in the soil were killed within a few hours of contact, that rodent herbivory was eliminated, and that avian herbivory was insignificant, the conclusion is that herbivory on *A. confertifolia* in 1974 was less than 10% of net primary production.

This is early evidence that herbivory in shrub-steppe ecosystems may, as in forest ecosystems, be less than 10% of net primary production. This is in contrast to grassland ecosystems where herbivory ranges between 13 and 20% of NPP (Petrusewicz and Grodzinski 1975) annually. An alternative hypothesis would be that herbivory in shrub-steppe ecosystems is a randomly occurring episodic event of large magnitude. There is evidence to support this. For example, when lagomorphs (*Lepus californicus*) browse *A. confertifolia* in the spring, they clip one-third to two-thirds of the total above-ground biomass of the plant. Another example is the ability of the sagebrush defoliator moth (*Agoseris websteri*) to destroy hectare-sized patches of sagebrush. In either case, herbivorous effects on vegetation in this community are unlikely to be measurable on a year-to-year basis; rather, they are likely to be episodic and/or of a nature that will have indirect rather than direct measurable effects on net primary production.

Further exclosure studies, calculation of energy requirements of consumer populations on the site, and simulations of herbivory in the field are in progress to clarify the effects of consumer organisms upon the vegetation in this ecosystem.

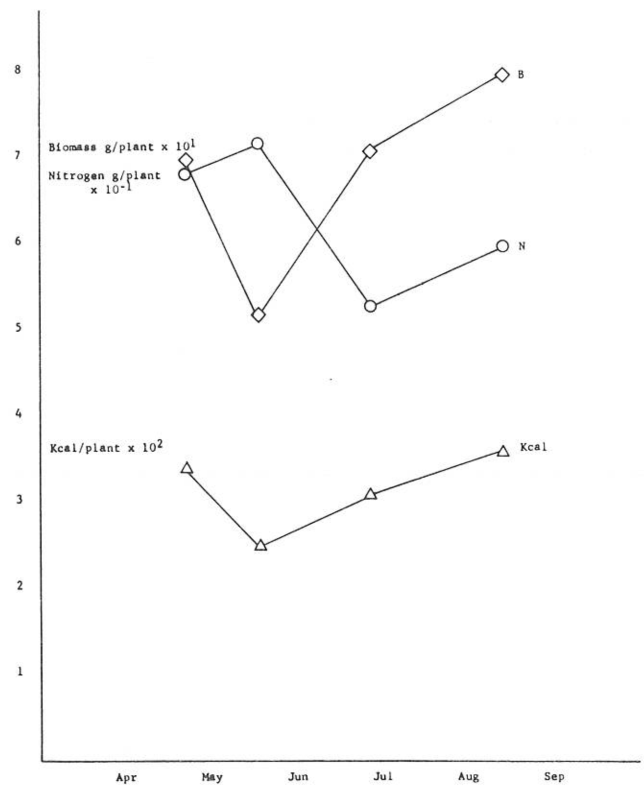

Figure 9. Biomass, nitrogen and energy fluctuations of the above-ground components of *Atriplex confertifolia* in 1973.

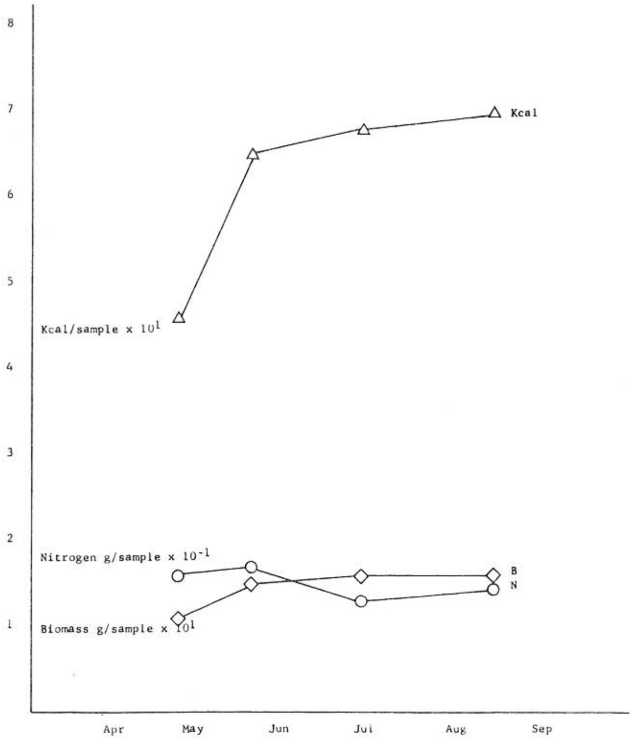

Figure 10. Biomass, nitrogen and energy fluctuations of roots sampled beneath *Atriplex confertifolia* in 1973.

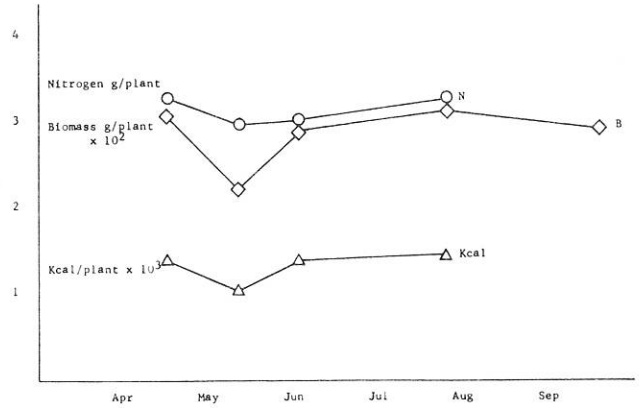

Figure 12. Biomass, nitrogen and energy fluctuations of the above-ground components of *Artemisia tridentata* in 1973.

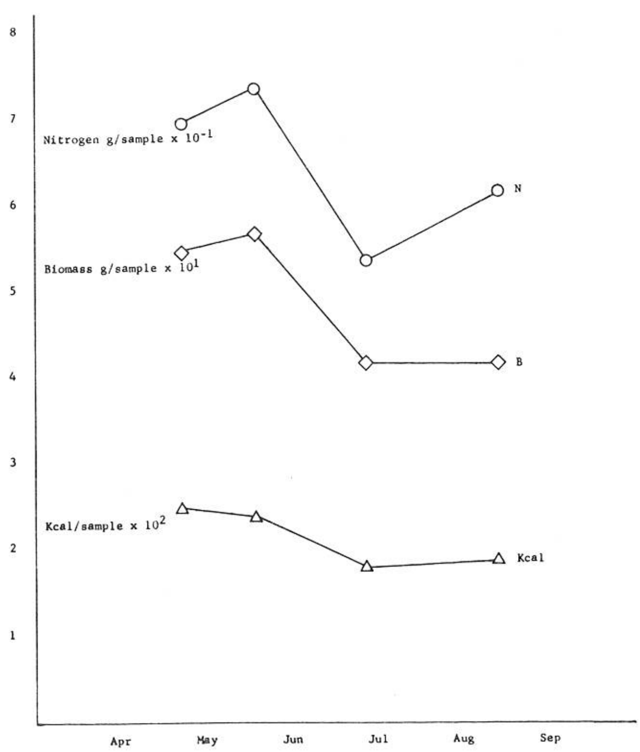

Figure 11. Biomass, nitrogen and energy fluctuations of litter sampled from beneath *Atriplex confertifolia* in 1973.

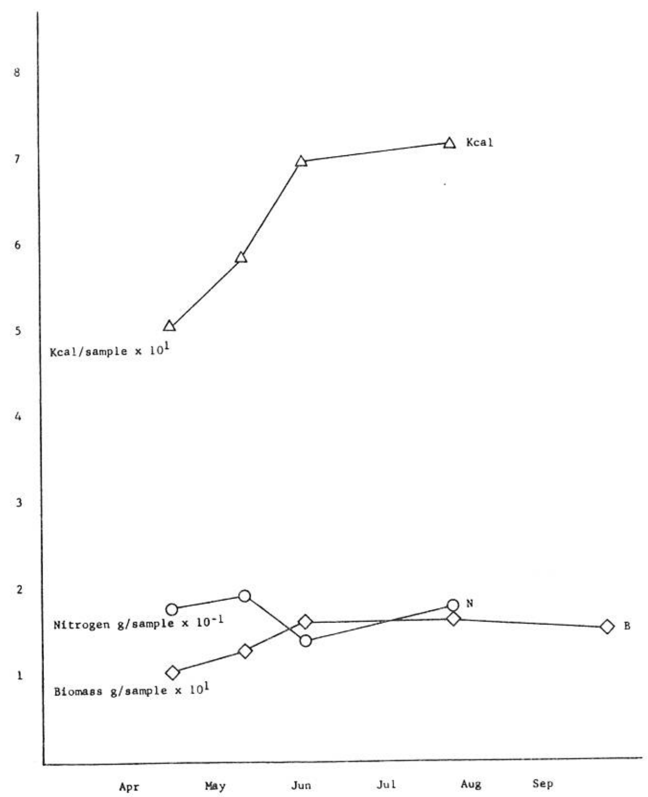

Figure 13. Biomass, nitrogen and energy fluctuations of roots sampled beneath *Artemisia tridentata* in 1973.

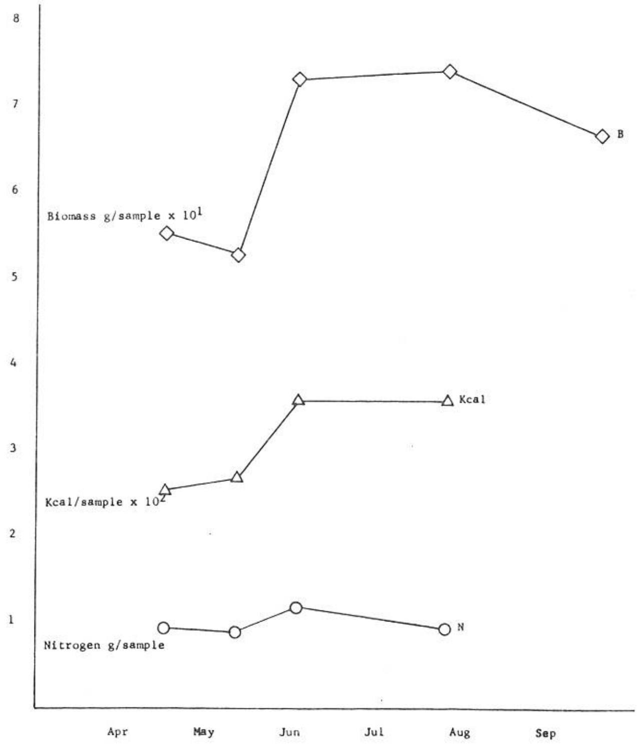

Figure 14. Biomass, nitrogen and energy fluctuations of litter sampled beneath *Artemisia tridentata* in 1973.

Agropyron

Investigations on the 100-ha *Agropyron desertorum* community began in 1971. In 1971 and in subsequent years the structure of the community was documented. This has been summarized in the plant reports (Balph et al. 1973 and 1974). In 1972, 1973 and 1974, production, energy flow and nutrient cycling were investigated using harvest techniques. Biomass, roots and litter were sampled randomly when above-ground standing crop peaked in the fall of each year. These materials were sorted, dried, weighed and chemically analyzed for protein, ash, fat and energy content. Biomass and above-ground production estimates for 1971, 1972, 1973 and 1974 are given in Table 3.

Biomass of the three components of the plant subsystem fluctuated appreciably over the four years. Above-ground biomass of *A. desertorum* was about 2400 kg/ha in 1971, 700 kg/ha in 1972, 2200 kg/ha in 1973 and 670 kg/ha in 1974. Above-ground *A. desertorum* new growth was 1900 kg/ha in 1971, 420 kg/ha in 1972, 1740 kg/hg in 1973 and 670 kg/ha in 1974. New growth on the Curlew Valley site exceeded that reported for similarly treated seedings near Benmore and Eureka, Utah, where the range of new growth production reported by Cook (1966) over the nine-year period was 52 kg/ha. The great fluctuations in biomass among years were due largely to differing annual precipitation regimes. Weaver and Albertson (1956) reported that grassland yields may vary by a factor of eight between wet and dry years.

Table 3. Above-ground production and biomass of *Agropyron desertorum* plant components

Components	1971	1972	kg/Ha 1973	1974
Aboveground new growth	1900	420	1740	340
Aboveground old growth	500	280	460	330
Total aboveground biomass	2400	700	2200	670
Coarse litter (> 2 mm)	1800	2700	1600	1600
Fine litter (< 2 mm)	3400	3300	3100	3000
Total litter	5200	6000	4700	4600
Roots 0-20 cm	8500	13000	17900	15200
Roots 20-40 cm	10000	7100	9500	9400
Total Roots	18500	20200	27300	24600

The litter mass was estimated to be 5200 kg/ha in 1971, 6000 kg/ha in 1972, 4700 kg/ha in 1973 and 4600 kg/ha in 1974. Over the four years there averaged about four times as much grass litter as above-ground grass biomass. About 40% of the grass litter occurred as coarse litter in particle sizes greater than 2 mm.

Root biomass from the soil surface to 40 cm deep was 18,500 kg/ha in 1971, 20,200 kg/ha in 1972, 27,300 kg/ha in 1973 and 24,600 kg/ha in 1974. About 60% of the roots occurred in the 0- to 20-cm zone and 40% in the 20- to 40-cm zone. Root biomass averaged 16.5 times that of the above-ground standing crop. During the four years of study it was estimated that root components comprised about 90% of the combined above-ground and below-ground biomass. One could expect the root to top biomass proportion to be high in an arid ecosystem (Bray 1963). Therefore, the Curlew Valley data are consistent with the findings of Rodin and Bazilevich (1968), who reported that root materials comprised 85% of the oven-dry peak biomass of dry steppe and temperate dry steppes of Eurasia.

The chemical content of biotic components is potentially a function of two factors: 1) the chemical concentration of the component, and 2) the weight of the component per unit area. Table 4 shows the chemical concentrations of ash elements, nitrogen and fats as well as the caloric contents of the vegetation components of the crested wheatgrass site in the fall of 1972 and 1973.

Holt and Hilst (1969) reported that the chemical composition of plants changes from day to day. Malone (1968) further reported that chemical changes occur in plants from season to season. In Curlew Valley, chemical concentrations of energy and nutrients of each *A. desertorum* component were remarkably similar in the fall of 1972 and of 1973 (Table 4). This is notable as 1972 was a dry year and 1973 a relatively wet year. The validation studies detected two exceptions; nitrogen decreased from 1.09 g to .57 g per 100 g of new *A. desertorum* shoot growth and ash elements increased from 11.96 g to 22.50 g per 100 g of old *A. desertorum* shoot growth. However, chemical concentrations remained relatively constant from one fall to the next.

Table 4. Concentrations of chemical contents in plant components collected in August 1972 and September 1973[a]

Component	Calories/gram 1972	Calories/gram 1973	% Ash by wt 1972	% Ash by wt 1973	% Nitrogen by wt 1972	% Nitrogen by wt 1973	% Fats by wt 1972	% Fats by wt 1973
New Growth *Agropyron desertorum*	4214± .71	4234±1.07	6.00± .73%	6.27±1.85	1.09<2	.57<2	4.47	4.25±3.03%
Old Growth *Agropyron desertorum*	3934± .82	3561±1.78	11.96±1.32	22.50± .21	.77<2	.95<2	2.29	2.74± .80%
Litter > 2 mm	3270± .17	3644± .50	26.88	22.33± .35	1.07<2	1.06<2	1.71	1.42±3.08%
Litter < 2 mm	2391± .19	2754± .10	46.03	40.12± .08	1.43<2	1.50<2	1.49	1.30±5.21%
Total Grass Litter								
Roots 0-20 cm	2985± .10	2848±1.50	32.81± .18	37.16± .15	1.59<2	1.53<2	.92±8.47%	.59±2.13%
Roots 20-40 cm	2981±1.75	2957± .70	32.10± .36	31.82± .03	1.52<2	1.42<2	1.08± .30%	.81±1.98

[a]Deviations about the means are all less than plus or minus two percent of the mean unless otherwise specified. Deviations were calculated by dividing the range of output by two and expressing it as a plus or minus percentage of the mean.

Table 5. Chemical contents in kilograms per hectare of the plant components collected August 1972 and September 1973

Component	Nitrogen Kg/Ha 1972	Nitrogen Kg/Ha 1973	Ash Kg/Ha 1972	Ash Kg/Ha 1973	Calories Kcal/Ha 1972	Calories Kcal/Ha 1973	Fats Kcal/Ha 1972	Fats Kcal/Ha 1973
New Growth *Agropyron desertorum*	5	10	29	108	1.77×10^6	7.36×10^6	31	74
Old Growth *Agropyron desertorum*	2	4	25	103	1.10×10^6	1.65×10^6	6	13
Total aboveground phytomass	7	14	54	211	2.87×10^6	9.01×10^6	37	87
Litter > 2 mm	29	17	737	366	8.83×10^6	5.83×10^6	46	23
Litter < 2 mm	47	46	1503	1241	7.89×10^6	8.54×10^6	49	40
Total Grass Litter	76	63	2240	1607	16.7×10^6	14.4×10^6	95	63
Roots 0-20 cm	208	273	4277	6635	38.8×10^6	50.9×10^6	120	106
Roots 20-40 cm	109	134	2304	3021	21.2×10^6	28.1×10^6	77	77
Total Roots	317	407	6581	9656	60.0×10^6	79.0×10^6	197	183
Overall Total	400	484	8875	11474	79.8×10^6	99.2×10^6	329	333

Golley (1961) reported some general energy values for plant materials. He found that above-ground parts averaged about 4 kcal/g, root materials 4.7 kcal/g and litter 4.3 kcal/g. The Curlew Valley *A. desertorum* averaged about 4 kcal/g for above-ground plant parts, 2.9 kcal/g for root materials and 3 kcal/g for litter. The discrepancies between Golley's estimates and the Curlew Valley data are not surprising. Golley (1961) stated at the conclusion of his paper that seasonal and annual variations in energy contents of plant materials were sufficiently great to discourage researchers from using general published averages. The Curlew Valley *A. desertorum* had a higher energy content than the generally published values for these components. In addition, the above-ground portions had a higher energy and nitrogen content than those reported for *A. desertorum* by Cook and Harris (1968). They reported digestible energy to be about 2 kcal/g and nitrogen about .65% of oven-dry weight late in the growing season. The Curlew Valley above-ground *A. desertorum* had a nitrogen content of about .85%.

Chemical concentrations changed little from fall to fall (Table 4). Table 3 showed that biomass fluctuated measurably from year to year. Thus, the chemical contents per hectare fluctuated primarily as a function of changing biomass. This is shown in Table 5, which gives estimates in kilograms per hectare of nitrogen, ash elements, calories and fats.

Table 5 shows that above-ground phytomass averaged about 10 kg/ha of nitrogen and 130 kg/ha of nitrogen and 8000 kg/ha of ash. Litter materials contributed about 70 kg/ha of nitrogen and 1900 kg/ha of ash. Rodin and Bazilevich (1968) estimated that combined above-ground and below-ground phytomass would yield 1060 kg/ha of nitrogen and 340 kg/ha of ash on the dry steppes and temperate dry steppes of Russia. They estimated the litter to contain about 8 kg/ha of nitrogen and 24 kg/ha of ash. West (1972), working in southeastern Idaho, reported that *A. desertorum* leaves, roots and litter contained 1.23, .70 and .65 % nitrogen, respectively. These figures demonstrate the variability in the chemical makeup of otherwise apparently similar plant communities.

Recently some efforts were made to investigate the relationships amont the plant components of *A. desertorum*. Simple regression was used to determine the extent of the relationship between grass volume and grass biomass. Simple linear regression equations predicting above-ground plant yields from simple plant measurements have been developed and reported for *A. desertorum* by Cook (1960) in Curlew Valley and Hickey (1961) in New Mexico. Hickey worked with a sample size of 923 plants and reported an r^2 of .91. His plant measurements included basal diameter, compressed crown diameter and compressed leaf length. On the Curlew Valley site, cylindrical volumes were calculated from the basal area and height data on 225 *A. desertorum* and regressed on their individual dry weights. The graph of this relationship is shown in Figure 15.

The regression formula, WT = 1.33 + .01V, accounts for 85% of the variability within the data (r^2 = .85).

An hypothesis was made that there was a precise relationship between parameters of above-ground biomass per unit area and the root biomass below that area. To test this hypothesis, the relationship between the sum of the *A. desertorum* basal areas per square meter and the estimated root biomass below that square meter was plotted. This relationship (r^2 = .04) was not precise. The relationship between *A. desertorum* above-ground biomass per square meter and below-ground biomass (r^2 = .09) was also not precise. These analyses show that neither *A. desertorum* basal nor above-ground biomass per unit area was a good predictor of below-ground biomass per unit area.

Another hypothesis was put forth that there was a precise relationship between parameters of above-ground phytomass per plot and the litter mass on that plot. To test this hypothesis, an analysis was made of the relationship between the sum of the *A. desertorum* basal areas per square meter and the sum of the litter mass on those plots (r^2 = .01). Analysis was also made of the relationship between the phytomass of the *A. desertorum* per square meter and the mass of litter on those square meters (r^2 = .01). Neither basal area of *A. desertorum* nor above-ground biomass of *A. desertorum* per square meter was a good predictor of litter mass.

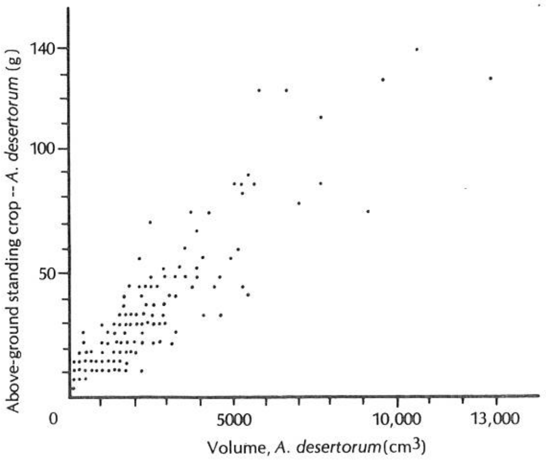

Figure 15. The relationship between volume and biomass of *A. desertorum* (y = 1.33 + .01x, r^2 = .85).

The relationships among above-ground biomass, root biomass and litter were not precise. These relationships must be considered functions of at least two dynamic processes: above-ground grass, root and litter production, and above-ground grass, root and litter disappearance (Medwecka-Kornas 1971). In deserts, production is primarily a function of total annual precipitation (Walter 1964). Disappearance is a function of rates of decay, mineralization, animal consumption, transport and harvest (West 1975). It is not probable that the outcome of these processes will be understood, or even properly measured, by making only one state measurement per year.

To continue the investigation of plant component relationships, data from four years of validation studies were used to determine whether the three primary vegetation components on the crested wheatgrass site responded precisely to different regimes of annual growing season precipitation.

The components of biomass were graphed as dependent variables. The four different precipitation regimes were graphed as the independent variables. Regression equations and coefficients of determination were calculated for each relationship. Each graph has only four points, one for each year of the study. Therefore, they have questionable statistical value. However, the graphs are important for the trends they display and the regression equations provide computable functions for the relationships.

The most basic relationships to examine were the effects of precipitation on the vegetation components of the ecosystem. Table 6 gives the growing season precipitation from 1970 through 1974. Growing season precipitation was defined as the total precipitation falling on the site from September 1 to August 31 the following year. Growing season precipitation ranged from 180 to 420 mm per year during the three years of the study. This represented 75% of the range of precipitation recorded in Snowville, Utah, during the last 24 years.

Table 6. Growing season precipitation from September 1969 to August 1973 on the Curlew Valley crested wheatgrass site

Growing Season	Precipitation
September 1969 - August 1970	350 mm
September 1970 - August 1971	420 mm
September 1971 - August 1972	180 mm
September 1972 - August 1973	380 mm
September 1973 - August 1974	210 mm

The hypothesis was made that increases in annual growing season precipitation generated increases in annual above-ground standing crops of *A. desertorum*. Several researchers have reported linear relationships between precipitation and above-ground phytomass production in semiarid areas of America (Craddock and Forsling 1938, Hutchings and Stewart 1953, Blaisdell 1958, Sneva and Hyder 1962, Currie and Peterson 1966, Rosenzweig 1968). Figure 16 shows the relationship between annual growing season precipitation and annual above-ground standing crops of *A. desertorum* on the Curlew Valley site. The rate of increase in above-ground standing crop is linear with respect to increasing precipitation. The precision is good over the range of conditions encountered. This adds further support to the theory that primary productivity in arid to semarid areas increases proportionately with increasing rainfall (Walter 1964).

A second hypothesis was made, that increases in annual growing season precipitation decrease rates of grass litter production and increase rates of litter decomposition, causing a net decrease in the mass of soil surface litter. Figure 17 shows the graph of the relationship. Further analysis shows that litter mass correlates directly with previous growing season precipitation (Figure 18). This was expected as *A. desertorum* litter falls primarily in the winter and early spring as leaf and stem parts produced the previous summer. Additionally, litter:above-ground grass ratios and growing season precipitation have an inverse relationship (Figure 19). This supports the concept that when precipitation is high, above-ground biomass is high and litter mass relatively low. When precipitation is low, above-ground biomass is low and litter mass relatively high. This relationship appears more precise than that developed between above-ground phytomass and litter previously discussed, because of the introduction of the precipitation factor. Precipitation heavily influences both production and decomposition rates in the desert.

A third hypothesis was made, that increases in growing season precipitation would generate increases in root biomass. Figure 20 shows this relationship. The scatter diagram lends no credence to the hypothesis. There are two factors which complicate the interpretation of root core data: 1) there are no generally accepted methods to distinguish live root material from dead material in the cores; and 2) there are no generally accepted methods to determine the longevity of root materials. However, Dahlman and Kucera (1965), using frequent harvest core techniques, estimated that the root turnover rate is four years in native tall grass prairie vegetation in Missouri. Also, Kucera et al. (1967) estimated that only 25% of the below-ground standing crop was living root material in their vegetation type.

Further analysis of the Curlew Valley root data shows that, if root biomass is regressed on previous growing season precipitation, the relationship is inverted (Figure 21). This may imply that the material collected in the root samples is more a function of the previous season's production and decomposition than of events of the current season.

When root biomass:above-ground biomass ratios are plotted against growing season precipitation, an inverse relationship emerges (Figure 22). This shows that the root and shoot portions of *A. desertorum* operate in a compensatory manner in response to precipitation input. When growing season precipitation is high, above-ground biomass is high and root biomass relatively low. When growing season precipitation is low, shoot biomass is low and root biomass relatively high.

Shoot:root ratios ranged from 1:7.7 to 1:12.5 during the three-year study. For perennial grasses in arid and semiarid regions, ratios between 1 and 20 have been reported (Noy-Meir 1973). Shoot:root ratios are high in arid lands for three reasons. The proportion of roots to tops increases with increasing aridity (Bray 1963). The proportion of dead to live roots can be expected to increase in arid areas where cooler, dryer conditions reduce decomposition rates (Lewis 1970). Shoot:root fractions include not only active roots and shoots but also reserve organs and below-ground litter. There may be an unusual amount of dead root material on the Curlew Valley grass site remaining from the shrub eradication program carried out in 1965.

The relationships between precipitation and root response were the least understood of the three components studied. Better methods and more frequent sampling will be required to gain better insights into the dynamics of underground plant components.

The research design calls for an understanding of how chemical contents per hectare vary as a function of different precipitation regimes. Concentrations of chemical contents in plant components have been shown to change little from fall to fall. Annual changes in chemical contents per hectare can be expected to vary closely as a function of annual changes in component biomass. Therefore, it is expected that fairly precise relationships will also be found between the chemical contents per hectare of the components and changing precipitation regimes.

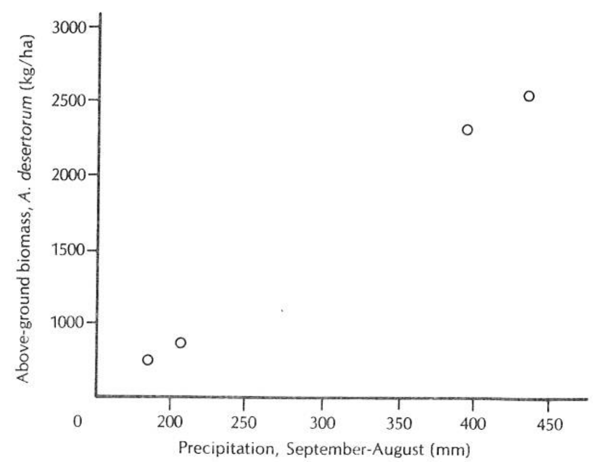

Figure 16. The relationship between growing season precipitation and the resultant August above-ground biomass of *A. desertorum*.

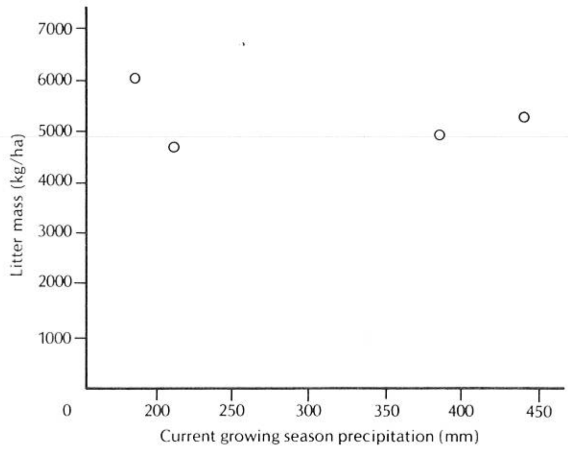

Figure 17. The trend of the relationship between current growing season precipitation and the current year's mass of *A. desertorum* soil surface litter.

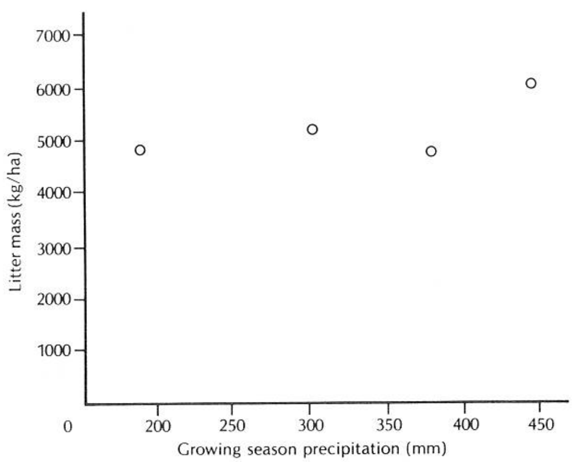

Figure 18. The trend of the relationship between preceding growing season precipitation and the current year's mass of *A. desertorum* soil surface litter.

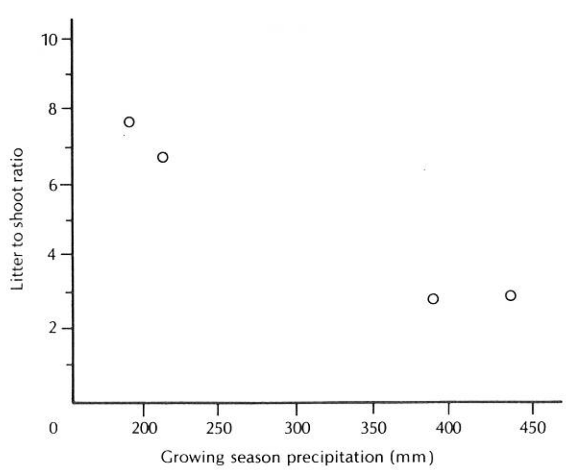

Figure 19. The trend of the relationship between growing season precipitation and annual litter mass: above-ground biomass ratios.

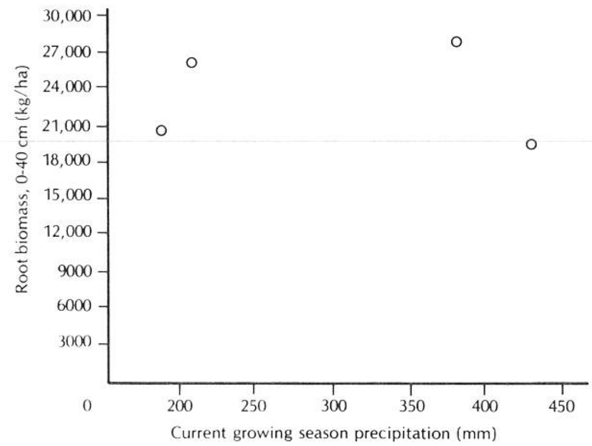

Figure 20. The trend of the relationship between current growing season precipitation and the current year's root biomass.

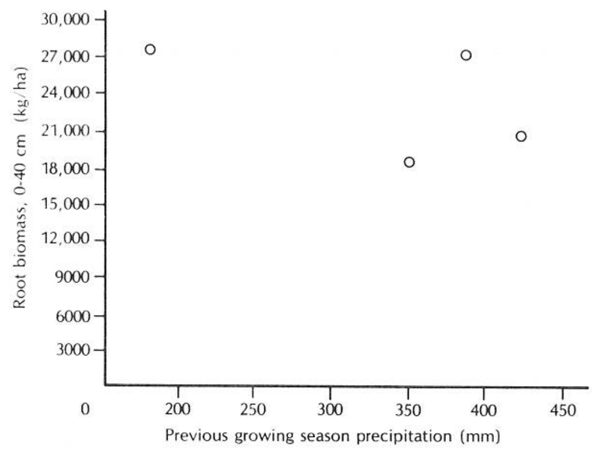

Figure 21. The trend of the relationship between previous growing season precipitation and the current year's root biomass.

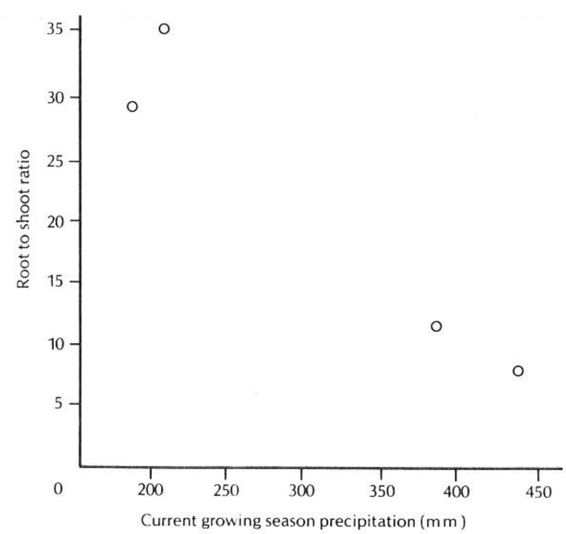

Figure 22. The trend of the relationship between current growing season precipitation and annual root biomass: above-ground biomass ratios.

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INVERTEBRATES

W. Osborne

Introduction

Invertebrate sampling has been carried out on the southern validation site since 1971, but a more detailed and diversified program was necessary for the 1974 field season. Sampling began in mid-April and ended in early November. Primary objectives were determination of the taxonomic composition, trophic structure and seasonal occurrence of Great Basin invertebrates of the Curlew Valley Validation Site. Information on structure and function of the invertebrate community associated with the cool desert herbaceous stratum could be obtained with intensive utilization and improvement of sampling techniques. A primary goal of data analysis was to determine the distribution of the insect fauna among the major taxonomic groups and the proportion of these species with herbivorous, predaceous and saprophagous feeding types.

The research area is divided into three vegetation types which are assumed to be appropriate representatives of the cool desert flora. Tables summarizing the structure and biomass of each vegetation type are in the 1973 Curlew Valley Validation Site report (Balph et al. 1973). Figure 23 illustrates the division of vegetation types with component species. Table 7 provides a key to the Curlew vegetation phenology of 1974.

Throughout the field season a systematic, rather than a random, method of sampling was employed due to the homogeneity of the vegetation types previously described (Bulan and Barrett 1971). However, vacuum samples were collected from different areas in each sampling period based on a rotational selection of sample sites.

Methods

The four primary methods of sampling Great Basin Desert invertebrates were D-Vac, pitfall trapping, emergent trapping and soil sampling. These methods were utilized in 1973 for intensive sampling and have been used through two additional field seasons with only slight modification. The D-Vac, or vacuum sample, has been utilized most efficiently for sampling shrub- and grass-infesting species that are limited in mobility and seek refuge within the vegetation when disturbed. Highly mobile familes such as Acrididae (Orthoptera), Asilidae (Diptera), Sphecidae (Hymenoptera) and Pompilidae (Hymenoptera) elude the vacuum, and are ineffectively sampled. Flush transects, sweep netting and Malaise traps would be more valuable methods for assessing their populations.

D-Vac

D-Vac sampling began April 16 and continued weekly through November 11, 1974. Three samples were taken over each dominant plant species in the shrub, grass and annual vegetation types. An individual sample was taken by rapidly placing a net-covered cage (.7 x .7 x 1 m) over the target plant and immediately recording parameters such as canopy width and length, plant height, percent cover, relative humidity and plant phenophase. Suction was then applied through the D-Vac apparatus and both plant and interior netting were sytematically vacuumed. The plant was continually manipulated throughout the suction process and insects were drawn into a nylon-organdy collection bag. The sample was then deposited in a standard Berlese funnel system for 72 hr to facilitate the separation of invertebrates from plant debris. Density (#/m^3 plant canopy) and biomass (g/m^3 plant canopy) are presented in Tables 8-31 (DSCODE A3UBJX1).

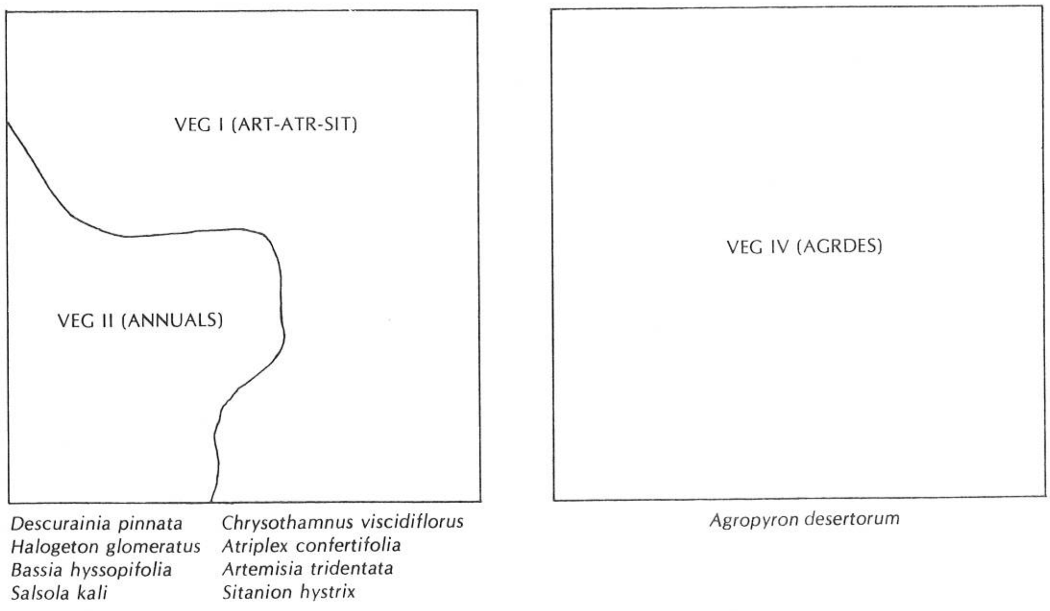

Figure 23. Curlew Valley Validation Site vegetation types.

Table 7. Curlew vegetation phenology, 1974*

Species	Leaf Bud	New Leaves or New Shoots	Floral Bud	Flowering	Seeds Present and/or Dispersing Seed	Dormant
Agropyron desertorum		Apr 16,22,29 May 6,13,20	May 28 Jun 3	Jun 10,17	Jun 24 Jul 1,8,15,22,29 Aug 12,19,26 Sep 4,9,17,23 Oct 1,14,27	Nov 11
Artemisia tridentata	Apr 16	Apr 22,29 May 6,13,20,28 Jun 3,10,17,24	Jul 1,8,15,22,29 Aug 12,19,26	Sep 4,9,17,23 Oct 1	Oct 14,27 Nov 11	
Chrysothamnus viscidiflorus	Apr 16,22,29 May 6,13	May 20,28 Jun 3	Jun 10,17,24	Jul 1,8,15,22,29 Aug 12,19,26 Sep 4	Sep 9,17,23 Oct 1,14,27 Nov 11	
Sitanion hystrix		Apr 16,22,29 May 6,13	May 20,28	Jun 3,10	Jun 17,24 Jul 1,8,15,22,29 Aug 12,19,26 Sep 4,9,17,23 Oct 1,14,27	Nov 11
Atriplex confertifolia		Apr 16	Apr 22,29 May 6,13,20,28 Jun 3	Jun 10,17,24 Jul 1,8,15,22,29	Aug 12,19,26 Sep 4,9,17,23 Oct 1,14,27 Nov 11	
Kassia hyssopifolia	Apr 16,22	Apr 29 May 6,13,20,28 Jun 3,10,17,24	Jul 1,8	Jul 15,22,29 Aug 12,19,26 Sep 4,9	Sep 17,23 Oct 1,14,27	Nov 11
Halogeton glomeratus	Apr 22,29	May 6,13,20,28 Jun 3,10,17,24 Jul 1,8,15	Jul 22,29	Aug 12,19,26 Sep 4,9,17,23	Oct 1,14,27 Nov 11	Apr 16
Descurainia pinnata		Apr 16,22	Apr 29 May 6	May 13,20,28 Jun 3	Jun 10,17,24 Jul 1,8,15,22,29 Aug 12,19,26 Sep 4,9,17,23 Oct 1,14,27	Nov 11

*Key to Curlew vegetation phenology:

1=Dormant
2=Leaf buds present
3=New leaves (shrubs) or new shoots (annuals)
4=Floral buds present
5=Flowering
6=Seeds present or dispersing seeds

Shrub volumes can be estimated from the formulas $V = 4/3\ \pi a^2 b$ and $V = \pi/3\ h(a^2+ab+b^2)$ for grasses (Pianka 1966), utilizing the parameters recorded in the D-Vac process. The number of insects per sample was divided by the number of samples to determine the mean insects per sample. Species diversity values (Tables 8-31) are based on Shannon's index (H′) as discussed by Pielou (1966), Poole (1974) and Shannon and Weaver (1963).

All invertebrates sampled in 1974 via pitfall and D-Vac were collected in cyanide kill-jars and stored in a freezer before further separation and taxonomic classification. Soil invertebrate and emergent samples were stored in 95% ETOH. All samples were oven-dried at 60 C for at least 48 hr and were then weighed for biomass determination.

Emergent Trapping

Emergent trapping was carried out by placing a conical-shaped steel frame, fitted with a fine wire mesh covering, over a target plant species and sealing it at the base with soil and fitting it with a collection jar (Fig. 24). Fifteen traps (five in each vegetation type) were sampled biweekly. Three of the five traps remained in the same position throughout the field season; the other two traps were relocated over different plants bimonthly. Emergent traps yielded data on the seasonal occurrence of plant-infesting taxa (A3UBJX2). A comparison of 1973 and 1974 results is presented in Table 32.

Pitfall

The experimental design of the pitfall trapping program was altered from that of previous years. Grid sizes were increased, traps remained in position for the entire field season and collection was done on a dry basis (not the liquid-filled collection traps used previously; Figs 25 and 26). Six pitfall grids were sampled for 28 consecutive weeks. A weekly grid sample contained all of the invertebrates trapped within the metal barrier for three consecutive days. A sample was also taken from each of the cans outside of the metal barrier. These data served as a measure of invertebrate activity within the vegetation type and also a check on the integrity of each pitfall barrier.

All samples were collected in cyanide kill-jars and were later hand-separated. Two methods of data analysis were used to calculate density and biomass. The first used the actual number of individuals per species caught within each 100 m^2-trapping grid (Janzen 1973) and the second was based on a modification of the pitfall trap design followed by Gist and Crossley (1973). Calculations were based upon the total number of invertebrates caught in three consecutive trap nights, beginning with the highest weekly capture rate. Each successive week's capture was then regressed upon the cumulative catch for the entire field season. A regression equation was derived and the ratio of the y-intercept to slope (B_0:B_1) yielded a population estimate. Confidence intervals were computed for these estimates at the 90 and 95% levels. Pitfall density and biomass estimates are presented in Tables 33-38 (A3UBJX3); coding explanation is given in Table 39.

Table 8. Average numbers of the invertebrate taxa sampled by D-Vac on *Agropyron desertorum* (#/m^3 plant canopy)

PLANT : AGRDES

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	14.51	1.74	5.03	6.46	3.76	5.97	11.00	4.37
ARA2LYC	PRE	0.00	1.12	2.65	0.00	0.00	3.55	0.00	0.00
COE2ENT	SAP	0.00	0.00	8.76	3.92	6.82	17.80	4.50	0.00
COE2SMI	SAP	0.00	0.00	0.00	8.42	0.00	0.00	0.00	0.00
COL2CHR	CHE	1.99	0.00	0.00	4.00	0.00	0.00	0.00	4.65
COL2CHRPHY	CHE	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00
COL2CRY ONE	SAP	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR FIV	CHE	0.00	0.00	0.00	2.40	0.00	0.00	0.00	0.00
COL2CUR ONE	CHE	0.00	3.48	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR THR	CHE	2.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR TWO	CHE	0.00	0.00	0.00	0.00	1.66	0.00	0.00	0.00
COL2DAS ONE	PRE	0.00	0.00	0.00	1.70	0.00	0.00	0.00	0.00
COL2DASLISINT	PRE	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2TENCONONE	CHE	0.00	2.02	0.00	0.00	0.00	0.00	0.00	0.00
COL2TENELEPIL	CHE	0.00	1.12	0.00	0.00	0.00	0.00	0.00	0.00
DIP2CEC	NON	0.00	0.00	0.00	1.78	0.00	0.00	0.00	0.00
DIP2CER	PRE	0.00	0.00	0.00	0.00	2.19	10.40	0.00	0.00
DIP2CHI	NEC	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.00
DIP2HEL	NON	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.71
DIP2PHO	SAP	0.00	0.00	0.00	4.79	2.45	0.00	0.00	0.00
DIP2SCI	SAP	0.00	0.00	1.50	2.08	2.15	0.00	0.00	0.00
HEM2LYG	SUC	0.00	0.00	1.52	0.00	0.00	0.00	0.00	0.00
HEM2LYGGEMBVIC	PRE	0.00	0.00	0.00	0.00	0.00	6.86	0.00	0.00
HEM2LYGGEO	PRE	0.00	0.00	0.00	0.00	1.88	0.00	0.00	0.00
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	0.00	9.31	3.55	10.87	5.11
HEM2LYGPERSAS	SUC	0.00	0.00	0.00	2.70	0.00	0.00	0.00	0.00
HEM2PIEPIEONE	SUC	2.42	1.80	1.59	5.10	1.37	3.37	0.00	0.00
HOM1COC	SUC	0.00	0.00	12.03	22.10	19.18	11.99	8.87	4.92
HOM1COC WHT	SUC	2.42	0.00	0.00	10.88	19.46	12.25	11.30	0.00
HOM2APH	SUC	0.00	0.00	0.00	0.00	0.00	0.00	18.48	0.00
HOM2CIC	SUC	2.07	1.86	2.09	2.77	2.29	2.54	5.65	0.00
HYM1CHA	NON	1.67	0.00	1.52	2.06	0.00	2.14	0.00	0.00
HYM2FOR	OMN	2.07	10.45	1.66	0.00	0.00	0.00	0.00	2.46
LEP	CHE	0.00	0.00	0.00	0.00	2.71	0.00	0.00	0.00
LEP	NEC	0.00	0.00	2.44	2.03	0.00	6.86	0.00	0.00
NEU2HEMMICVAR	PRE	0.00	0.00	0.00	0.00	2.98	0.00	3.89	0.00
ORT2ACR	CHE	0.00	0.00	4.63	2.28	3.11	0.00	0.00	0.00
PSE2CHEDACSIL	PRE	4.84	0.00	0.00	0.00	0.00	0.00	2.13	1.91
PSO	SAP	1.38	0.00	0.00	1.78	3.10	4.16	9.51	0.00
THS2MAC ONE	SAP	0.00	0.00	0.00	2.17	1.88	0.00	0.00	0.00
THY	SUC	0.00	0.00	0.00	1.77	2.17	0.00	21.55	0.00
PHENOLOGY STAGES		3	3 4	4 5 6	6	6	6	6	6
SPECIES DIVERSITY		0.884	0.887	0.951	1.147	1.068	1.029	0.968	0.821

Table 9. Average numbers of invertebrates per feeding type sampled by D-Vac on *Agropyron desertorum* (#/m^3 plant canopy)

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	2.136	1.938	4.626	3.162	2.545	0.000	0.000	4.647
FEEDING TYPE	NEC	0.000	1.496	2.441	2.034	0.000	6.861	0.000	0.000
FEEDING TYPE	NON	1.673	0.000	1.524	1.964	0.000	2.140	0.000	5.708
FEEDING TYPE	OMN	2.065	10.449	1.658	0.000	0.000	0.000	0.000	2.460
FEEDING TYPE	PRE	6.980	1.330	4.730	5.931	3.288	6.174	7.005	3.554
FEEDING TYPE	SAP	1.378	1.124	6.344	4.782	4.853	12.115	7.361	0.000
FEEDING TYPE	SUC	2.301	1.847	3.485	8.763	11.329	8.889	12.178	5.082
TOTAL		16.534	18.183	24.807	26.636	22.016	36.179	26.544	21.451

Table 10. Average weights of invertebrates per feeding type sampled by D-Vac on *Agropyron desertorum* (g/m³ plant canopy)

WEIGHTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.253	3.454	2.651	3.215	1.308	0.000	0.000	0.098
FEEDING TYPE	NEC	0.000	0.018	0.190	0.065	0.000	6.230	0.000	0.000
FEEDING TYPE	NON	0.025	0.000	0.012	0.031	0.000	0.011	0.000	0.365
FEEDING TYPE	OMN	0.074	1.285	0.081	0.000	0.000	0.000	0.000	0.062
FEEDING TYPE	PRE	0.642	3.360	1.138	0.774	0.354	1.027	0.396	0.178
FEEDING TYPE	SAP	0.010	0.007	0.037	0.040	0.022	0.047	0.019	0.000
FEEDING TYPE	SUC	0.056	0.145	0.130	0.101	0.091	0.118	0.196	0.068
TOTAL		1.060	8.270	4.239	4.226	1.776	7.432	0.611	0.770

Table 11. Average numbers of the invertebrate taxa sampled by D-Vac on *Artemisia tridentata* (#/m³ plant canopy)

PLANT : ARTTRI

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	0.00	3.42	6.51	4.44	4.70	4.87	6.94	6.03
ARA2LYC	PRE	0.00	0.00	5.81	3.33	0.00	5.28	0.00	0.00
COE2ENT	SAP	0.00	0.00	0.00	6.76	30.92	20.91	7.17	0.00
COE2SMI	SAP	0.00	0.00	0.00	5.07	0.00	0.00	0.00	0.00
COL2CHR	CHE	2.63	0.00	3.28	4.51	7.06	4.09	4.78	0.00
COL2CHRCRY	CHE	0.00	0.00	0.00	0.00	0.00	3.95	0.00	0.00
COL2CHRMONCON	CHE	0.00	0.00	0.00	2.45	2.79	5.90	0.00	0.00
COL2CUR FOR	CHE	0.00	2.43	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR ONE	CHE	2.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR THR	CHE	1.79	1.24	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR TWO	CHE	0.00	0.00	0.00	4.89	7.22	0.00	0.00	0.00
COL2CURAPIONE	CHE	5.05	1.71	0.00	1.72	0.00	0.00	0.00	0.00
COL2DAS ONE	PRE	11.07	0.00	0.00	0.00	0.00	0.00	2.87	0.00
COL2DASLISINT	PRE	4.75	2.93	0.00	0.00	0.00	0.00	3.82	0.00
COL2MOR ONE	CHE	0.00	0.00	3.15	0.00	0.00	0.00	0.00	0.00
COL2TEN ONE	CHE	0.00	2.21	0.00	0.00	0.00	0.00	0.00	0.00
DIP2BIB ONE	NEC	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.00
DIP2CEC	NON	0.00	0.00	6.12	0.00	0.00	0.00	0.00	0.00
DIP2CER	PRE	0.00	0.00	6.12	3.83	3.83	0.00	0.00	0.00
DIP2PHO	SAP	0.00	0.00	0.00	2.87	0.00	0.00	0.00	0.00
DIP2SCI	SAP	0.00	0.00	6.12	0.00	0.00	0.00	0.00	0.00
HEM2LYG	SUC	0.00	0.00	3.16	0.00	0.00	0.00	0.00	0.00
HEM2LYGEMBVIC	PRE	0.00	0.00	4.81	3.97	0.00	6.28	0.00	4.81
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	0.00	13.81	3.48	0.00	3.24
HEM2LYGPERSAS	SUC	0.00	0.00	0.00	3.25	0.00	0.00	0.00	0.00
HEM2MIR	SUC	0.00	2.47	0.00	0.00	0.00	0.00	0.00	0.00
HEM2NABNABALT	PRE	0.00	0.00	0.00	0.00	0.00	3.09	0.00	0.00
HEM2PENAELAME	SUC	0.00	1.71	0.00	0.00	0.00	0.00	0.00	0.00
HEM2PIEPIEONE	SUC	3.14	3.63	3.68	3.78	7.79	6.68	11.46	3.24
HOM1COC	SUC	0.00	2.57	0.00	18.82	10.10	8.48	37.75	0.00
HOM1COC WHT	SUC	1.01	0.00	0.00	3.23	13.58	0.00	0.00	0.00
HOM2CIC	SUC	2.11	3.35	4.81	4.35	3.83	3.60	0.00	0.00
HOM2FUL ONE	SUC	0.00	0.00	4.69	4.08	0.00	6.44	0.00	0.00
HOM2PSY ONE	SUC	0.00	7.49	0.00	0.00	0.00	0.00	0.00	0.00
HYM1CHA	NON	1.51	0.00	4.14	0.00	7.06	10.56	0.00	0.00
HYM2BRA	NON	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.00
HYM2FOR	OMN	2.09	7.64	19.25	5.86	0.00	0.00	3.82	3.71
LEP	CHE	0.00	0.00	1.35	0.00	0.00	25.12	0.00	0.00
LEP	NEC	0.00	1.46	3.15	4.26	3.83	2.50	0.00	0.00
LEP NOC	CHE	2.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ORT2ACR	CHE	0.00	0.00	0.00	4.27	0.00	5.28	0.00	0.00
PSE2CHEDACSIL	PRE	1.51	2.28	3.15	3.80	0.00	0.00	5.46	0.00
PSO	SAP	0.00	0.00	0.00	0.00	9.14	6.99	4.52	0.00
SCO2VEJVEJBOR	PRE	0.00	3.42	0.00	0.00	0.00	0.00	0.00	0.00
THS2MAC ONE	SAP	0.00	3.37	0.00	3.32	0.00	0.00	0.00	0.00
THY	SUC	0.00	1.68	0.00	7.64	8.86	2.74	0.00	0.00
PHENOLOGY STAGES		2 3	3	3	4	4	5	6	6
SPECIES DIVERSITY		1.009	1.240	1.151	1.295	1.082	1.172	0.823	0.685

Table 12. Average numbers of invertebrates per feeding type sampled by D-Vac on *Artemisia tridentata* (#/m³ plant canopy)

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	2.591	1.956	2.284	3.958	6.075	7.529	4.779	0.000
FEEDING TYPE	NEC	0.000	1.552	3.148	4.255	3.825	2.500	0.000	0.000
FEEDING TYPE	NON	1.515	1.735	4.801	0.000	7.063	10.564	0.000	0.000
FEEDING TYPE	OMN	2.089	7.643	19.248	5.856	0.000	0.000	3.820	3.711
FEEDING TYPE	PRE	4.265	2.749	5.486	4.193	4.523	4.875	5.488	5.724
FEEDING TYPE	SAP	0.000	3.368	6.123	5.758	26.079	19.981	5.406	0.000
FEEDING TYPE	SUC	2.359	4.358	3.945	7.649	10.333	5.324	32.495	3.241
TOTAL		12.818	23.360	45.034	31.669	57.898	50.772	51.988	12.676

Table 13. Average weights of invertebrates per feeding type sampled by D-Vac on *Artemisia tridentata* (g/m³ plant canopy)

WEIGHTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.240	0.989	0.365	2.203	0.233	3.753	0.167	0.000
FEEDING TYPE	NEC	0.000	1.867	0.246	0.342	0.945	2.270	0.000	0.000
FEEDING TYPE	NON	0.023	0.010	0.027	0.065	0.155	0.053	0.000	0.000
FEEDING TYPE	OMN	0.075	0.940	0.943	0.457	0.000	0.000	0.359	0.093
FEEDING TYPE	PRE	0.344	4.188	2.024	0.504	0.484	0.819	0.347	0.557
FEEDING TYPE	SAP	0.000	0.047	0.092	0.058	0.102	0.079	0.019	0.000
FEEDING TYPE	SUC	0.100	0.307	0.150	0.121	0.179	0.207	0.118	5.085
TOTAL		0.782	8.348	3.846	3.749	2.098	7.182	1.010	5.735

Table 14. Average numbers of the invertebrate taxa sampled by D-Vac on *Atriplex confertifolia* (#/m³ plant canopy)

PLANT : ATRCON

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	6.11	0.00	9.19	15.26	11.96	12.41	12.64	26.62
ARA2LYC	PRE	0.00	5.97	9.88	0.00	0.00	0.00	0.00	0.00
COE2ENT	SAP	0.00	0.00	26.16	14.70	21.31	32.51	13.20	0.00
COE2SMI	SAP	0.00	0.00	0.00	5.13	0.00	0.00	0.00	0.00
COL2CAR	PRE	0.00	0.00	0.00	0.00	0.00	4.78	0.00	0.00
COL2CHR	CHE	0.00	0.00	12.29	16.30	0.00	8.51	5.06	0.00
COL2CHRCRY	CHE	0.00	0.00	0.00	0.00	6.09	15.30	0.00	0.00
COL2CHRMONCON	CHE	4.54	0.00	0.00	15.22	13.45	18.48	0.00	0.00
COL2CHRPHY	CHE	5.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR FIV	CHE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.38
COL2CURAPIONE	CHE	5.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2DASLISINT	PRE	0.00	0.00	8.15	0.00	0.00	0.00	12.81	0.00
COL2TEN	CHE	6.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DIP2CEC	NON	0.00	0.00	5.68	6.41	6.94	0.00	0.00	0.00
DIP2CER	PRE	0.00	0.00	0.00	7.52	10.91	0.00	0.00	0.00
DIP2CHI	NEC	0.00	5.26	0.00	0.00	0.00	8.91	0.00	0.00
DIP2PHO	SAP	0.00	0.00	0.00	6.16	0.00	0.00	0.00	0.00
DIP2SCI	SAP	0.00	0.00	0.00	0.00	10.05	0.00	0.00	0.00
HEM2LYG	SUC	0.00	0.00	257.01	0.00	0.00	0.00	0.00	0.00
HEM2LYGEMBWIC	PRE	0.00	0.00	0.00	0.00	20.81	0.00	9.14	0.00
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	2.92	38.58	0.00	12.36	11.63
HEM2MIR	SUC	0.00	5.26	0.00	0.00	0.00	0.00	0.00	0.00
HEM2MABPAGFUS	PRE	0.00	5.26	0.00	0.00	0.00	0.00	0.00	0.00
HEM2PENAELAME	SUC	0.00	5.29	0.00	0.00	0.00	5.10	0.00	0.00
HEM2PENTHYONE	SUC	0.00	0.00	0.00	8.73	0.00	9.62	0.00	0.00
HEM2PIEPIEONE	SUC	41.00	55.78	82.46	98.83	82.84	77.23	21.58	23.25
HOM1CDC	SUC	0.00	0.00	11.09	153.54	15.26	24.70	20.65	0.00
HOM1CDC WHT	SUC	0.00	9.12	0.00	8.63	151.84	4.78	33.18	0.00
HOM2CIC	SUC	7.01	6.73	9.78	18.91	13.55	9.46	8.04	0.00
HOM2FUL ONE	SUC	0.00	4.15	11.33	7.10	0.00	5.10	0.00	0.00
HOM2PSY ONE	SUC	0.00	5.26	8.72	0.00	0.00	0.00	0.00	0.00
HYM1CHA	NON	0.00	7.39	39.54	11.12	0.00	7.96	0.00	0.00
HYM2ORA	NON	0.00	6.86	0.00	0.00	0.00	0.00	0.00	0.00
HYM2FOR	OMN	6.06	6.54	0.00	9.69	6.94	11.05	33.42	16.00
LEP	CHE	0.00	4.49	0.00	15.94	10.05	0.00	0.00	0.00
LEP	NEC	0.00	7.56	7.30	13.98	8.40	14.29	0.00	0.00
LEP NOC	CHE	12.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ORT2ACR	CHE	0.00	0.00	9.88	4.63	0.00	0.00	0.00	0.00
PSE2CHEDACSIL	PRE	0.00	7.19	0.00	0.00	0.00	0.00	5.06	9.81
PSO	SAP	6.11	0.00	0.00	3.76	13.46	9.19	5.60	0.00
THS2MAC ONE	SAP	0.00	0.00	8.72	4.29	9.97	0.00	0.00	0.00
THY	SUC	0.00	43.04	19.77	22.09	69.73	21.60	0.00	0.00
PHENOLOGY STAGES		3 4	4	4 5	5	6	6	6	6
SPECIES DIVERSITY		0.847	1.018	0.844	1.042	1.036	1.129	1.034	0.809

Table 15. Average numbers of invertebrates per feeding type sampled by D-Vac on *Atriplex confertifolia* (#/m³ plant canopy)

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	6.220	4.488	11.689	14.097	10.714	13.698	5.063	10.690
FEEDING TYPE	NEC	0.000	6.985	7.300	13.978	8.403	10.704	0.000	0.000
FEEDING TYPE	NON	0.000	7.255	16.967	8.766	6.936	7.957	0.000	0.000
FEEDING TYPE	OMN	6.059	6.541	0.000	9.690	6.936	11.048	33.423	15.995
FEEDING TYPE	PRE	6.115	6.403	9.131	14.746	12.744	11.562	11.430	15.414
FEEDING TYPE	SAP	6.115	0.000	17.440	9.305	17.830	30.563	9.401	0.000
FEEDING TYPE	SUC	27.403	30.983	44.139	56.544	63.133	37.935	21.690	17.440
TOTAL		51.912	62.655	106.666	127.125	126.696	123.466	81.007	59.539

Table 16. Average weights of invertebrates per feeding type sampled by D-Vac on *Atriplex confertifolia* (g/m³ plant canopy)

WEIGHTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	0.463	0.489	2.052	2.578	1.424	1.353	0.177	1.048
FEEDING TYPE NEC	0.000	0.815	0.569	0.615	2.075	4.456	0.000	0.000
FEEDING TYPE NON	0.000	0.082	0.124	0.130	0.014	0.040	0.000	0.000
FEEDING TYPE OMN	0.218	0.805	0.000	0.756	1.457	4.463	3.142	0.400
FEEDING TYPE PRE	0.703	0.276	3.222	1.829	2.055	3.120	1.300	0.697
FEEDING TYPE SAP	0.043	0.000	0.253	0.055	0.096	0.112	0.028	0.000
FEEDING TYPE SUC	0.675	1.095	1.295	1.288	0.851	1.204	0.256	36.176
TOTAL	2.103	3.562	7.516	7.251	7.971	14.749	4.903	38.320

Table 17. Average numbers of the invertebrate taxa sampled by D-Vac on *Bassia hyssopifolia* (#/m³ plant canopy)

PLANT : BASHYS

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	1.53	2.29	8.25	5.06	1.58	2.72	0.00	0.00
ARA2LYC	PRE	0.00	1.56	5.42	0.00	0.00	2.31	0.00	0.00
COE2ENT	SAP	0.00	0.00	18.10	4.11	9.86	11.34	1.36	0.00
COE2SMI	SAP	0.00	0.00	0.00	6.71	0.00	0.00	0.00	0.00
COL2CAR	PRE	0.00	3.94	0.00	19.99	0.00	0.00	0.00	0.00
COL2CHRPHY	CHE	4.47	2.57	0.00	0.00	0.00	0.00	0.00	0.00
COL2CRY ONE	SAP	2.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2DAS ONE	PRE	0.00	0.00	0.00	4.33	0.00	0.00	0.00	0.00
COL2DASLISINT	PRE	1.75	2.29	0.00	0.00	0.00	0.00	0.00	0.00
COL2MELEPINAC	CHE	0.00	0.00	9.05	0.00	2.17	0.00	0.00	0.00
COL2TEN ONE	CHE	1.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2TENCONONE	CHE	0.00	0.00	0.00	3.82	0.00	0.00	0.00	0.00
COL3EUM	CHE	0.00	0.00	9.05	0.00	0.00	0.00	0.00	0.00
DIP2CEC	NON	0.00	0.00	0.00	2.60	0.00	0.00	1.36	0.00
DIP2CER	PRE	0.00	0.00	0.00	0.00	2.35	0.00	0.00	0.00
DIP2CHI	NEC	0.00	9.04	0.00	0.00	0.00	0.00	0.00	0.00
DIP2PHO	SAP	0.00	1.57	1.08	0.00	0.00	0.00	0.00	0.00
DIP2SCI	SAP	0.00	1.06	0.00	0.00	0.00	0.00	0.00	0.00
HEM	SUC	2.26	9.18	0.00	0.00	0.00	0.00	0.00	0.00
HEM2LYG	SUC	2.51	2.50	11.35	14.60	0.00	0.00	0.00	0.00
HEM2LYGEMBVIC	PRE	0.00	0.00	0.00	2.29	0.00	0.00	0.00	0.00
HEM2LYGGEO	PRE	0.00	0.00	0.00	9.49	2.82	2.05	0.00	0.00
HEM2LYGLYGKAL	SUC	0.00	0.00	0.00	4.58	0.00	0.00	0.00	0.00
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	156.97	37.41	2.98	0.00	0.00
HEM2LYGPERSAS	SUC	0.00	4.68	0.00	10.79	2.49	0.00	0.00	0.00
HEM2MIR	SUC	0.00	4.69	0.00	0.00	0.00	0.00	0.00	0.00
HEM2NABNABALT	PRE	0.00	0.00	0.00	1.67	1.50	0.93	0.00	0.00
HEM2PENTHYONE	SUC	0.00	0.00	0.00	1.58	0.00	0.00	0.00	0.00
HEM2PIEPIEONE	SUC	0.00	0.00	0.00	0.00	0.00	2.05	0.00	0.00
HOM1COC	SUC	0.00	1.17	0.00	0.00	2.08	3.86	0.00	0.00
HOM1COC WHT	SUC	0.00	9.04	0.00	0.00	1.30	0.00	0.00	0.00
HOM2CIC	SUC	1.14	0.00	0.00	3.18	0.00	2.98	2.50	0.00
HYM1CHA	NON	0.00	0.00	9.05	0.00	0.00	0.00	0.00	0.00
HYM2FOR	OMN	2.66	1.44	0.00	5.58	3.49	0.00	1.36	0.00
HYM2POM ONE	PRE	0.00	0.00	4.28	0.00	0.00	0.00	0.00	0.00
HYM2SPH	NEC	0.00	0.00	0.00	5.00	3.92	0.00	0.00	0.00
LEP	CHE	0.00	0.00	0.00	0.00	0.00	2.31	0.00	0.00
LEP	NEC	0.00	0.00	0.00	3.31	0.00	0.00	0.00	0.00
LEP NOC	CHE	1.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ORT2ACR	CHE	0.00	0.00	0.81	5.14	1.73	9.52	0.00	0.00
ORT2MANLITMIN	PRE	0.00	0.00	0.00	1.98	0.00	0.00	0.00	0.00
PSO	SAP	0.00	0.00	0.00	0.00	1.73	0.00	2.57	0.00
SOL ONE	PRE	0.00	0.00	0.00	0.00	0.00	1.32	0.00	0.00
THS2MAC ONE	SAP	0.00	0.00	0.00	1.96	0.00	0.00	0.00	0.00
THY	SUC	0.00	0.00	0.00	4.41	0.00	1.43	1.60	0.00
PHENOLOGY STAGES		1 3	3	3	4 5	5	5 6	6	
SPECIES DIVERSITY		0.964	1.065	0.903	0.838	0.811	0.987	0.760	0.000

Table 18. Average numbers of invertebrates per feeding type sampled by D-Vac on *Bassia hyssopifolia* (#/m³ plant canopy)

COUNTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	3.712	2.572	6.304	4.975	1.878	8.321	0.000	0.000
FEEDING TYPE NEC	0.000	9.041	0.000	3.872	3.915	0.000	0.000	0.000
FEEDING TYPE NON	0.000	0.000	9.049	2.599	0.000	0.000	1.359	0.000
FEEDING TYPE OMN	2.665	1.444	0.000	5.575	3.488	0.000	1.359	0.000
FEEDING TYPE PRE	1.564	2.521	6.471	7.305	2.130	2.454	0.000	0.000
FEEDING TYPE SAP	2.247	1.319	9.591	5.666	6.811	11.335	2.266	0.000
FEEDING TYPE SUC	2.044	4.425	11.347	81.578	30.344	2.781	2.142	0.000
TOTAL	12.233	21.321	42.762	111.571	48.566	24.891	7.127	0.000

Table 19. Average weights of invertebrates per feeding type sampled by D-Vac on *Bassia hyssopifolia* (g/m³ plant canopy)

WEIGHTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	0.150	0.229	7.974	16.248	10.392	12.084	0.000	0.000
FEEDING TYPE NEC	0.000	1.013	0.000	0.436	0.846	0.000	0.000	0.000
FEEDING TYPE NON	0.000	0.000	0.072	0.016	0.000	0.000	0.026	0.000
FEEDING TYPE OMN	0.096	0.178	0.000	0.435	0.733	0.000	0.128	0.000
FEEDING TYPE PRE	0.188	0.544	4.246	2.604	0.247	0.625	0.000	0.000
FEEDING TYPE SAP	0.034	0.026	0.053	0.036	0.026	0.045	0.007	0.000
FEEDING TYPE SUC	0.278	0.294	1.180	4.129	0.787	0.091	0.025	0.000
TOTAL	0.746	2.283	13.525	23.903	13.030	12.845	0.185	0.000

Table 20. Average numbers of the invertebrate taxa sampled by D-Vac on *Chrysothamnus viscidiflorus* (#/m³ plant canopy)

PLANT : CHRVIS

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	0.00	3.08	9.19	4.57	5.60	7.60	6.12	5.02
ARA2LYC	PRE	0.00	0.00	4.49	0.00	0.00	0.00	0.00	0.00
COE2ENT	SAP	0.00	0.00	0.00	30.84	19.40	24.38	4.65	0.00
COE2SMI	SAP	0.00	0.00	0.00	5.66	0.00	0.00	0.00	0.00
COL2CAR	PRE	1.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2CHR	CHE	0.00	0.00	4.74	4.91	0.00	0.00	0.00	0.00
COL2CHRDISQUI	CHE	0.00	0.00	0.00	0.00	3.30	9.02	0.00	0.00
COL2CHRMONCON	CHE	0.00	0.00	0.00	0.00	3.69	0.00	0.00	0.00
COL2CHRPHY	CHE	5.56	1.97	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR FIV	CHE	0.00	0.00	0.00	7.51	0.00	0.00	0.00	0.00
COL2CUR FOR	CHE	4.93	0.00	5.58	0.00	0.00	0.00	0.00	0.00
COL2CUR THR	CHE	1.13	12.99	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR TWO	CHE	0.00	5.97	16.95	3.57	3.95	4.00	0.00	0.00
COL2CURAPIONE	CHE	3.03	2.12	6.67	0.00	0.00	0.00	0.00	0.00
COL2DASLISINT	PRE	0.00	4.33	1.41	0.00	0.00	0.00	3.90	0.00
COL2ELA ONE	CHE	0.00	0.00	0.00	3.08	0.00	0.00	0.00	0.00
COL2ELA TWO	CHE	0.00	0.00	0.00	2.35	0.00	0.00	0.00	0.00
COL2STA ONE	PRE	0.00	0.00	0.00	0.00	0.00	0.00	3.03	0.00
COL2TEN FOR	CHE	0.00	0.00	0.00	0.00	0.00	5.26	0.00	0.00
COL2TEN ONE	CHE	3.92	1.06	0.00	3.08	0.00	0.00	0.00	0.00
COL2TENELEPIL	CHE	5.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DIP2CEC	NON	0.00	0.00	2.74	3.01	1.67	0.00	0.00	0.00
DIP2CER	PRE	0.00	0.00	0.00	4.64	4.84	0.00	0.00	0.00
DIP2CHL	SAP	0.00	0.00	0.00	4.64	0.00	0.00	0.00	0.00
DIP2PHO	SAP	0.00	0.00	0.00	3.62	6.52	0.00	0.00	0.00
DIP2SCI	SAP	0.00	0.00	0.00	0.00	0.00	5.64	0.00	0.00
HEM2LYG	SUC	0.00	0.00	5.14	0.00	0.00	0.00	0.00	0.00
HEM2LYGEMBVIC	PRE	0.00	0.00	0.00	11.74	0.00	0.00	0.00	0.00
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	5.27	8.78	32.00	3.32	0.00
HEM2PENAELAME	SUC	0.00	0.00	0.00	2.54	0.00	0.00	0.00	0.00
HEM2PIEPIEONE	SUC	7.08	3.72	41.06	4.33	1.52	8.77	9.73	0.00
HOM1COC	SUC	0.00	0.00	0.00	24.52	12.09	4.40	5.63	0.00
HOM1COC WHT	SUC	0.00	0.00	0.00	0.00	0.00	0.00	3.03	0.00
HOM2CIC	SUC	3.92	2.81	5.13	4.95	6.01	4.43	4.08	0.00
HOM2FUL ONE	SUC	0.00	0.00	2.57	5.01	0.00	0.00	0.00	0.00
HOM2PSY ONE	SUC	0.00	3.64	0.00	0.00	0.00	0.00	0.00	0.00
HYM1CHA	NON	2.52	6.70	10.33	4.18	5.21	0.00	0.00	0.00
HYM2FOR	OMN	7.58	2.69	4.74	5.06	0.00	0.00	2.79	5.96
HYM2SPH	NEC	0.00	0.00	0.00	0.00	2.63	0.00	0.00	0.00
LEP	CHE	0.00	9.35	0.00	1.63	6.52	4.57	7.43	0.00
LEP	NEC	8.85	3.48	4.16	3.92	6.92	7.51	0.00	0.00
LEP NOC	CHE	3.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ORT2ACR	CHE	0.00	0.00	2.69	3.81	7.52	0.00	0.00	0.00
PSE2CHEDACSIL	PRE	2.78	1.97	0.00	0.00	0.00	0.00	0.00	7.55
PSO	SAP	0.00	0.00	0.00	4.62	5.10	4.29	3.38	0.00
THS2MAC ONE	SAP	0.00	0.00	6.00	0.00	0.00	2.68	0.00	0.00
THY	SUC	0.00	0.00	4.74	6.20	5.68	5.03	3.37	4.57
PHENOLOGY STAGES		2	2 3	3 4	5	5	5 6	6	6
SPECIES DIVERSITY		1.088	1.085	1.080	1.290	1.204	1.042	1.079	0.594

Table 21. Average numbers of invertebrates sampled by D-Vac on *Chrysothamnus viscidiflorus* (#/m³ plant canopy)

COUNTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	3.883	5.677	6.570	4.091	4.610	4.977	7.426	0.000
FEEDING TYPE NEC	8.853	3.480	4.156	3.919	4.774	7.510	0.000	0.000
FEEDING TYPE NON	2.523	6.702	6.536	3.593	4.027	0.000	0.000	0.000
FEEDING TYPE OMN	7.576	2.694	4.737	5.057	0.000	0.000	2.792	5.962
FEEDING TYPE PRE	1.953	3.114	6.326	5.177	5.384	7.597	5.045	6.286
FEEDING TYPE SAP	0.000	0.000	5.996	11.381	14.789	19.338	4.229	0.000
FEEDING TYPE SUC	5.815	3.447	8.130	7.836	7.594	6.634	4.872	4.573
TOTAL	30.604	25.114	42.452	41.054	41.178	46.057	24.364	16.821

Table 22. Average weights of invertebrates sampled by D-Vac on *Chrysothamnus viscidiflorus* (g/m^3 plant canopy)

WEIGHTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	2.675	0.812	1.500	3.207	11.124	1.099	1.344	0.000
FEEDING TYPE NEC	0.292	0.491	0.324	0.443	1.002	4.673	0.000	0.000
FEEDING TYPE NON	0.038	0.087	0.048	0.051	0.077	0.000	0.000	0.000
FEEDING TYPE OMN	0.273	0.331	0.232	0.394	0.000	0.000	0.262	0.149
FEEDING TYPE PRE	0.268	0.446	1.294	0.674	0.528	2.013	0.329	0.269
FEEDING TYPE SAP	0.000	0.000	0.258	0.032	0.057	0.098	0.016	0.000
FEEDING TYPE SUC	0.171	0.084	0.168	0.245	0.168	0.127	0.099	0.233
TOTAL	3.717	2.251	3.825	5.045	12.956	8.010	2.050	0.651

Table 23. Average numbers of the invertebrate taxa sampled by D-Vac on *Descurainia pinnata* ($\#/m^3$ plant canopy)

PLANT : DESPIN

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	0.00	0.00	2.12	0.00	0.00	0.00	0.00	0.00
ARA2LYC	PRE	0.00	1.61	1.08	0.00	0.00	0.00	0.00	0.00
COL2CHR	CHE	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.00
COL2CHRPHY	CHE	6.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2CRY ONE	SAP	2.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2DAS ONE	PRE	0.00	0.00	2.61	0.00	0.00	0.00	0.00	0.00
COL2TEN	CHE	3.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2TEN ONE	CHE	5.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2TENCONONE	CHE	3.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DIP2BIB ONE	NEC	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.00
DIP2SCI	SAP	0.00	0.00	1.55	0.00	0.00	0.00	0.00	0.00
HEM	SUC	1.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HEM2LYG	SUC	0.00	2.77	3.37	0.00	0.00	0.00	0.00	0.00
HEM2MIR	SUC	0.00	5.19	0.00	0.00	0.00	0.00	0.00	0.00
HOM1COC	SUC	0.00	2.11	0.00	0.00	0.00	0.00	0.00	0.00
HOM2CIC	SUC	0.00	1.60	0.00	0.00	0.00	0.00	0.00	0.00
HYM2FOR	OMN	165.08	2.79	0.00	0.00	0.00	0.00	0.00	0.00
ORT2ACR	CHE	0.00	0.00	1.62	0.00	0.00	0.00	0.00	0.00
THY	SUC	0.00	2.50	0.00	0.00	0.00	0.00	0.00	0.00
PHENOLOGY STAGES		3 4	5	5 6					
SPECIES DIVERSITY		0.247	0.917	0.749	0.000	0.000	0.000	0.000	0.000

Table 24. Average numbers of invertebrates per feeding type sampled by D-Vac on *Descurainia pinnata* ($\#/m^3$ plant canopy)

COUNTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	5.173	1.603	1.624	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE NEC	0.000	1.603	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE NON	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE OMN	165.083	2.790	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE PRE	0.000	1.614	2.112	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE SAP	2.281	0.000	1.547	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE SUC	1.828	3.716	3.369	0.000	0.000	0.000	0.000	0.000
TOTAL	174.365	11.326	8.652	0.000	0.000	0.000	0.000	0.000

Table 25. Average weights of invertebrates per feeding type sampled by D-Vac on *Descurainia pinnata* (g/m^3 plant canopy)

WEIGHTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	2.041	0.648	0.931	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE NEC	0.000	4.796	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE NON	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE OMN	5.943	0.343	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE PRE	0.000	0.057	0.204	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE SAP	0.034	0.000	0.023	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE SUC	0.013	0.135	0.174	0.000	0.000	0.000	0.000	0.000
TOTAL	8.031	5.979	1.332	0.000	0.000	0.000	0.000	0.000

Table 26. Average numbers of the invertebrate taxa sampled by D-Vac on *Halogeton glomeratus* (#/m³ plant canopy)

PLANT : HALGLO

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	0.00	2.41	5.26	5.71	4.96	3.22	3.70	0.00
ARA2LYC	PRE	0.00	2.89	5.09	5.00	0.00	0.00	0.00	0.00
ARA2THO	PRE	0.00	0.00	0.00	0.00	0.00	0.00	2.26	0.00
COE2ENT	SAP	0.00	0.00	0.00	10.47	10.81	18.34	5.29	0.00
COE2SMI	SAP	0.00	0.00	4.41	25.12	3.08	0.00	0.00	0.00
COL2CHR	CHE	0.00	0.00	2.60	11.73	0.00	0.00	0.00	0.00
COL2CHRCRY	CHE	0.00	0.00	0.00	0.00	3.08	0.00	0.00	0.00
COL2CHRPHY	CHE	6.54	2.79	2.95	0.00	0.00	0.00	0.00	0.00
COL2CRY ONE	SAP	3.61	2.50	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR FOR	CHE	0.00	0.00	0.00	5.00	0.00	0.00	0.00	0.00
COL2DAS ONE	PRE	0.00	0.00	3.28	0.00	0.00	0.00	0.00	0.00
COL2DASLISINT	PRE	3.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2MELEPIMAC	CHE	0.00	0.00	0.00	0.00	15.92	0.00	0.00	0.00
COL2MOR ONE	CHE	0.00	0.00	0.00	6.09	0.00	0.00	0.00	0.00
COL2TEN ONE	CHE	6.85	4.16	0.00	0.00	0.00	0.00	0.00	0.00
COL2TENCONONE	CHE	0.00	5.91	0.00	0.00	0.00	0.00	0.00	0.00
COL3EUM	CHE	0.00	0.00	0.00	4.33	0.00	0.00	0.00	0.00
DIP2BIB ONE	NEC	0.00	4.69	0.00	0.00	0.00	0.00	0.00	0.00
DIP2CEC	NON	0.00	0.00	5.54	0.00	0.00	0.00	0.00	0.00
DIP2CER	PRE	0.00	0.00	2.71	1.91	0.00	2.66	0.00	0.00
DIP2CHI	NEC	0.00	0.00	0.00	0.00	2.50	0.00	0.00	0.00
DIP2MUS	NEC	0.00	0.00	0.00	0.00	0.00	0.00	3.06	0.00
DIP2PHO	SAP	0.00	0.00	2.95	5.30	0.00	0.00	3.06	0.00
DIP2SCI	SAP	0.00	0.00	7.22	0.00	2.50	0.00	0.00	0.00
HEM	SUC	10.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HEM2LYG	SUC	0.00	2.93	13.66	5.00	2.57	0.00	0.00	0.00
HEM2LYGEMBVIC	PRE	5.22	0.00	0.00	3.72	0.00	0.00	0.00	0.00
HEM2LYGGEO	PRE	0.00	0.00	0.00	23.64	6.38	0.00	0.00	0.00
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	102.04	75.76	2.95	11.67	0.00
HEM2LYGPERSAS	SUC	0.00	0.00	0.00	0.00	13.14	0.00	0.00	0.00
HEM2MIR	SUC	0.00	2.86	0.00	0.00	0.00	0.00	0.00	0.00
HEM2PENTHYONE	SUC	0.00	0.00	0.00	5.41	2.86	0.00	0.00	0.00
HEM2PIEPIEONE	SUC	0.00	45.20	0.00	4.33	0.00	0.00	0.00	0.00
HOM1COC	SUC	C.00	0.00	5.00	6.12	0.00	0.00	4.34	0.00
HOM2CIC	SUC	0.00	0.00	5.00	6.94	4.13	2.63	3.17	0.00
HYM1CHA	NON	0.00	2.17	0.00	1.91	0.00	0.00	2.44	0.00
HYM2FOR	OMN	0.00	0.00	8.12	0.00	0.00	0.00	5.72	0.00
HYM2SPH	NEC	0.00	0.00	0.00	0.00	12.23	0.00	0.00	0.00
LEP	NEC	0.00	0.00	0.00	4.35	0.00	2.59	0.00	0.00
LEP NOC	CHE	0.00	3.47	0.00	0.00	0.00	0.00	0.00	0.00
ORT2ACR	CHE	0.00	0.00	3.61	5.49	0.00	0.00	0.00	0.00
ORT2MANLITMIN	PRE	0.00	0.00	0.00	0.00	3.38	0.00	0.00	0.00
PSO	SAP	0.00	0.00	0.00	0.00	6.19	4.59	3.45	0.00
THY	SUC	0.00	0.00	0.00	5.45	12.33	5.51	2.26	0.00
PHENOLOGY STAGES		1 3	3	3	3 4	5	5	6	
SPECIES DIVERSITY		0.747	0.756	1.124	1.021	0.943	0.767	1.019	0.000

Table 27. Average numbers of invertebrates per feeding type sampled by D-Vac on *Halogeton glomeratus* (#/m³ plant canopy)

COUNTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	6.639	3.880	3.053	7.454	9.503	0.000	0.000	0.000
FEEDING TYPE NEC	0.000	4.691	0.000	4.350	7.363	2.595	3.063	0.000
FEEDING TYPE NON	0.000	2.165	5.536	1.911	0.000	0.000	2.436	0.000
FEEDING TYPE OMN	0.000	0.000	8.120	0.000	0.000	0.000	5.723	0.000
FEEDING TYPE PRE	4.390	2.729	4.558	12.449	5.303	3.118	3.219	0.000
FEEDING TYPE SAP	3.609	2.502	4.748	16.593	8.514	11.467	3.814	0.000
FEEDING TYPE SUC	10.466	8.940	10.772	57.067	50.777	3.698	6.977	0.000
TOTAL	25.105	24.907	36.788	99.823	81.461	20.878	25.232	0.000

Table 28. Average weights of invertebrates per feeding type sampled by D-Vac on *Halogeton glomeratus* (g/m³ plant canopy)

WEIGHTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	0.350	6.089	0.796	9.111	6.589	0.000	0.000	0.000
FEEDING TYPE NEC	0.000	6.312	0.000	0.492	1.345	2.356	0.270	0.000
FEEDING TYPE NON	0.000	0.028	0.028	0.038	0.000	0.000	0.037	0.000
FEEDING TYPE OMN	0.000	0.000	0.398	0.000	0.000	0.000	0.538	0.000
FEEDING TYPE PRE	0.782	5.861	1.965	1.319	1.144	0.575	0.169	0.000
FEEDING TYPE SAP	0.054	1.218	0.049	0.048	0.037	0.044	0.018	0.000
FEEDING TYPE SUC	0.073	0.390	0.258	1.901	1.399	0.053	0.327	0.000
TOTAL	1.259	19.898	3.494	12.909	10.514	3.028	1.358	0.000

Table 29. Average numbers of the invertebrate taxa sampled by D-Vac on *Sitanion hystrix* (#/m³ plant canopy)

PLANT : SITHYS

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ARA	PRE	15.85	3.93	5.10	23.91	0.00	0.00	0.00	0.00
ARA2LYC	PRE	3.85	0.00	0.00	10.70	0.00	0.00	0.00	0.00
COE2ENT	SAP	0.00	0.00	0.00	77.85	0.00	0.00	0.00	0.00
COE2SMI	SAP	0.00	0.00	0.00	9.43	0.00	0.00	0.00	0.00
COL2CHR	CHE	0.00	4.23	10.64	23.51	0.00	0.00	0.00	0.00
COL2CHRPHY	CHE	0.00	6.05	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR ONE	CHE	3.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2CUR THR	CHE	0.00	3.46	0.00	0.00	0.00	0.00	0.00	0.00
COL2DAS ONE	PRE	0.00	0.00	0.00	28.59	0.00	0.00	0.00	0.00
COL2DASLISINT	PRE	3.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00
COL2TEN ONE	CHE	7.70	8.93	0.00	5.75	0.00	0.00	0.00	0.00
DIP2CEC	NON	0.00	3.17	3.18	0.00	0.00	0.00	0.00	0.00
DIP2CER	PRE	6.68	0.00	6.36	0.00	0.00	0.00	0.00	0.00
DIP2PHO	SAP	0.00	0.00	0.00	4.09	0.00	0.00	0.00	0.00
HEM2LYG	SUC	0.00	0.00	15.00	0.00	0.00	0.00	0.00	0.00
HEM2LYGEMBVIC	PRE	0.00	0.00	0.00	5.75	0.00	0.00	0.00	0.00
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	10.71	0.00	0.00	0.00	0.00
HEM2LYGPERSAS	SUC	0.00	0.00	0.00	26.86	0.00	0.00	0.00	0.00
HEM2MIR	SUC	0.00	18.11	0.00	0.00	0.00	0.00	0.00	0.00
HEM2NABPAGFUS	PRE	0.00	3.37	0.00	0.00	0.00	0.00	0.00	0.00
HEM2PENAELANE	SUC	0.00	12.26	7.13	4.92	0.00	0.00	0.00	0.00
HEM2PENTHYONE	SUC	0.00	0.00	0.00	4.09	0.00	0.00	0.00	0.00
HEM2PIEPIEONE	SUC	11.00	19.21	17.54	112.47	0.00	0.00	0.00	0.00
HOM1COC	SUC	6.68	4.12	5.41	46.51	0.00	0.00	0.00	0.00
HOM1COC WHT	SUC	35.63	8.46	2.70	0.00	0.00	0.00	0.00	0.00
HOM2CIC	SUC	10.09	21.39	19.02	11.17	0.00	0.00	0.00	0.00
HOM2PSY ONE	SUC	0.00	12.57	0.00	0.00	0.00	0.00	0.00	0.00
HYM1CHA	NON	0.00	6.16	10.33	19.47	0.00	0.00	0.00	0.00
HYM2FOR	OMN	43.14	19.47	0.00	8.16	0.00	0.00	0.00	0.00
HYM2SPH	NEC	0.00	0.00	0.00	28.59	0.00	0.00	0.00	0.00
LEP	NEC	0.00	7.20	0.00	0.00	0.00	0.00	0.00	0.00
ORT2ACR	CHE	0.00	3.37	0.00	0.00	0.00	0.00	0.00	0.00
PSE2CHEDACSIL	PRE	0.00	0.00	10.04	0.00	0.00	0.00	0.00	0.00
THS2MAC ONE	SAP	0.00	0.00	0.00	7.39	0.00	0.00	0.00	0.00
PHENOLOGY STAGES		3	3	5 6	6				
SPECIES DIVERSITY		0.885	1.162	1.025	1.116	0.000	0.000	0.000	0.000

Table 30. Average numbers of invertebrates per feeding type sampled by D-Vac on *Sitanion hystrix* (#/m³ plant canopy)

COUNTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	5.841	5.349	10.635	19.070	0.000	0.000	0.000	0.000
FEEDING TYPE NEC	0.000	7.201	0.000	28.589	0.000	0.000	0.000	0.000
FEEDING TYPE NON	0.000	5.165	6.754	19.473	0.000	0.000	0.000	0.000
FEEDING TYPE OMN	43.135	19.469	0.000	8.157	0.000	0.000	0.000	0.000
FEEDING TYPE PRE	7.591	3.649	7.331	20.946	0.000	0.000	0.000	0.000
FEEDING TYPE SAP	0.000	0.000	0.000	38.791	0.000	0.000	0.000	0.000
FEEDING TYPE SUC	13.059	17.361	12.783	37.665	0.000	0.000	0.000	0.000
TOTAL	69.626	58.194	37.503	172.692	0.000	0.000	0.000	0.000

Table 31. Average weights of invertebrates per feeding type sampled by D-Vac on *Sitanion hystrix* (g/m³ plant canopy)

WEIGHTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	0.375	2.215	0.734	1.754	0.000	0.000	0.000	0.000
FEEDING TYPE NEC	0.000	1.999	0.000	3.202	0.000	0.000	0.000	0.000
FEEDING TYPE NON	0.000	0.079	0.029	0.159	0.000	0.000	0.000	0.000
FEEDING TYPE OMN	1.553	2.395	0.000	0.636	0.000	0.000	0.000	0.000
FEEDING TYPE PRE	3.880	2.442	0.235	2.687	0.000	0.000	0.000	0.000
FEEDING TYPE SAP	0.000	0.000	0.000	0.280	0.000	0.000	0.000	0.000
FEEDING TYPE SUC	0.296	4.266	1.603	1.537	0.000	0.000	0.000	0.000
TOTAL	6.103	13.396	2.600	10.255	0.000	0.000	0.000	0.000

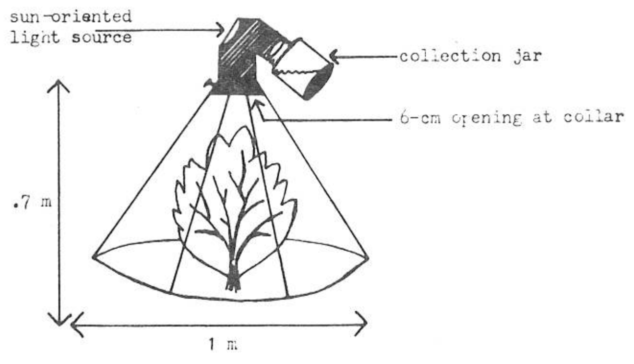

Figure 24. Emergent trap.

Table 32. Seasonal occurrence of some invertebrate taxa sampled by emergent trapping from all vegetation types in 1973 and 1974*

TAXA	1974	1973
Lepidoptera (except Noctuidae)	3/18----10/11	5/9-----10/6
Diptera (Cecidomyiidae)	4/16----8/20	5/16----5/23
Diptera (Muscidae)	3/18----7/23	5/23----7/19
Hymenoptera (Chalcidoidea)	5/14----8/20	5/16----10/6
Hymenoptera (Braconidae)	3/18----8/6	NONE
Hymenoptera (Mutillidae)	7/9-----7/23	7/12----8/9
Hymenoptera (Formicidae)	5/14----10/17	5/16----10/6
Araneida	3/5-----10/17	5/9-----10/6
Araneida (Lycosidae)	5/14----9/5	INCL. IN ARANEIDA
Neuroptera (Hemerobiidae)	3/18----10/1	5/23----6/28
Solpugida (one species)	6/25----9/5	8/30 (ONE RECORD)
Collembola (Sminthuridae)	4/30----8/20	5/9-----8/16
Diptera (Phoridae)	4/2-----10/17	6/15----9/21
Hemiptera (Lygaeidae)	6/11----8/20	6/21----9/29
Hemiptera (*Nysius ericae*)	5/14----10/1	INCL. IN LYGAEIDAE
Hemiptera (*Peritrechus saskatchewanensis*)	6/25----9/5	INCL. IN LYGAEIDAE
Hemiptera (Miridae)	5/14----9/18	5/16----9/21
Homoptera (Aphididae)	5/29----8/20	NONE
Homoptera (Cicadellidae)	5/29----8/20	6/7-----6/15
Thysanoptera	5/14----10/1	6/28----7/26

* Taxa listed occurred four or more times in emergent traps during 1974 field season: 3 March----7 October

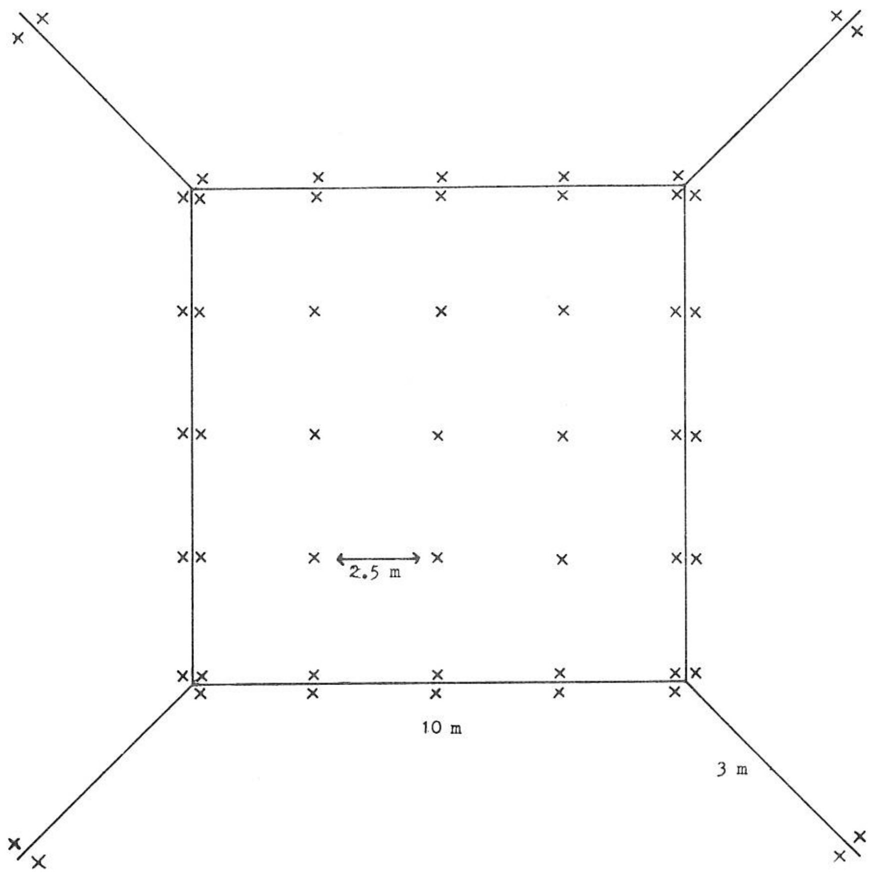

Figure 25. Pitfall grid utilized in the 1974 field season.

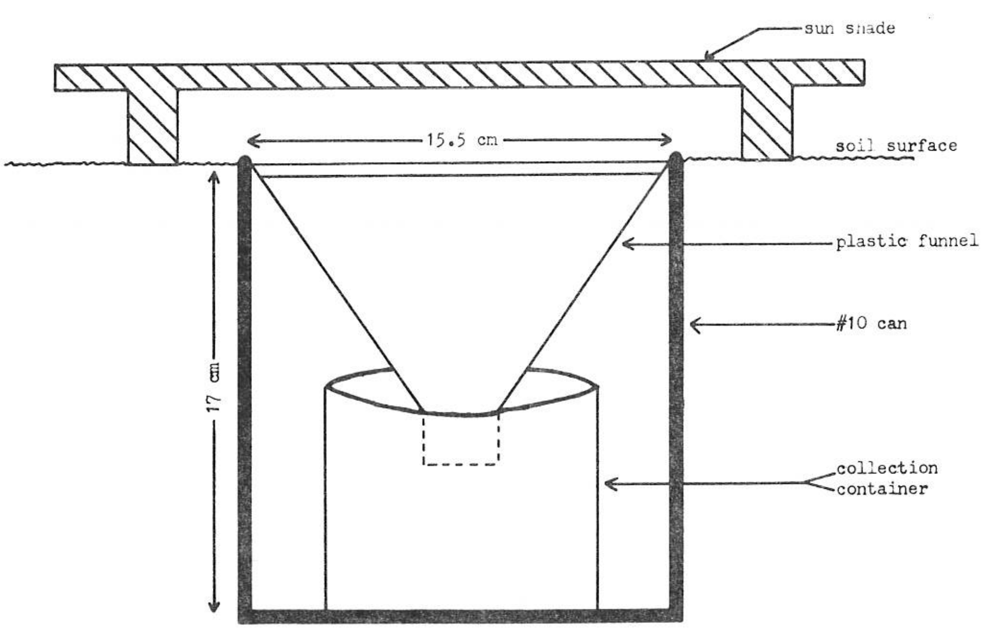

Figure 26. Individual pitfall trap.

Table 33. Mean density (#/m²) and average individual weight (g) of invertebrates sampled by pitfall from the AGRDES site

TRAP	TAXON		N	POP.EST. 80/81	CONFIDENCE INT. 90%	95%	RSQUARE	WEIGHT VALUES MEAN	S.D.
1I	ARA	A	25	1.033	0.297	0.358	0.84300	0.00386	0.00430
1I	ARA2LYC	A	27	2.999	0.546	0.658	0.74991	0.03769	0.04348
1I	ARA2LYC	1	18	0.296	0.045	0.055	0.94528	0.02336	0.02835
1I	ARA2LYC	2	18	0.176	0.147	0.179	0.63282	0.01803	0.02003
1I	COL2CAR	A	27	2.913	0.292	0.352	0.51060	0.01660	0.01758
1I	COL2CUR	THRA	3	0.081	0.325	0.654	0.41019	0.01014	0.01663
1I	COL2TEN	ONEA	21	0.175	0.086	0.105	0.77616	0.00594	0.00791
1I	COL2TENCONONEA		11	0.083	0.015	0.018	0.81581	0.03273	0.03584
1I	COL2TENELEHISA		20	0.110	0.025	0.030	0.76128	0.25675	0.29651
1I	COL2TENELEPILA		7	0.134	0.028	0.036	0.76378	0.11143	0.16219
1I	HYM2FOR	A	23	2.970	0.357	0.432	0.95917	0.00160	0.00167
1I	HYM2POMPRIONEA		3	0.073	0.045	0.091	0.92308	0.01215	0.01510
1I	LEP	A	10	0.041	0.025	0.030	0.51688	0.00135	0.00162
1I	ORT2GRYCEUONE1		14	0.058	0.041	0.050	0.10179	0.03840	0.04896
1I	ORT2GRYSTEFUSA		13	0.105	0.029	0.035	0.88496	0.51485	0.59667
1I	ORT2GRYSTEFUSI		5	0.113	0.041	0.056	0.82931	0.18012	0.22139
1I	SCO2VEJVEJBORA		7	0.125	0.044	0.056	0.75293	0.15362	0.17425
1I	SCO2VEJVEJBOR1		8	0.129	0.022	0.028	0.80164	0.10817	0.12817
1I	SCO2VEJVEJBOR2		20	0.075	0.031	0.038	0.01740	0.05322	0.06129
1I	SOL	ONEA	6	0.054	0.015	0.020	0.82941	0.08709	0.09750
1I	SOL	ONE1	9	0.070	0.017	0.021	0.34621	0.05746	0.06550
1I	SOL	ONE2	9	0.147	0.013	0.016	0.66309	0.02810	0.03790
1I	THS2MAC	ONEA	4	0.124	0.010	0.015	0.98063	0.01702	0.03963

Table 34. Mean density (#/m²) and average individual weight (g) of invertebrates sampled by pitfall from the AGRDES site

TRAP	TAXON		N	POP.EST. 80/81	CONFIDENCE INT. 90%	95%	RSQUARE	WEIGHT VALUES MEAN	S.D.
2I	ARA	A	26	0.809	0.195	0.236	0.85952	0.00390	0.00427
2I	ARA2LYC	A	26	2.410	0.405	0.489	0.77429	0.03571	0.04123
2I	ARA2LYC	1	19	0.546	0.105	0.127	0.96302	0.01732	0.02049
2I	ARA2LYC	2	9	1.100	0.361	0.451	0.65156	0.01801	0.01938
2I	ARA2THO	A	10	0.097	0.030	0.037	0.71074	0.01089	0.01368
2I	COL2CAR	A	20	1.755	0.267	0.324	0.90346	0.01548	0.01601
2I	COL2TEN	ONEA	8	0.500	0.149	0.188	0.59685	0.00547	0.00730
2I	COL2TENCONONEA		10	0.188	0.092	0.114	0.74986	0.03273	0.03584
2I	COL2TENELECONA		5	0.107	0.116	0.157	0.26723	0.07166	0.08393
2I	COL2TENELEHISA		18	0.527	0.113	0.137	0.86888	0.28931	0.31209
2I	COL2TENEMBONEA		18	0.121	0.034	0.041	0.18090	0.10771	0.14375
2I	HYM2FOR	A	20	0.730	0.219	0.265	0.38351	0.00343	0.00614
2I	ORT2GRYSTEFUSA		18	0.058	0.010	0.012	0.73516	0.35195	0.42543
2I	ORT2GRYSTEFUSI		6	0.101	0.029	0.037	0.62436	0.21496	0.26569
2I	SCO2VEJVEJBORA		3	0.296	0.279	0.561	0.47016	0.09829	0.12746
2I	SCO2VEJVEJBOR1		12	0.111	0.088	0.108	0.58876	0.09555	0.10952
2I	SOL	ONE2	14	0.110	0.014	0.018	0.48781	0.03932	0.06110

Table 35. Mean density (#/m²) and average individual weight (g) of invertebrates sampled by pitfall from the ART-ATR-SIT site

TRAP	TAXON		N	POP.EST. 80/81	CONFIDENCE INT. 90%	95%	RSQUARE	WEIGHT VALUES MEAN	S.D.
3I	ARA	A	26	0.863	0.213	0.256	0.42839	0.00397	0.00432
3I	ARA2LYC	A	18	0.261	0.220	0.267	0.62240	0.04313	0.04978
3I	ARA2LYC	1	20	0.178	0.056	0.068	0.83084	0.02183	0.02460
3I	ARA2LYC	2	21	0.143	0.036	0.044	0.69352	0.01425	0.01605
3I	COL2CAR	A	27	0.065	0.010	0.012	0.79159	0.01871	0.02054
3I	COL2TEN	ONEA	23	0.351	0.117	0.142	0.83758	0.00882	0.01579
3I	COL2TENCONONEA		5	0.044	0.073	0.098	0.10333	0.02088	0.02838
3I	HEM2LYGEMBVICA		10	0.131	0.066	0.082	0.33916	0.00240	0.00285
3I	HEM2LYGNYSERI1		9	60.046	107.369	133.999	0.22831	0.00053	0.00103
3I	HYM2FOR	A	11	1.193	0.768	0.948	0.28875	0.00167	0.00179
3I	LEP	A	17	0.136	0.058	0.070	0.73880	0.00309	0.00433
3I	LEP NOC	I	9	0.405	0.148	0.185	0.85507	0.02583	0.03023
3I	ORT2GRYCEUONEA		26	0.354	0.206	0.248	0.44129	0.06388	0.10333
3I	ORT2GRYCEUONE1		4	0.070	0.074	0.110	0.38870	0.03993	0.05290
3I	ORT2GRYCEUONE2		21	0.108	0.043	0.052	0.30362	0.01121	0.01609
3I	ORT2GRYSTEFUSA		5	0.086	0.060	0.081	0.82566	0.36167	0.52122
3I	ORT2GRYSTEFUSI		14	0.149	0.066	0.081	0.58192	0.22178	0.24385
3I	PSE2CHEDACSILA		27	0.046	0.015	0.018	0.24169	0.00034	0.00044
3I	SCO2VEJVEJBOR1		18	0.079	0.015	0.018	0.43459	0.12829	0.15540
3I	SOL	ONE1	10	0.042	0.027	0.033	0.42771	0.10714	0.16932
3I	SOL	ONE2	9	0.063	0.014	0.017	0.84275	0.02112	0.02472
3I	SOL	ONE3	6	0.123	0.033	0.043	0.54963	0.00934	0.01283

Table 36. Mean density (#/m^2) and average individual weight (g) of invertebrates sampled by pitfall from ART-ATR-SIT

TRAP	TAXON		N	POP.EST. 80/81	CONFIDENCE INT. 90%	95%	RSQUARE	WEIGHT VALUES MEAN	S.D.
4I	ARA	A	18	0.435	0.190	0.230	0.43455	0.00452	0.00485
4I	ARA2LYC	1	20	0.365	0.078	0.094	0.70966	0.02052	0.02302
4I	ARA2LYC	2	21	0.286	0.088	0.107	0.78122	0.01433	0.01585
4I	COL2CAR	A	21	0.329	0.257	0.311	0.62464	0.01580	0.01690
4I	COL2TEN	ONEA	16	0.545	0.132	0.160	0.60532	0.00579	0.00735
4I	COL2TENCONONEA		10	0.091	0.088	0.109	0.05035	0.02097	0.02772
4I	COL2TENELECONA		18	0.238	0.030	0.037	0.32549	0.07676	0.08288
4I	COL2TENELEPILA		23	0.216	0.095	0.114	0.45911	0.05004	0.05621
4I	HEM2LYGEMBVICA		18	0.087	0.072	0.088	0.13124	0.01393	0.03150
4I	HEM2PIEPIEONEA		11	0.177	0.113	0.139	0.74155	0.00830	0.01881
4I	HOM1COC	WHTA	4	0.105	0.055	0.081	0.86256	0.00079	0.00094
4I	HYM2FOR	A	20	5.764	0.568	0.689	0.32017	0.00156	0.00162
4I	LEP	A	22	0.523	0.153	0.185	0.56240	0.00383	0.00650
4I	LEP NOC	I	6	0.363	0.059	0.077	0.97765	0.02601	0.03181
4I	ORT2GRYCEUONEA		15	0.092	0.054	0.066	0.42709	0.04303	0.05536
4I	ORT2GRYCEUONE1		26	0.126	0.096	0.116	0.32782	0.04697	0.05180
4I	ORT2GRYCEUONE2		27	0.069	0.051	0.061	0.25852	0.01322	0.01486
4I	ORT2GRYSTEFUSA		16	0.098	0.064	0.078	0.22455	0.43639	0.52760
4I	ORT2GRYSTEFUSI		16	0.193	0.035	0.043	0.78955	0.19488	0.22639
4I	SOL	ONE2	8	0.097	0.059	0.074	0.08086	0.06622	0.12885

Table 37. Mean density (#/m^2) and average individual weight (g) of invertebrates sampled by pitfall from ANNUALS

TRAP	TAXON		N	POP.EST. 80/81	CONFIDENCE INT. 90%	95%	RSQUARE	WEIGHT VALUES MEAN	S.D.
5I	ARA	A	20	0.742	0.270	0.327	0.58295	0.00778	0.01664
5I	ARA2LYC	A	20	0.173	0.087	0.105	0.68227	0.04579	0.05072
5I	ARA2LYC	1	14	0.263	0.140	0.171	0.58365	0.02109	0.02469
5I	ARA2LYC	2	5	0.224	0.279	0.377	0.58838	0.01735	0.01956
5I	ARA2THO	A	9	0.152	0.056	0.070	0.89262	0.00835	0.01025
5I	COL2CAR	A	20	15.724	2.552	3.092	0.97245	0.01554	0.01599
5I	COL2MALCOLBIPA		5	0.151	0.024	0.033	0.44789	0.01038	0.01364
5I	COL2TEN	I	11	0.568	0.099	0.122	0.72948	0.00717	0.01100
5I	COL2TEN	ONEA	12	5.152	1.501	1.846	0.80104	0.00480	0.00531
5I	COL2TENCONONEA		13	1.778	0.317	0.389	0.95751	0.05630	0.09778
5I	HEM2LYGEMBVICA		4	0.175	0.033	0.049	0.93011	0.01187	0.02512
5I	HEM2LYGLYGKALA		10	0.286	0.084	0.104	0.27438	0.01091	0.01560
5I	HEM2LYGNYSERIA		15	54.355	21.812	26.604	0.89582	0.00043	0.00047
5I	HEM2LYGNYSERI1		9	340.092	251.247	313.561	0.77333	0.00017	0.00018
5I	HEM2LYGNYSERI2		9	810.321	299.259	373.482	0.83492	0.00012	0.00014
5I	HEM2LYGPERSASA		17	23.326	10.922	13.277	0.91158	0.00069	0.00078
5I	HEM2LYGPERSASI		5	7.911	20.775	28.094	0.19440	0.00045	0.00059
5I	HEM2NABPAGFUSA		8	0.059	0.018	0.022	0.76197	0.00142	0.00175
5I	HYM2FOR	A	27	0.168	0.106	0.128	0.45240	0.00160	0.00176
5I	HYM2MUTTYP	A	15	0.303	0.086	0.105	0.89099	0.00376	0.00422
5I	HYM2POMPRIOREA		15	0.124	0.042	0.051	0.72427	0.01305	0.01513
5I	LEP	A	19	0.117	0.036	0.044	0.12938	0.01080	0.01455
5I	LEP NOC	I	17	0.045	0.060	0.072	0.08798	0.03785	0.04936
5I	ORT2GRYSTEFUSA		10	0.107	0.044	0.055	0.77010	0.47132	0.60762
5I	SCO2VEJVEJBORA		11	0.065	0.084	0.103	0.11258	0.15669	0.18023
5I	SCO2VEJVEJBOR1		11	0.060	0.038	0.047	0.15897	0.09984	0.11315
5I	SOL	ONEA	15	0.629	0.205	0.250	0.53211	0.07552	0.08538
5I	SOL	ONE2	3	0.796	0.857	1.724	0.19477	0.04120	0.07583
5I	SOL	ONE3	3	0.171	0.613	1.234	0.34846	0.02558	0.04657

Table 38. Mean density (#/m^2) and average individual weight (g) of invertebrates sampled by pitfall from the ANNUALS site

TRAP	TAXON		N	POP.EST. 80/81	CONFIDENCE INT. 90%	95%	RSQUARE	WEIGHT VALUES MEAN	S.D.
6I	ARA	A	17	1.208	1.119	1.361	0.58053	0.00440	0.00469
6I	ARA2LYC	A	28	1.728	0.954	1.150	0.77391	0.03721	0.04394
6I	ARA2LYC	1	18	0.062	0.027	0.033	0.62206	0.02796	0.03503
6I	ARA2THO	A	4	0.230	0.119	0.175	0.46085	0.00896	0.01225
6I	COL2CAR	A	27	12.672	2.602	3.139	0.25152	0.01756	0.01824
6I	COL2CUR	THRA	6	0.090	0.018	0.023	0.50582	0.00724	0.01218
6I	COL2TEN	I	8	1.370	0.747	0.941	0.55983	0.00668	0.00877
6I	COL2TEN	ONEA	19	1.884	0.314	0.380	0.57199	0.00544	0.00676
6I	COL2TENCONONEA		16	0.818	0.207	0.252	0.67341	0.02932	0.03270
6I	COL2TENELEPILA		15	0.082	0.025	0.030	0.06418	0.05478	0.06092
6I	HEM2LYGEMBVICA		7	0.269	0.270	0.344	0.65889	0.01043	0.02107
6I	HEM2LYGNYSERIA		12	102.720	45.714	56.209	0.92850	0.00561	0.01498
6I	HEM2LYGNYSERI1		12	1309.380	585.920	720.436	0.76751	0.00421	0.01298
6I	HEM2LYGNYSERI2		7	1100.769	381.739	487.072	0.89221	0.00011	0.00012
6I	HEM2LYGPERSASA		6	0.075	0.052	0.068	0.79085	0.00071	0.00096
6I	HYM2FOR	A	18	5.559	1.132	1.374	0.74314	0.00151	0.00158
6I	HYM2MUTTYP	A	12	0.490	0.124	0.153	0.68428	0.00398	0.00430
6I	HYM2POMPRIOREA		19	0.241	0.054	0.066	0.89841	0.01310	0.01512
6I	LEP	A	27	0.178	0.028	0.034	0.02746	0.00994	0.01330
6I	LEP NOC	I	20	0.070	0.036	0.044	0.63009	0.02934	0.03373
6I	ORT2GRYCEUONEA		24	0.039	0.012	0.014	0.59125	0.09939	0.15798
6I	ORT2GRYSTEFUSI		11	0.106	0.057	0.070	0.67862	0.20398	0.25246
6I	SOL	ONEA	13	0.133	0.083	0.102	0.36342	0.06923	0.08351
6I	SOL	ONE2	13	0.343	0.070	0.086	0.60187	0.01746	0.01941
6I	SOL	ONE3	10	0.232	0.045	0.056	0.38879	0.00829	0.01063

Table 39. Coding explanation

Flora

AGR DES - Agropyron desertorum

ART TRI - Artemisia tridentata

ATR CON - Atriplex confertifolia

BAS HYS - Bassia hyssopifolia

CHR VIS - Chrysothamnus viscidiflorus

DES PIN - Descurainia pinnata

HAL GLO - Halogeton glomeratus

SIT HYS - Sitanion hystrix

Fauna

example*: Coleoptera - Tenebrionidae - Eleodes hispilabris - Adult

COL|2|TEN|ELE|HIS|A
(ⓐ under 2; ⓑ under A)

ⓐ: 0 = suborder
1 = superfamily
2 = family
3 = subfamily

ⓑ: A = adult
I = immature
#'s 1-4 = size category

* The first three letters of the orders, family, genus, and species names are used as the taxa code, unless otherwise indicated on the Curlew species list.

Discussion

Six species of Tenebrionidae (Coleoptera) compose 97% of all darkling beetles captured in 1974. These insects are particularly significant in the Great Basin region because they take over the ecological niche that is occupied by the Carabidae in less arid areas, and most tenebrionid species are western in their range (Borror and DeLong 1971). Community organization of the six herbivorous tenebrionids can be seen in the frequency distribution curves (Figs. 27-29) as described by Price (1975). These data are based on 28 weeks of pitfall trapping in each of the three vegetation types. Even though all six species are represented in these three vegetation types, evenness and abundance are variable (Table 40). The greatest species diversity is observed in AGRDES (grass).

Density estimates range from a high of $.31/m^2$ (*Eleodes hispilabris*) to a low of $.06/m^2$ (*Eleodes concinna* and *Embaphion* sp.), from an area which is dominated by one plant species, *Agropyron desertorum*. The species diversity in ART-ATR-SIT (shrub) is slightly lower than that of the grass community. Density estimates ranged from $.85/m^2$ (tenebrionid sp. 1) to $.09/m^2$ (*Embaphion* sp.). The dominant flora of the area includes three shrubs, *Artemisia tridentata, Atriplex confertifolia, Chrysothamnus viscidiflorus*, and one bunchgrass, *Sitanion hystrix.*

ANNUALS showed the lowest degree of species diversity among the six beetles. Density estimates ranged from $8.80/m^2$ (tenebrionid sp. 1) to $.02/m^2$ (*Eleodes concinna*). This area contained two dominant species, tenebrionid sp. 1 and *Coniotus* sp. The combined density estimates of the other four species did not equal the densities of these two beetles. The flora in ANNUALS is characterized by *Halogeton glomeratus* and *Bassia hyssopifolia*, dominant annuals with an abundant seed crop in 1974.

Of the six tenebrionids, sp. 1 had the greatest estimated density in the three vegetation types. *Coniotus* sp. had the next highest estimated density and appeared to favor the habitat and resources of ANNUALS. *E. hispilabris* was the dominant species in AGRDES, but was seldom observed in the other two vegetation types. *E. pilosa* had its greatest density in ART-ATR-SIT, although only 53 specimens were sampled. *E. concinna* also displayed a preference for ART-ATR-SIT, although almost equal numbers of individuals were found in samples from AGRDES. *Embaphion* sp. had the lowest density of all tenebrionids; only 25 were sampled during the entire field season. However, more than half were collected from AGRDES.

Invertebrate data from the three vegetation types indicate that ANNUALS and ART-ATR-SIT have similar invertebrate biomass and density fluctuations (Figs. 30 and 31). AGRDES is dominated by a single bunchgrass, *Agropyron desertorum*, and shows little change in density and biomass over the entire field season (Fig. 32). The monoculture of AGRDES contrasts with ART-ATR-SIT and ANNUALS by exhibiting peak invertebrate density during September and October while the latter two areas show decreasing trends. This early-fall increased activity in AGRDES can be attributed to the reappearance of Collembola to cooler soil surface areas, the "explosive" infestation of *Nysius* sp. (Lygaeidae) seed feeders, and a marked increase in sucking types, e.g., homopterans and thysanopterans. Accompanying the activity increase, species diversity values also increased in comparison to earlier spring and summer months (Table 8).

The data in Table 7 indicate the phenology scheme utilized in 1974. These phenophases will be modified to fit a more convenient system in 1975 according to West and Gunn (1974) and West and Wein (1971). The herbivores response to phenology in all three vegetation types appeared to be the primary force influencing invertebrate numbers. This response is illustrated (Table 20) by four species of Curculionidae (weevils), on *Chrysothamnus viscidiflorus*, which attain their highest density estimates during the "greening-up" and early growth period of the plant (phenophases 2-4).

In ART-ATR-SIT, the density and biomass trends of the dominant cool desert shrub, *Artemisia tridentata*, are inconsistent with the other vegetative species in the area. The number of invertebrates increases in August, presumably because of the late season bloom and consequent seed dispersal phases (Fig. 33, Table 12). At this time, *Atriplex confertifolia, S. hystrix* and *C. viscidiflorus* (Figs. 34, 35) have less succulent leaves and seeds and are approaching dormancy, which accounts for their decreasing trends in invertebrate densities. *A. confertifolia* is notable because this species maintains the highest invertebrate densities of all plant species sampled for the June-November season (Fig. 36). This may be partially a result of early-season flowering and the plant's ability to retain its seeds longer.

Table 40. Pitfall trapping data from six species of herbivorous tenebrionid beetles

Taxa	Trap No.	# trapped/100m^2	Estimated density (#/m^2)		Comment
Eleodes hispilabris	1	16	.16	grass	dominant species in Veg IV (grass)
	2	47	.47		
	3	8	.08	shrub	
	4	6	.06		
	5	1	.01	annuals	
	6	1	.01		
Eleodes pilosa	1	11	.11	grass	has its highest estimated density in Veg I (shrub)
	2	9	.09		
	3	4	.04	shrub	
	4	22	.22		
	5	5	.05	annuals	
	6	4	.04		
Coniotus sp.	1	8	.08	grass	very common in Veg II (annuals)
	2	26	.26		
	3	6	.06	shrub	
	4	9	.09		
	5	201	2.01	annuals	
	6	110	1.10		
Teneb. sp. 1	1	19	.19	grass	the dominant species (with respect to numbers) for all three veg. types
	2	35	.35		
	3	36	.36	shrub	
	4	49	.49		
	5	739	7.39	annuals	
	6	141	1.41		
Eleodes concinna	1	4	.04	grass	both species are relatively uncommon but occur over the entire site
	2	9	.09		
	3	3	.03	shrub	
	4	12	.12		
	5	0	.00	annuals	
	6	2	.02		
Embaphion sp.	1	4	.04	grass	
	2	9	.09		
	3	4	.04	shrub	
	4	5	.05		
	5	2	.02	annuals	
	6	1	.01		

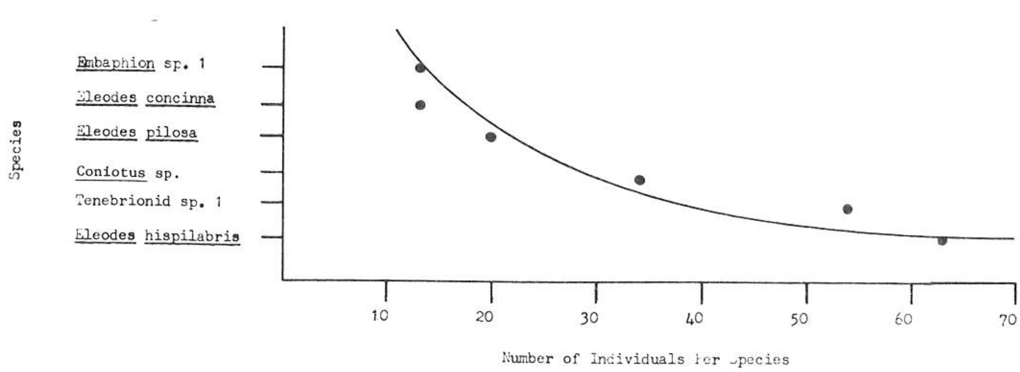

Figure 27. Frequency distribution of the abundance of tenebrionid beetles in AGRDES.

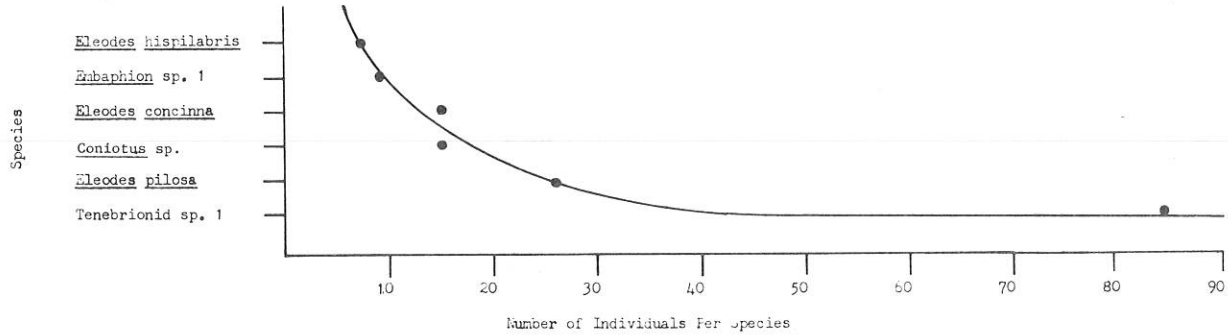

Figure 28. Frequency distribution of the abundance of tenebrionid beetles in Veg Type I (ART-ATR-SIT).

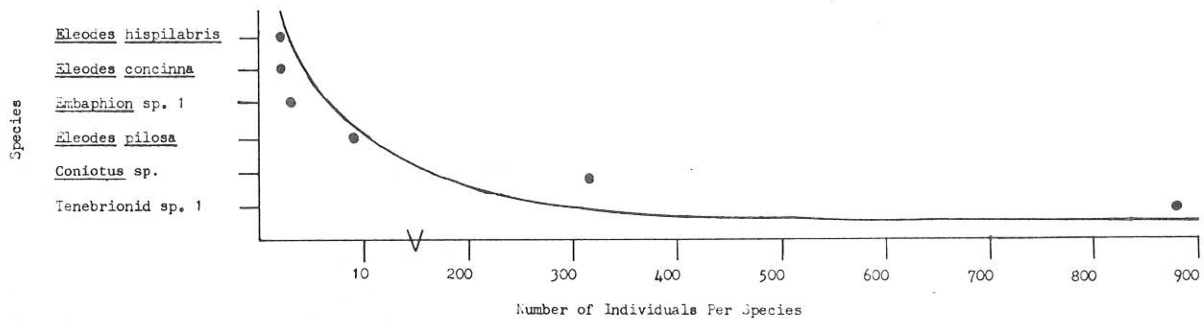

Figure 29. Frequency distribution of the abundance of tenebrionid beetles in Veg Type II (ANNUALS).

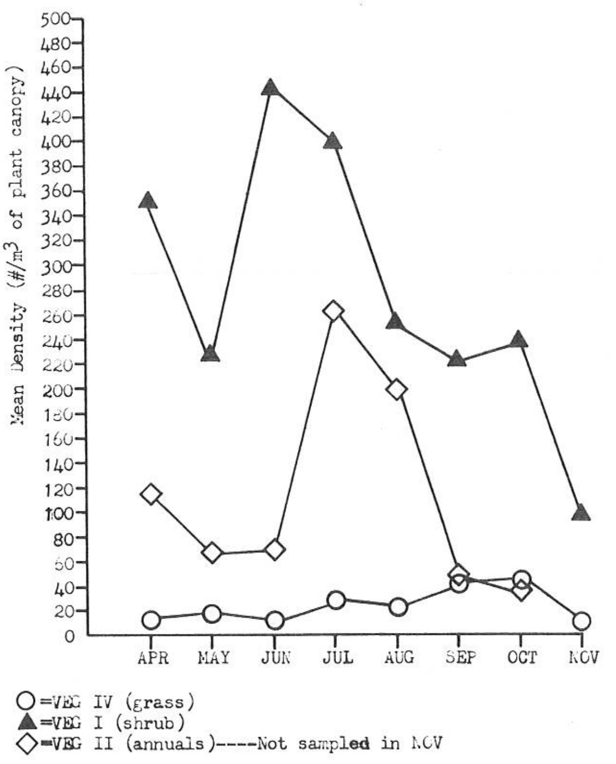

Figure 30. Fluctuations in mean invertebrate density (#/m³ of plant canopy) for three vegetation types as sampled by D-Vac in 1974.

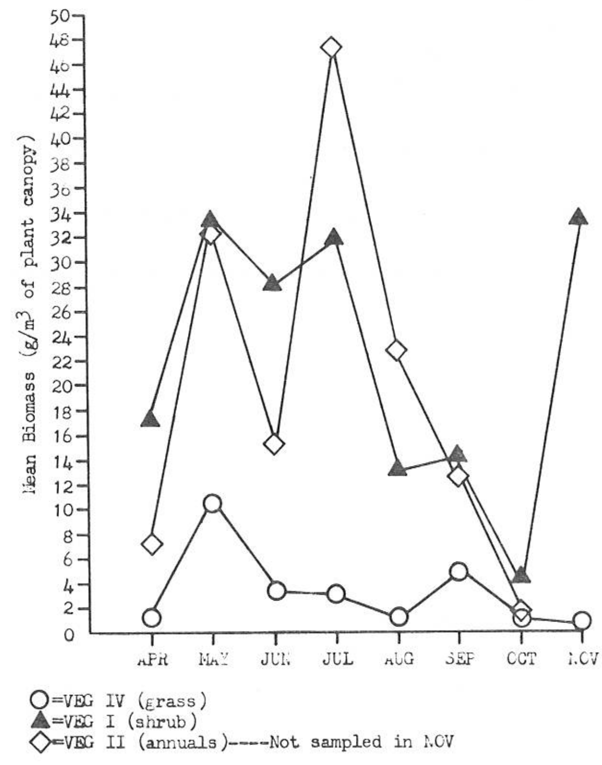

Figure 31. Fluctuations in mean invertebrate biomass (g/m³ of plant canopy) for three vegetation types as sampled by D-Vac in 1974.

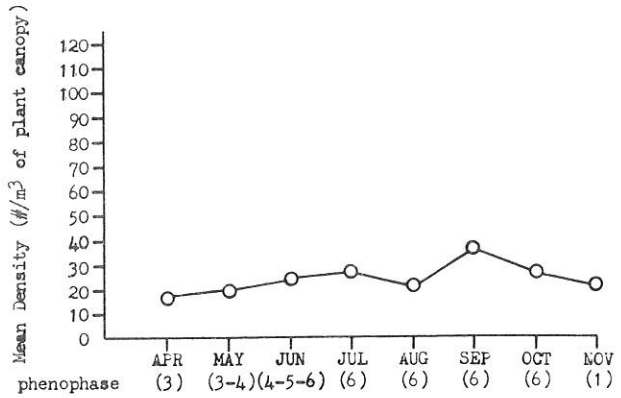

Figure 32. Monthly fluctuations in mean density of all invertebrates sampled by D-Vac from *Agropyron desertorum* in 1974.

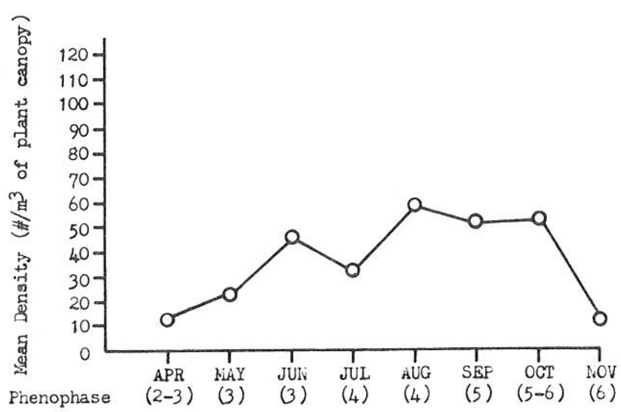

Figure 33. Monthly fluctuations in mean density of all invertebrates sampled by D-Vac from *Artemisia tridentata* in 1974.

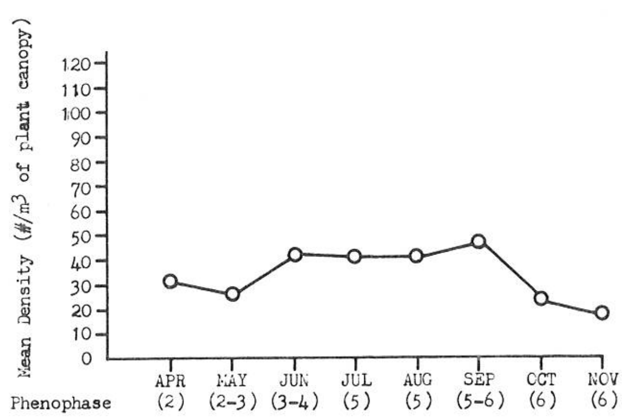

Figure 34. Monthly fluctuations in mean density of all invertebrates sampled by D-Vac from *Chrysothamnus viscidiflorus* in 1974.

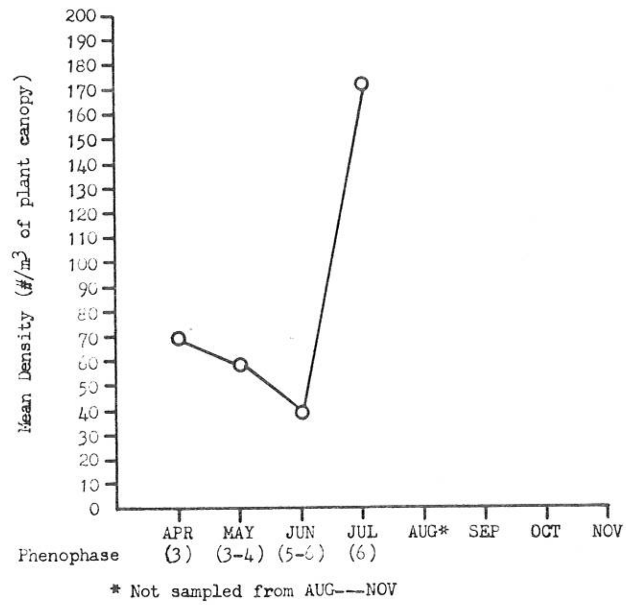

Figure 35. Monthly fluctuations in mean density of all invertebrates sampled by D-Vac from *Sitanion hystrix* in 1974.

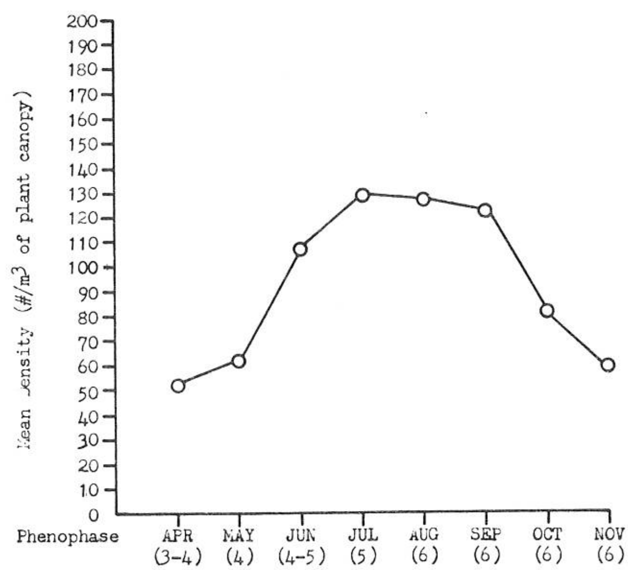

Figure 36. Monthly fluctuations in mean density of all invertebrates sampled by D-Vac from *Atriplex confertifolia* in 1974.

In 1974, ANNUALS was dominated by three nonnative annuals: *Descurainia pinnata*, *Halogeton glomeratus* and *Bassia hyssopifolia*. These species withstood the arid, unfavorable conditions long enough to be vacuumed several times. *D. pinnata* grew, flowered and dispersed seeds in approximately 100 days. After leaf fall, the plant became indistinguishable from other decaying stems and sampling was discontinued. Maximum invertebrate densities of *D. pinnata* occurred early in the season (Fig. 37). This was primarily due to the abundant formicids and some herbivorous Coleoptera. Both *H. glomeratus* and *B. hyssopifolia* had invertebrate densities similar to *D. pinnata* but with peak periods occurring in midsummer. *H. glomeratus* and *B. hyssopifolia* were heavily infested with *Nysius ericae* (Lygaeidae) during the prefloral and flowering phases in July (Figs. 38, 39). These plants were succulent at this time, while other less significant annuals and forbs had withered. The massive explosion of lygaeids in midsummer resulted in a formidable biomass estimate of 47.26 g/m^3 of plant canopy (Fig. 31). During this period, portions of plant clumps and individual vegetative parts were entirely hidden due to the teeming numbers of insects. High lygaeid densities in select areas caused the soil surface to appear to be flowing. This type of outbreak did not occur in the 1975 field season, which was subjected to various climatic factors.

An overview of the invertebrate response to phenology, as sampled by D-Vac, can be surmised from Table 41. The three annual species attained peak invertebrate densities during their early growth stages. Shrubs became heavily infested during the floral stages. *A. desertorum*, the dominant plant in AGRDES, showed a peak density of invertebrates in September during the seed dispersal phase.

Figures 40 and 41 illustrate possible relationships between estimated invertebrate densities and mean daily temperatures, and densities and relative humidity, respectively. It is difficult to suggest any positive correlations between these parameters. Plant phenology seems to be a more accurate indicator of invertebrate activity than either daily temperature or humidity.

Emergent trapping has been carried out for three consecutive years in Curlew Valley. The primary value of this sampling technique is shown by the data in Table 32. The dates indicate the duration of on-site activity of each specific taxon. Since 1973 trapping commenced in May and 1974 sampling began in March, it is difficult to compare the two seasons. A complete comparison of vegetation types, invertebrate activity duration and seasonal fauna from four consecutive field seasons will be included in the next annual report.

Taxonomic Composition and Trophic Structure Analysis

The feeding type categories assigned to the invertebrate fauna (Table 42) are based upon Odum's (1971) designations. Further modification and refinement of categories from Bohart (pers. comm.), Van Emden (1973) and Borror and DeLong (1971) are given in a detailed trophic-level analysis (Table 43). Table 44 provides complete definitions for all feeding types. The taxonomic composition of the invertebrate fauna is presented in Table 45 with an additional comparison of these data to an old field grassland in Table 46. The conspicuous difference in total species is an indication that a complete enumeration of the cool desert fauna is not yet accomplished. This reasoning applies primarily to the following orders: Coleoptera, Lepidoptera and Araneida. A Curlew Valley species list follows this report (Appendix I, see p. 61).

The average density and individual weight estimates presented in Tables 33-38 are for true ground-dwelling taxa having five or more occurrences in an individual pitfall grid during the entire season. Whenever possible, a species was separated into size classes on the basis of weight as in Moulder and Reichle (1972), and as shown in Table 47. Density estimates were also calculated for these special categories. A notable element of the pitfall density tables is the difference in population estimates shown by a taxon in two different trap grids occuring within the same vegetation type. This is exemplified by *Eleodes hispilabris* in Trap 1 (.11/m^2) compared to Trap 2 (.52/m^2).

The low r-square values applied to some taxa are a reflection of low density and/or erratic emergence within the trapping grid. These elements prevented a definite peak-capture figure from occurring, lowering the accuracy of fit of the regression line. The estimated biomass for a taxon is obtained by multiplying the population estimate by the average individual weight.

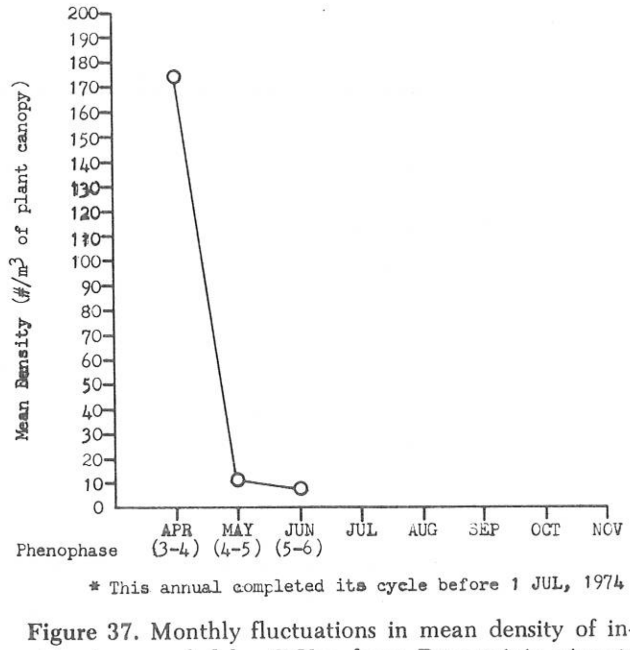

Figure 37. Monthly fluctuations in mean density of invertebrates sampled by D-Vac from *Descurainia pinnata* in 1974.

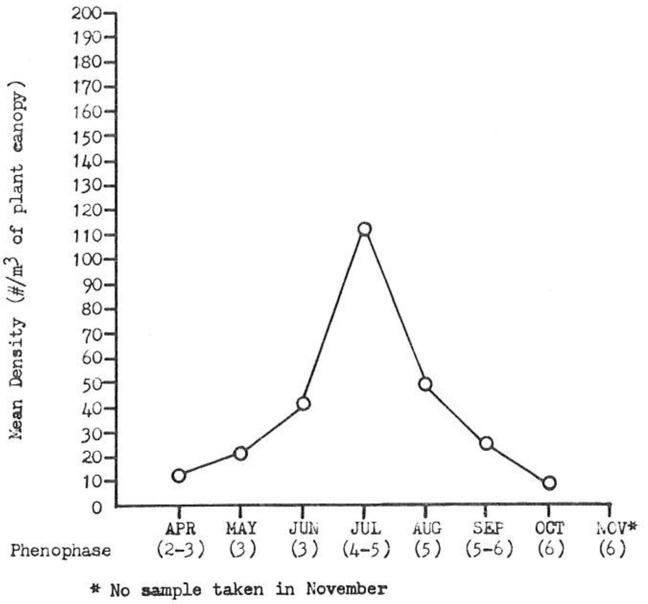

Figure 38. Monthly fluctuations in mean density of all invertebrates sampled by D-Vac from *Bassia hyssopifolia* in 1974.

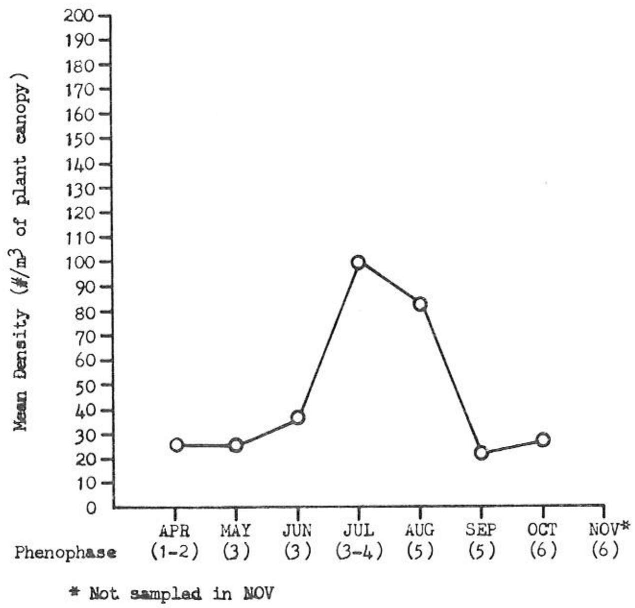

Figure 39. Monthly fluctuations in mean density of all invertebrates sampled by D-Vac from *Halogeton glomeratus* in 1974.

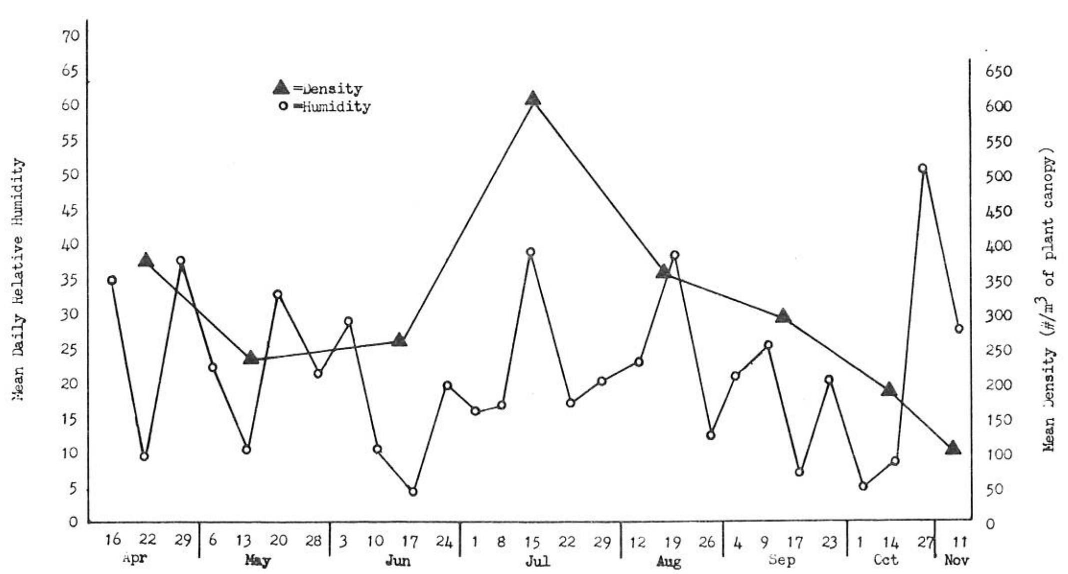

Figure 40. Weekly fluctuations in mean daily relative humidity and mean invertebrate density (#/m³ of plant canopy) for all taxa sampled by D-Vac; April through November 1974.

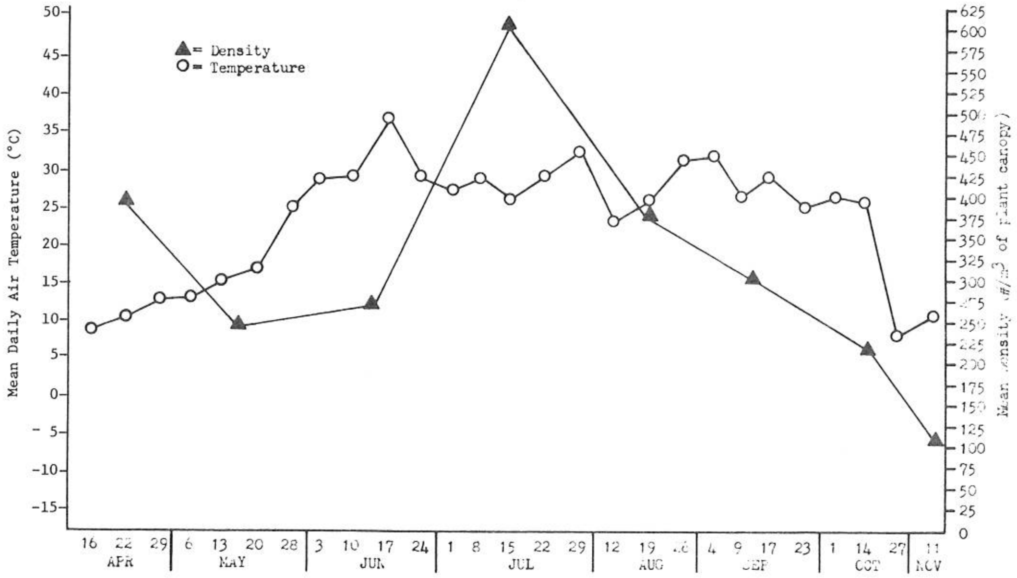

Figure 41. Weekly fluctuations in mean daily temperature (°C) and mean invertebrate density (#/m³ of plant canopy) for all taxa sampled by D-Vac, April through November 1974.

Table 41. Invertebrate response to phenology

Veg Type	Plant species	Mo. of peak biomass	Mo. of highest sp. diversity (H')	Mo. of peak density	Plant phenophase during peak density
IV	Agropyron desertorum	May	July	Sept	(6) late seed dispersal
I	Atriplex confertifolia	Sept.	Sept	July	(5) flower
I	Artemisia tridentata	May	July	Aug	(4) flower bud
I	Chrysothamnus viscidiflorus	Aug	July	Sept	(5-6) flower - seed dispersal
I	Sitanion hystrix	May	May	July	(6) seed dispersal
II	Bassia hyssopifolia	July	May	July	(4-5) flower bud - flower
II	Halogeton glomeratus	May	June	July	(3-4) new leaf - flower bud
II	Descurainia pinnata	April	May	April	(3-4) new leaf - flower bud

Table 42. Comparison of feeding type frequencies as they occurred in samples in 1973 and 1974

	FEEDING TYPE	FREQUENCY	% OF TOTAL
(1974)	CHE	1858	26.8 } 33.7
	SAP	476	6.9 } 33.7
	NEC	383	5.5
	NON	232	3.3
	OMN	388	5.7
	PRE	2450	35.3
	SUC	1144	16.5
	TOTAL	6931	100.0
(1973)	CHE, SAP	1749	35.8*
	NEC	600	12.2
	NON	318	6.5
	OMN	331	6.8
	PRE	1051	21.5
	SUC	840	17.2
	TOTAL	4889	100.0

CHE = chewing
SAP = saprophagous
NEC = nectar feeding
NON = non-feeding adults
OMN = omnivorous
PRE = predaceous
SUC = sucking

* Combined as phytophagous in 1973

Table 43. Trophic structure (number of species in feeding categories) of Curlew Valley invertebrates

Feeding Category	Collembola	Thysanura	Odonata	Orthoptera	Isoptera	Dermaptera	Psocoptera	Thysanoptera	Hemiptera	Homoptera	Neuroptera Imm.	Neuroptera Adlt.	Coleoptera Imm.	Coleoptera Adlt.	Lepidoptera Imm.	Lepidoptera Adlt.	Diptera Imm.	Diptera Adlt.	Hymenoptera Imm.	Hymenoptera Adlt.	Scorpionida	Pseudoscorpionida	Araneida	Acarina	Geophilomorpha	Solpugida
1. Zoophagic Harvesting			1	1								4	31	26												
2. Zoophagic Sucking								1	8		4						14	24			1	1	10	4	2	1
3. Parasitoids													6				36		221							
4. Phytophagic Har.	4			6									37	49	23		29		51					5		
5. Phytophagic Suc.								4	39	60							12	47								
6. Saprophagic		1			1		3						10	11			38	8						4		
7. Omnivorous				2															15	15						
1 and 6													7	3												
2 and 5									15																	
2 and 6								1									12	1								
3 and 4																			22							
4 and 5																		3		294						
4 and 6						1							20	22			14									
5 and 6																	13	22								
5 and Non-feeding																23		63								
Total	4	1	1	9	1	1	3	6	62	60	4	4	111	111	23	23	168	168	309	309	1	1	10	13	2	1
Combined Categories																										
Zoophagous			1	1				2	23		4	4	38	29			26	25			1	1	10	4	2	1
Phytophagous	4			6		1		5	54	60			57	71	23	23	68	135	73	294				5		
Parasitoid													6				36		243							
Saprophagic		1			1	1	3						37	36			77	31						4		
Omnivorous				2															15	15						
Total	4	1	1	9	1	2	3	7	77	60	4	4	138	136	23	23	207	191	331	309	1	1	10	13	2	1

Table 43, continued

Feeding Category	Total Feeding Types all Categories	% of Total	T.F.T. Simple Metamorphic Orders and Non-Insect Orders	% of Total	T.F.T. Holometabolous Orders (Imm. and Adlts.)	% of Total	T.F.T. Holometabolous Orders (Immatures)	% of Total	T.F.T. Holometabolous Orders (Adults)	% of Total	T.F.T. Simple Metamorphic and Holometabolous Orders (Immatures)	% of Total	T.F.T. Simple Metamorphic and Holometabolous Orders (Adults)	% of Total
1	63	4.5	2	1.1	61	5.0	31	5.0	30	4.9	33	5	32	3.1
2	70	5.0	28	16	42	3.4	18	3.0	24	3.9	27	4	34	3.3
3	263	19	0	0	263	21	263	43	0	0	263	36	263	26
4	204	15	15	8.5	189	15	140	23	49	8.0	150	21	59	5.7
5	162	12	103	59	59	4.8	12	2.0	47	7.6	115	16	150	15
6	76	5.4	9	5.1	67	5.4	48	8.0	19	3.1	53	7.2	24	2.3
7	32	2.3	2	1.1	30	2.4	15	2.4	15	2.4	17	2.3	17	17
1 and 6	0	0.7	0	0	10	0.8	7	1.1	3	0.5	7	1	3	0.3
2 and 5	10	1.1	16	9.1	0	0	0	0	0	0	16	2.2	16	1.6
2 and 6	16	0.9	0	0	13	1.1	12	2.0	1	0.2	12	1.6	1	0.01
3 and 4	13	1.6	0	0	22	1.8	22	3.6	0	0	22	3	0	0
4 and 5	297	21	0	0	297	24	0	0	297	48	0	0	297	29
4 and 6	57	4.1	1	0.6	56	4.6	34	5.5	22	3.6	35	4.8	23	2.2
5 and 6	35	2.5	0	0	35	2.8	13	2.1	22	3.6	13	1.8	22	2.1
5 and Non-Feeding	86	6.1	0	0	86	7.0	0	0	86	14	0	0	86	8.4
Total	1406		176		1230		615		615		793		1027	
Combined Cat.														
Zoophagous	176	11	46	24	126	9.2	68	9.7	58	8.7	95	11	85	8
Phytophagous	879	56	135	70	744	54	221	31	523	79	351	40	653	59
Parasitoid	285	18	0	0	285	21	285	41	0	0	285	33	285	26
Saprophagic	191	12	10	5.2	181	13	114	16	67	10	120	14	73	11
Omnivorous	32	2.1	2	1.0	30	2.2	15	2.1	15	2.3	17	2	17	2
Total	1559		193		1366		703		663		868		1113	

Table 44. Explanation of feeding types

Feeding Types Defined:

1. Zoophagic Harvesting - mandibulate predators.
2. Zoophagic Sucking - haustellate predators.
3. Parasitoid - larval Coleoptera, Diptera, and Hymenoptera which feed on prey captured by adults.
4. Phytophagic Harvesting - mandibulate herbivores, leaf miners, gall makers, fungal and pollen feeders.
5. Phytophagic Sucking - haustellate herbivores: sap and nectar feeders.
6. Saprophagic - consume dead and decaying organic matter.
7. Omnivorous - any combination of the previous six categories.

Combined Feeding Types:

Zoophagous - includes feeding types: 1,2,3,1 and 6,2 and 5, 2 and 6,3 and 4.

Phytophagous - includes feeding types: 4,5,2 and 4,3 and 4, 4 and 6,4 and 5,5 and 6,5 and Non-Feeding

Parasitoids - includes feeding types: 3,3 and 4.

Saprophagous - includes feeding types: 6,1 and 6,2 and 6, 4 and 6,5 and 6.

Omnivorous - feeding type: 7.

Table 45. Taxonomic composition of Curlew Valley invertebrates

Taxon	# Species/Order	# Families/Order	% Species of Total
Insecta			
Collembola	4	4	0.5
Thysanura	1	1	0.1
Odonata	1	1	0.1
Orthoptera	9	3	1.1
Isoptera	1	1	0.1
Dermaptera	1	1	0.1
Psocoptera	3	3	0.4
Thysanoptera	6	3	0.8
Hemiptera	62	12	7.4
Homoptera	60	12	7.6
Neuroptera	4	4	0.5
Coleoptera	111	27	14.0
Lepidoptera	23	10	2.9
Diptera	168	37	21.2
Hymenoptera	309	34	39.1
Chilopoda			
Geophilomorpha	2	-	0.3
Arachnida			
Scorpionida	1	-	0.1
Solpugida	1	-	0.1
Pseudoscorpionida	1	-	0.1
Acarina	13	-	1.6
Araneida	10	-	1.3
Total	791	153	99.4

Table 46. Comparison of cool desert and old-field community composition

Species Data	Curlew Valley	Old-Field Grassland*
Taxonomic Composition		
# of Orders	15	15
# of Families	153	179
# of Species	763	1,584
% of Total Contributed by:		
Hymenoptera, Diptera Coleoptera and Lepidoptera	77%	86%
Hemiptera, Homoptera Orthoptera and Thysanoptera (Curlew) or Odonata (Old-Field)	17%	12%
Trophic Structure		
Adults:		
% Herbivorous species	59%	85%
% Carnivorous species	34%	12%
Immatures:		
% Herbivorous species	40%	41%
% Carnivorous species	44%	52%

*Evans and Murdoch 1968.

Table 47. Weights for size classes of invertebrates sampled by pitfall in 1974

TAXA	SIZE CATEGORY	WEIGHT RANGE (g)
Orthoptera - Gryllacrididae	adult	.05001 and above
Ceuthophilus sp.	#1	.01101 - .05000
	#2	.00176 - .01100
	#3	.00175 and below
Orthoptera - Gryllacrididae	adult	.[illegible]0901 and above
Stenopelmatus fuscus	immature	.[illegible]0900 and below
Hemiptera - Lygaeidae	adult	.00016 and above
Nysius ericae	immature	.00015 and below
Scorpionida - Vejovidae	adult	.10501 and above
Vejovis boreus	#1	.06001 - .10500
	#2	.00901 - .06000
	#3	.00900 and below
Araneida - Lycosidae	adult	.03501 and above
	#1	.02001 - .03500
	#2	.00601 - .02000
	#3	.00201 - .00600
	#4	.00200 and below
Solpugida	adult	.06501 and above
	#1	.03001 - .06500
	#2	.00701 - .03000
	#3	.00301 - .00700
	#4	.00300 and below

Future Research

Calibration of sampling methods began late in 1974 and continued through 1975. The results will appear in the 1975 annual report. The grass and shrub vegetation types will receive special emphasis in 1975 with respect to a detailed invertebrate feeding analysis. The next report will also contain complete soil-arthropod data from field seasons 1974-76.

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VERTEBRATES

R. D. Anderson

Reptiles, Amphibians and Birds

A decision was made in 1971 not to sample reptiles and amphibians since so few are found on the sites. Birds were not sampled in 1974.

Rodents

Introduction

A live-trapping program that began in August 1971 for the estimation of rodent density and biomass was continued in 1973. In 1974, the program was restricted to an August sample on the south shrub and grass sites only. The northern sites were not sampled as that portion of the validation study had been discontinued.

Methods

The field methods used were essentially the same as those used since 1971 and described in Balph et al. (1973). The trap design remained a 12 x 12 grid with two traps per station, 15 m between stations. Traps were operated for five nights per sample. All animals captured were marked by toe clipping.

Analytical methods differed from previous years. All live-trapping data from 1971 to 1974, inclusive, were run on a new program written for this study by Kim Marshall of the Desert Biome Data Processing Group. This program computes numeric estimates of population size using eight different estimators and allows the user to compare and decide which to use. Traditional capture-recapture estimators, such as the Schnabel (1938), as modified by Overton (1965), the Schumacher-Eschmeyer (1943) and the Jolly (1965), are included as well as several based upon frequency of capture distributions (Edwards and Eberhardt 1967, Eberhardt 1969, Tanton 1965).

There was much discrepancy between the various estimators, with a surprising number of capture-recapture estimates lower than the number of animals actually observed. In fact, out of 69 separate estimates, only 27.5% of those calculated using the Schnabel formula (the method used in previous Curlew Valley validation work) and 29% of the Schumacher-Eschmeyer estimates exceeded the number of animals actually captured by one or more, with only 13.1% of both types equaling or exceeding the number of animals actually captured by less than one.

The Jolly estimator performed even more poorly, with daily estimates exceeding the number of animals actually captured by one or more; an average of only 19.1% of the time.

The various frequency of capture estimators in nearly all cases (the few exceptions being with the negative binomial estimator, which is a special case), estimated greater than the number of animals actually captured. The problem lies in determining which estimator provides the most realistic estimate of numbers. It may not be enough to accept the estimate of the best-fitting distribution, as the traditional goodness-of-fit tests, such as chi-square, may not be sensitive enough, as shown by Roff (1973).

The Curlew Valley validation data support Roff's (1973) contention that tests such as chi-square may not be sensitive enough to discriminate between different distributions. In many cases there appears to be no significant difference in goodness-of-fit between any of the four types tested (geometric maximum likelihood, geometric regression, Poisson, negative binomial) with Curlew Valley data. Although none may deviate significantly from the observed data, there is a great deal of difference between estimates of the number of animals not captured. Figures 42 to 44 demonstrate this with data for *Peromyscus maniculatus*, *Perognathus parvus* and *Eutamias minimus*, captured in the ART-ATR-SIT vegetation type (hectare 15) on the south shrub site in 1974. Selecting the distribution showing the lowest chi-square value (i.e., best fit) may not be enough, as shown by Roff's (1973) simulation work where the distribution with the lowest chi-square value gave the worst estimate, far exceeding the known population.

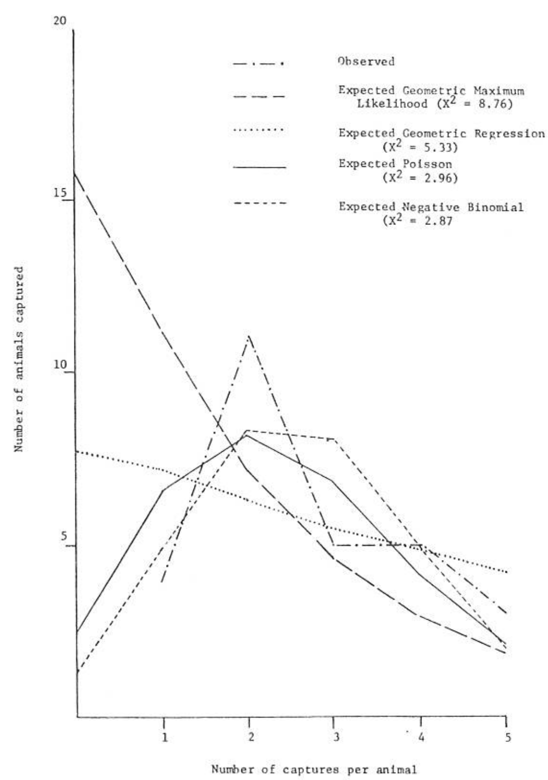

Figure 42. Goodness-of-fit of observed *Peromyscus maniculatus* frequency-of-capture data to the expected values of four different distributions, south shrub site, hectare 15, August 1974.

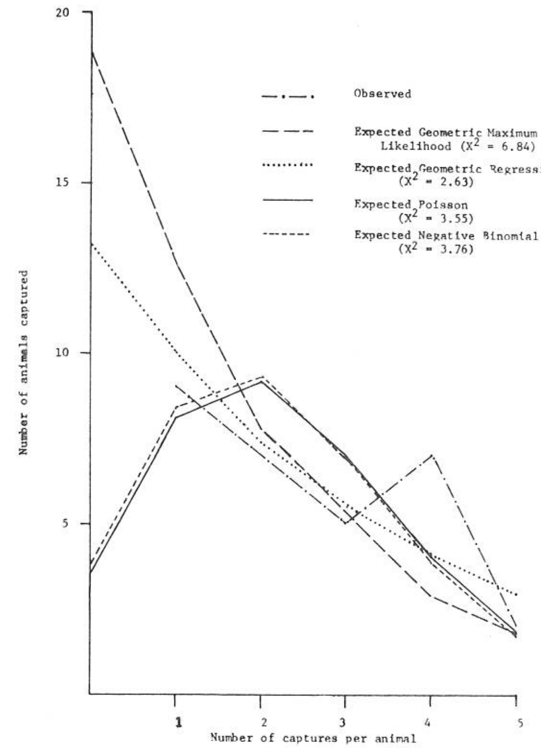

Figure 43. Goodness-of-fit of observed *Perognathus parvus* frequency of capture data to the expected values of four different distributions, south shrub site, hectare 15, August 1974.

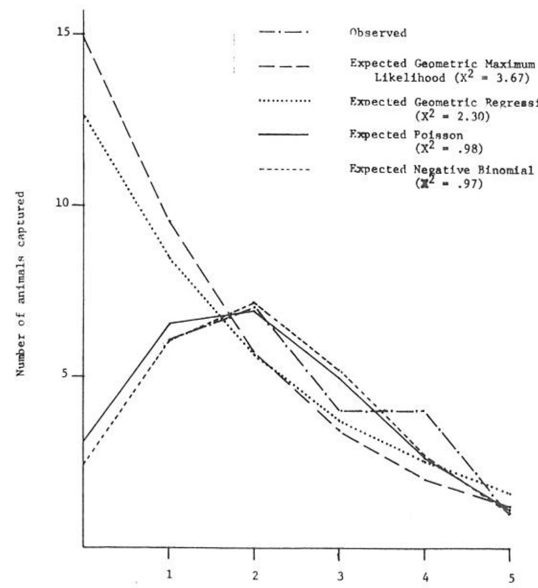

Figure 44. Goodness-of-fit of observed *Eutamias minimus* frequency-of-capture data to the expected values of four different distributions, south shrub site, hectare 15, August 1974.

Generally, the two types of estimates based upon the geometric distribution tended to be larger than the other estimators used, with the geometric maximum likelihood estimate being the largest.

Because of the problems of interpretation, it was decided to follow the precedent of Krebs (1966), Maza (in Turner and McBrayer 1974) and others, and base all density and biomass estimates for 1974 upon the number of animals actually captured. It is felt that, although this is a **minimum** estimate, it is at least a known quantity. A strong supporting argument in favor of using such a minimum estimate is that cumulative capture curves begin to level off after three to five days of trapping, indicating that, by that time, the bulk of the trappable animals have been captured (Figs. 45-47). All density and biomass estimates since 1971 on the southern sites have been revised in this manner and are presented here in tabular and graphical form.

Home Range and Estimated Area Sampled

Home range estimates are based upon the Jennrich and Turner (1969) elliptical estimator as in previous reports, although the means of pooling individual estimates to derive a mean home range area for each species was changed.

In past years the estimate of area sampled in each sampling period was based upon the pooled home range size of each species captured in that sample (Turner et al. 1971). There were often only one or two individuals with enough capture points to allow an estimate of home-range areas and the estimate of sampling area was based upon these few animals. When no home-range area could be calculated, the area of the trapping grid was arbitrarily expanded by the distance between the traps (Balph et al. 1973) as an approximation of the area sampled.

In this report, it was decided to follow the lead of B. Maza of the Rock Valley Validation Site study (Turner and McBrayer 1974), and base the estimate of area sampled upon the mean home-range size of each species, based on all captures since the beginning of the program.

All Curlew Valley live-trapping data were searched and each animal that met certain criteria (a minimum of three captures at three different points not in a straight line) was listed by species with the home-range area calculated by the Jennrich and Turner (1969) method. The mean distance between successive captures (Brant 1962) as well as the numbers of captures for each individual were also listed. Means and confidence limits at the 90% level ($P < .10$) were calculated for all these parameters. Three species, *Peromyscus maniculatus*, *Perognathus parvus* and *Eutamias minimus*, had enough individuals for meaningful analysis with 187, 116 and 48, respectively. Results for these species are shown in Table 48.

In addition to these basic statistics, these data were subjected to a step-wise multiple regression analysis with home-range area as the Y variable and the other parameters as the Xi's.

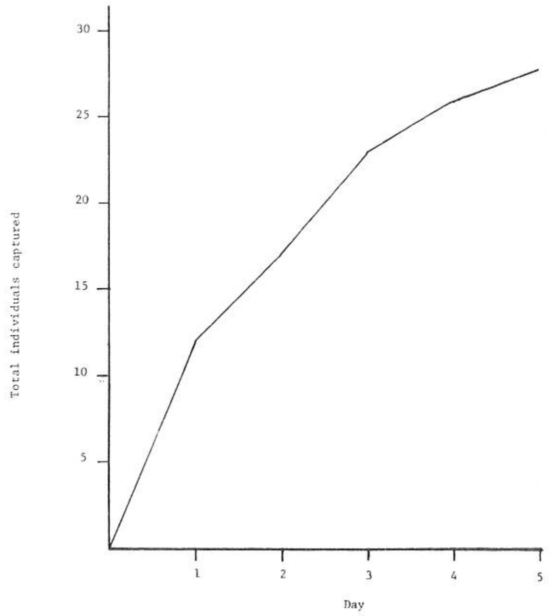

Figure 45. Cumulative capture curve for *Peromyscus maniculatus* on the south shrub site, hectare 15, August 1974.

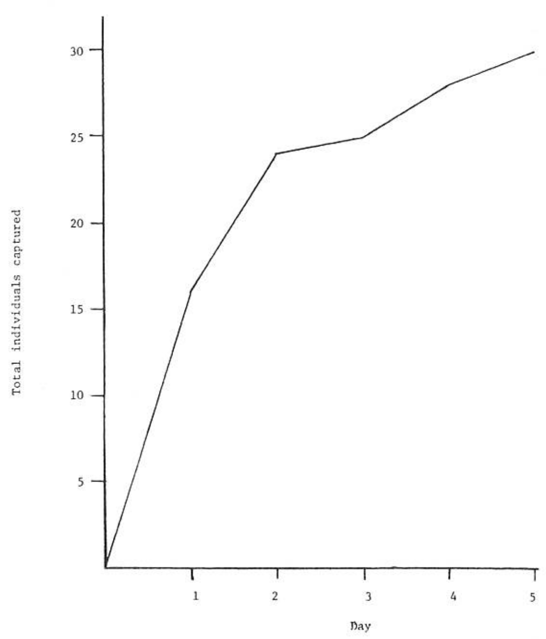

Figure 46. Cumulative capture curve for *Perognathus parvus* on the south shrub site, hectare 15, August 1974.

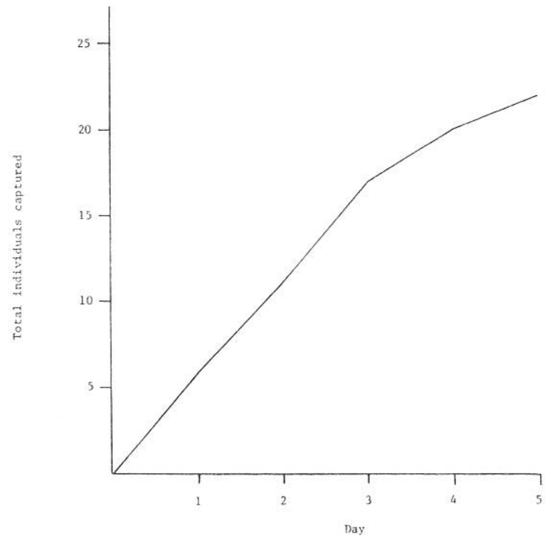

Figure 47. Cumulative capture curve for *Eutamias minimus* on the south shrub site, hectare 15, August 1974.

Based upon these analyses, it was decided to use the mean home-range area calculated with all the data since 1971 as a standard home-range area for these three species and to expand the sampling grid area by a factor of this area as an estimate of the area sampled as described by Maza et al. (1973) and in Turner and McBrayer (1974). This is accomplished by converting the pooled home-range area to a circle, computing the diameter and then adding that distance (meters) to the side of the trapping grid (165 m). This distance is then squared to estimate the total area actually sampled (Turner et al. 1971).

For the other species, the grid is expanded by adding twice the mean distance between successive captures (based on all the data since 1971) to the side of the trapping grid. This is consistent with Brant (1962), who felt that the mean distance between successive captures was a range size in *Microtus* sp. Also, the regression analysis done with these data indicates that this parameter is by far the most important of those tested. The regression analysis of the mean distance between successive captures against the Jennrich and Turner home-range area gave r^2 values of .64 for *Eutamias*, .46 for *Peromyscus* and .58 for *Perognathus*. Addition of all the other variables (maximum distance across captures, number of captures, year, site, hectare) raised the r^2 values an average of only .059.

In those few cases where neither home-range area nor distance between successive captures could be calculated, the sampling-grid size was arbitrarily expanded by adding twice the distance between trap stations (15 m) to the side of the trapping grid.

The standard values for the estimated area sampled for each species based upon these analyses are shown in Table 49.

Table 48. Means and 90% confidence intervals of various movement parameters based upon pooled 1971-74 Curlew Valley data

Species	Number of Individuals		Number of Captures	Mean Distribution Between Successive Captures (m)	Maximum Distance Across Captures (m)	Home Range (hectares)
PERMAN	187	$\bar{X}$	4.08	37.72	64.97	.90
		90%CI	3.98-4.18	35.12-40.31	60.76-69.17	.74-1.05
PERPAR	115	$\bar{X}$	3.79	29.86	46.23	.65
		90%CI	3.68-3.91	26.94-32.79	41.69-50.77	.51-.79
EUTMIN	48	$\bar{X}$	3.63	54.04	83.68	1.72
		90%CI	3.47-3.78	47.51-60.57	74.11-93.25	1.24-2.20
DIPMIC	13	$\bar{X}$	----	52.64	----	---
		90%CI		33.6-71.67		
DIPORD	26	$\bar{X}$	----	24.35	----	---
		90%CI		18.34-30.35		
ONYLEU	9	$\bar{X}$	----	41.43	----	---
		90%CI		26.88-55.98		
LAGCUR	5	$\bar{X}$	----	20.41	----	---
		90%CI		13.28-27.54		
REIMEG	2	$\bar{X}$	----	54.06	----	---

Table 49. Standard values of area sampled and mean weight used in density and biomass calculations. Based upon pooled 1971-74 data for each species (see Table 48)

Species	Estimated Area Sampled (Hectares)	Mean Air-Dry Weight (Grams)
PERMAN	7.4	4.78
PERPAR	6.55	4.91
EUTMIN	9.8	8.64
ONYLEU	6.14	5.97
DIPORD	4.57	13.61
DIPMIC	7.31	17.69
LAGCUR	4.24	5.85
REIMEG	3.8	2.65

Biomass

Biomass estimates for each species are based upon the mean weight of all individuals captured on the southern sites since 1971. The assumption of a 70% water content was made in converting live weights to an estimated dry weight (Golley 1960). These standard dry-weight values for each species are listed in Table 49.

Results and Discussion

The three most important rodent species in Curlew Valley (as indicated by live-trapping), in terms of numbers and distribution, are *Peromyscus maniculatus*, *Perognathus parvus* and *Eutamias minimus*. Other species may also be important, but do not appear so due to the biases in live-trapping. There is some evidence of this in that *Lagurus curatus*, and other microtines, are apparently an important item in the diet of both coyotes (Steve Hoffman, pers. comm.) and badgers (Lindsey 1971) in Curlew Valley, although they are very uncommon in live-traps. Table 50 lists the rodent species that have been observed to date on the Curlew Valley Validation Site. The presence of *Mus musculus* in the table is not indicative of a resident population. Only one individual of this species has been observed on the south sage site (in 1973) and probably represents an accidental introduction to the site. The individual in question was probably transported to the site in a truck carrying traps and equipment from Snowville.

Revised density and biomass estimates for all samples taken on the southern sites, as well as the sex and age structure of the 1974 samples since 1971, are given in Tables 51-81. These revised estimates are based on the number of animals observed rather than on some mathematical estimator and should be viewed as minimum estimates of population size. The change in the method of estimating the area actually sampled has resulted in a reduction in the magnitude of apparent density fluctuation but with little change in the relative trends.

Figures 48 through 52 show the changes in density of the southern sites' three most important species, *Peromyscus maniculatus*, *Perognathus parvus* and *Eutamias minimus*, since 1971. An attempt has been made to correlate these changes in density to changes in precipitation, but with little success. Such a correlation has been shown for *Perognathus parvus* in south-central Washington (O'Farrell et al. 1975). In that study, changes in *Perognathus* density correlated with the preceding October-April precipitation (r = .99) rather than with annual precipitation. Although precipitation is undoubtedly an important climatic variable in Curlew Valley, there may be others, such as spring minimum temperatures, that confound the correlation with rodent density. Even though precipitation is adequate for germination and growth of annual vegetation, late spring freezing temperatures could kill newly germinated seedlings and cause a relatively poor annual crop.

As shown in Figure 50, *Eutamias minimus* populations on the south shrub site have been fairly stable over the period since 1971. Populations of both *Peromyscus maniculatus* (Fig. 48) and *Perognathus parvus* (Fig. 49) have fluctuated much more, with *Peromyscus* showing a peak in 1972 and *Perognathus* showing a peak in 1973.

Table 50. Rodent species observed on Curlew Valley validation sites

Species	Species Code	N. Shrub	N. Grass	S. Shrub	S. Grass
Spermophilus townsendii	SPETOW			X	X
Ammospermophilus leucurus	AMMLEU	X			
Eutamias minimus	EUTMIN	X	X	X	X
Perognathus parvus	PERPAR	X	X	X	X
Dipodomys microps	DIPMIC			X	X
Dipodomys ordii	DIPORD	X		X	
Reithrodontomys megalotis	REIMEG		X	X	X
Peromyscus maniculatus	PERMAN	X	X	X	X
Peromyscus truei	PERTRU		X		
Onychomys leucogaster	ONYLEU	X	X	X	
Mus musculus	MUSMUS			X	
Lagarus curtatus	LAGCUR	X	X	X	X

Table 51. Estimated rodent density and biomass in the ART-ATR-SIT vegetation type on the south shrub site, hectare 15, August 1971. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	2	0.27	4.84
EUTMIN	4	0.41	3.53
ONYLEU	1	0.16	.972
PERMAN	7	0.95	4.52
PERPAR	3	0.46	2.25

Table 52. Estimated rodent density and biomass in the ART-ATR-SIT vegetation type on the south shrub site, hectare 15, August 1972. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	9	1.23	21.78
EUTMIN	14	1.43	12.34
PERMAN	12	1.62	7.75
PERPAR	32	4.88	23.99

The periodic sampling (April, June, August) on the south shrub site indicated a decrease in the density of all three species in the HAL-ART vegetation type (hectare 75) from April to August. This is coupled with a density increase in the ANNUALS vegetation type (hectare 72). This may be indicative of a movement of animals into the ANNUALS area as seeds became available. It is now planned to conduct a similar, periodic sampling program in at least the ART-ATR-SIT vegetation type (hectare 15). Trapping will be done at two- to three-week intervals throughout the entire season, with the goal of gaining a better understanding of seasonal changes in rodent populations.

As part of another research program, a portion of hectare 60 (80 x 120 m) on the south shrub site was plowed and seeded with *Agropyron desertorum* during the summer of 1974. It was decided to make use of this experimental opportunity and to trap the plowed area, plus the adjacent undisturbed shrub community. The results are shown in Tables 70 and 71. No animal was captured within the plowed area, although a large number were captured in the adjacent shrub area. The density estimates reported in Table 71 are averaged over the entire trapping grid and may underrepresent the density in the undisturbed area. It may be best to double these figures as an approximation of the density found in the shrub portion of the trapping grid. This area will be trapped again in August 1975, to assess changes that may take place as the plowed area becomes vegetated.

Lagomorphs

Introduction

Blacktail jackrabbits (*Lepus californicus*) are the only lagomorph considered abundant enough to be censused on the Curlew Valley site. Drag censuses of this species have been conducted each October since 1971 on the south shrub site (A3UBJI1).

Methods

Methods used to census jackrabbits are those described in Balph et al. (1973).

Results

Only the south shrub site was censused in 1974. Table 82 shows density, biomass and the changes in each since the 1973 sample. Figure 53 illustrates the changes in jackrabbit density and biomass since October 1971.

Jackrabbit populations continued to decline in 1974. The low density found on the south shrub site reflects the situation throughout Curlew Valley (L. C. Stoddart, pers. comm.). Possible factors responsible for the decline were discussed in Balph et al. (1973)

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Table 53. Estimated rodent density and biomass in the ART-ATR-SIT vegetation type on the south shrub site, hectare 15, April 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	6	0.82	14.52
EUTMIN	4	0.40	3.53
PERMAN	6	0.81	3.88
PERPAR	18	2.75	13.49

Table 54. Estimated rodent density and biomass in the ART-ATR-SIT vegetation type on the south shrub site, hectare 15, June 1973. Density and biomass calculated using the standard values for area and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	2	0.27	4.84
EUTMIN	14	1.43	12.34
MUSMUS	1	0.26	3.16
PERMAN	22	2.98	14.21
PERPAR	39	5.95	29.24

Table 55. Estimated rodent density and biomass in the ART-ATR-SIT vegetation type on the south shrub site, hectare 15, August 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	5	0.68	12.10
EUTMIN	14	1.43	12.34
ONYLEU	2	0.33	1.94
PERMAN	6	0.81	3.88
PERPAR	62	9.47	46.48

Table 56. Species, sex and age structure of rodents in the ART-ATR-SIT vegetation type on the south shrub site, hectare 15, August 1974

Species	Number Captured	Males	Females	Females %	Juvenile	Subadults	Adults
DIPMIC	2	2	0	0	0	0	2
EUTMIN	22	9	11	59.09	0	2	20
PERMAN	28	14	14	50.00	2	17	9
PERPAR	30	13	17	56.67	3	15	12
REIMEG	1	1	0	0	0	0	1

Table 57. Estimated rodent density and biomass in the ART-ATR-SIT vegetation type on the south shrub site, hectare 15, August 1974. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	2	0.27	4.84
EUTMIN	22	2.25	19.40
PERMAN	28	3.78	18.09
PERPAR	30	4.58	22.49
REIMEG	1	0.26	0.70

Table 58. Estimated rodent density and biomass in the ANNUALS vegetation type on the south shrub site, hectare 72, August 1972. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPORD	8	1.75	23.82
EUTMIN	1	0.10	0.88
PERMAN	18	2.43	11.63
PERPAR	11	1.68	8.25

Table 59. Estimated rodent density and biomass in the ANNUALS vegetation type on the south shrub site, hectare 72, April 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPORD	4	0.88	11.91
EUTMIN	1	0.10	0.88
PERMAN	8	1.08	5.17
PERPAR	7	1.07	5.25

Table 60. Estimated rodent density and biomass in the ANNUALS vegetation type on the south shrub site, hectare 72, June 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPORD	6	1.31	17.87
EUTMIN	2	0.20	1.76
PERMAN	4	0.54	2.58
PERPAR	9	1.37	6.75
SPETOW	1	0.26	0.00

Table 61. Estimated rodent density and biomass in the ANNUALS vegetation type on the south shrub site, hectare 72, August 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	1	0.14	2.42
DIPORD	3	0.66	8.93
PERMAN	12	1.62	7.75
PERPAR	21	3.21	15.74

Table 62. Species, sex and age structure of rodents in the ANNUALS vegetation type on the south shrub site, hectare 72, August 1974

Species	Number Captured	Males	Females	Females %	Juvenile	Subadults	Adults
DIPMIC	1	0	1	100	0	0	1
DIPORD	1	0	1	100	0	0	1
PERMAN	5	4	1	20.00	0	1	4
PERPAR	5	1	4	80.00	1	1	3

Table 63. Estimated rodent density and biomass in the ANNUALS vegetation type on the south shrub site, hectare 72, August 1974. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	1	0.14	2.42
DIPORD	1	0.22	2.98
PERMAN	5	0.68	3.23
PERPAR	5	0.76	3.75

Table 64. Estimated rodent density and biomass in the HAL-ART vegetation type on the south shrub site, hectare 75, August 1971. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
EUTMIN	13	1.33	11.46
PERMAN	23	3.11	14.86
PERPAR	2	0.30	1.50

Table 65. Estimated rodent density and biomass in the HAL-ART vegetation type on the south shrub site, hectare 75, August 1972. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	1	0.14	2.42
DIPORD	18	3.94	53.61
EUTMIN	15	1.53	13.22
ONYLEU	1	0.16	0.97
PERMAN	52	7.03	33.59
REIMEG	3	0.79	2.09
PERPAR	11	1.69	8.25

Table 66. Estimated rodent density and biomass in the HAL-ART vegetation type on the south shrub site, hectare 75, April 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
EUTMIN	13	1.33	11.46
PERMAN	12	1.62	7.75
PERPAR	17	2.60	12.75

Table 67. Estimated rodent density and biomass in the HAL-ART vegetation type on the south shrub site, hectare 75, June 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	1	0.14	2.42
DIPORD	2	0.44	5.96
EUTMIN	8	0.82	7.05
LAGCUR	1	0.24	1.38
PERMAN	8	1.08	5.17
PERPAR	15	2.29	11.24

Table 68. Estimated rodent density and biomass in the HAL-ART vegetation type on the south shrub site, hectare 75, August 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	3	0.41	7.26
EUTMIN	6	0.61	5.29
PERMAN	7	0.95	4.52
PERPAR	10	1.53	7.50

Table 69. Species, sex and age structure of rodents in the HAL-ART vegetation type on the south shrub site, hectare 75, August 1974

Species	Number Captured	Males	Females	Females %	Juvenile	Subadults	Adults
DIPORD	2	0	2	100	0	0	2
EUTMIN	12	6	6	50.00	0	1	11
PERMAN	15	9	6	40.00	0	7	8
PERPAR	6	3	3	50.00	0	0	6

Table 70. Estimated rodent density and biomass in the HAL-ART vegetation type on the south shrub site, hectare 75, August 1974. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPORD	2	0.44	5.96
EUTMIN	12	1.22	10.58
PERMAN	15	2.03	9.69
PERPAR	6	0.92	4.50

Table 71. Species, sex and age structure of rodents in the plowed ARTTRI vegetation type on the south shrub site, hectare 60, August 1974

Species	Number Captured	Males	Females	Females %	Juvenile	Subadults	Adults
DIPORD	6	3	3	50.00	0	0	6
EUTMIN	18	8	10	55.56	0	4	14
PERMAN	12	7	5	41.67	0	10	2
PERPAR	4	3	1	25.00	0	0	4

Table 72. Estimated rodent density and biomass in the plowed ARTTRI vegetation type on the south shrub site, hectare 60, August 1974. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	1	0.14	2.42
DIPORD	6	1.31	17.87
EUTMIN	18	1.84	15.87
PERMAN	12	1.62	7.75
PERPAR	4	0.61	3.00

Table 73. Estimated rodent density and biomass in the AGRDES vegetation type on the south shrub site, hectare 17, August 1972. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
PERMAN	8	1.08	5.17
PERPAR	17	2.60	12.74
REIMEG	5	1.32	3.49

Table 74. Estimated rodent density and biomass in the AGRDES vegetation type on the south grass site, hectare 17, August 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
LAGCUR	1	0.24	1.39
PERMAN	28	3.78	18.09
PERPAR	19	2.90	14.24
REIMEG	1	0.26	0.70

Table 75. Species, sex and age structure of rodents in the AGRDES vegetation type on the south grass site, hectare 17, August 1974

Species	Number Captured	Males	Females	Females %	Juvenile	Subadults	Adults
PERMAN	5	2	3	60.00	0	2	3
PERPAR	11	6	5	45.45	0	1	10

Table 76. Estimated rodent density and biomass in the AGRDES vegetation type on the south grass site, hectare 17, August 1974. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
PERMAN	5	0.68	3.23
PERPAR	11	1.68	8.25

Table 77. Estimated rodent density and biomass in the AGRDES vegetation type on the south grass site, hectare 62, August 1971. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	1	0.14	2.42
PERMAN	5	0.68	3.23
PERPAR	7	1.07	5.25

Table 78. Estimated rodent density and biomass in the AGRDES vegetation type on the south grass site, hectare 62, August 1972. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	4	0.55	9.68
PERMAN	10	1.35	6.46
PERPAR	23	3.51	17.24
REIMEG	2	0.53	1.39

Table 79. Estimated rodent density and biomass in the AGRDES vegetation type on the south grass site, hectare 62, August 1973. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
PERMAN	5	0.68	3.23
PERPAR	20	3.05	15.00

Table 80. Species, sex and age structure of rodents in the AGRDES vegetation type on the south grass site, hectare 62, August 1974

Species	Number Captured	Males	Females	Females %	Juvenile	Subadults	Adults
DIPMIC	1	0	1	100	0	1	0
EUTMIN	2	1	1	50.00	0	0	2
ONYLEU	3	3	0	00.00	0	0	3
PERMAN	19	12	7	36.84	0	9	10
PERPAR	29	14	15	51.72	1	12	16

Table 81. Estimated rodent density and biomass in the AGRDES vegetation type on the south grass site, hectare 62, August 1974. Density and biomass calculated using the standard values for area sampled and mean weight from Table 49

Species	Number captured	Estimated density number/hectare	Estimated air-dry biomass grams/hectare
DIPMIC	1	0.14	2.42
EUTMIN	2	0.20	1.76
ONYLEU	3	0.49	2.92
PERMAN	19	2.57	12.27
PERPAR	29	4.43	21.74

Table 82. Density and estimated biomass of jackrabbits on south shrub site, October 1972 and 1973

No. Counted 1973	No. Counted 1974	Change 1973-1974	No./Ha 1973	No./Ha 1974	Change 1973-1974	Biomass (kg/ha) 1973	Biomass (kg/ha) 1974	Change 1973-1974
16	12	-4	.16	.12	-.04	.1	.07	-.03

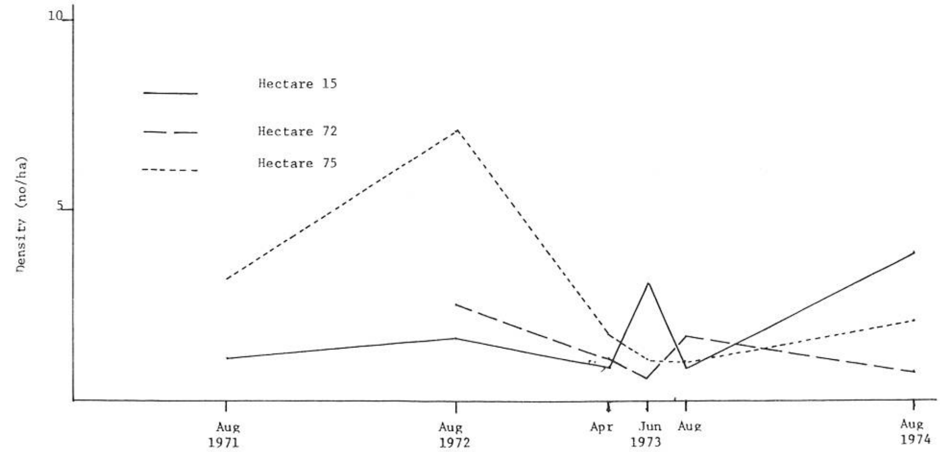

Figure 48. Changes in density of *Peromyscus maniculatus* in three vegetation types on the south shrub site, hectares 15, 72 and 75, August 1971 through August 1974.

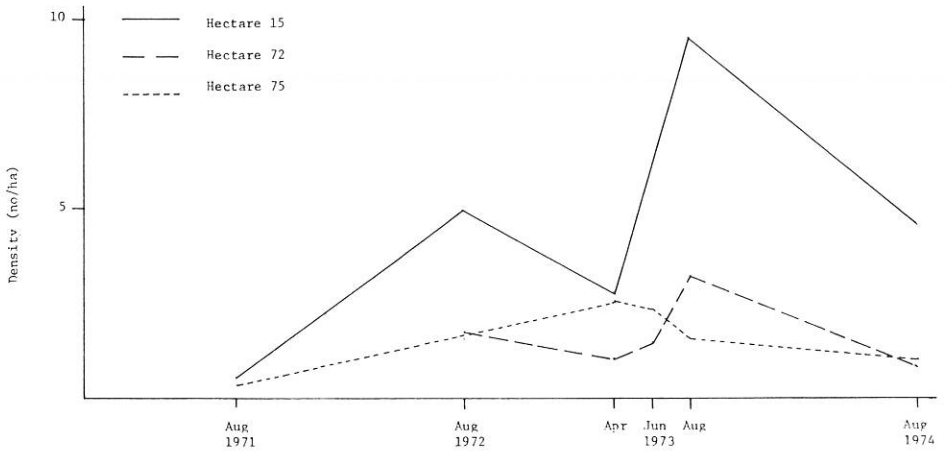

Figure 49. Changes in density of *Perognathus parvus* in three vegetation types on the south shrub site, hectares 15, 72 and 75, August 1971 through August 1974.

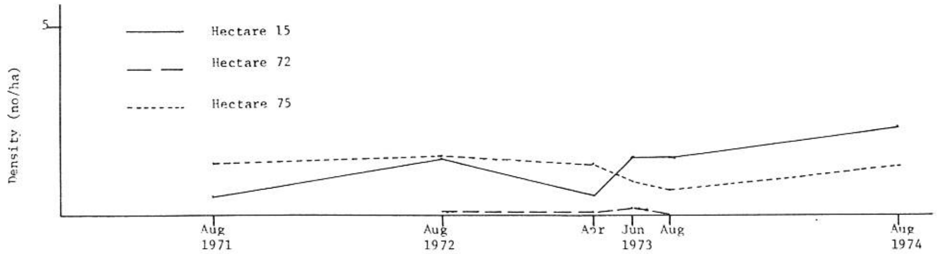

Figure 50. Changes in density of *Eutamias minimus* in three vegetation types on the south shrub site, hectares 15, 72 and 75, August 1971 through August 1974.

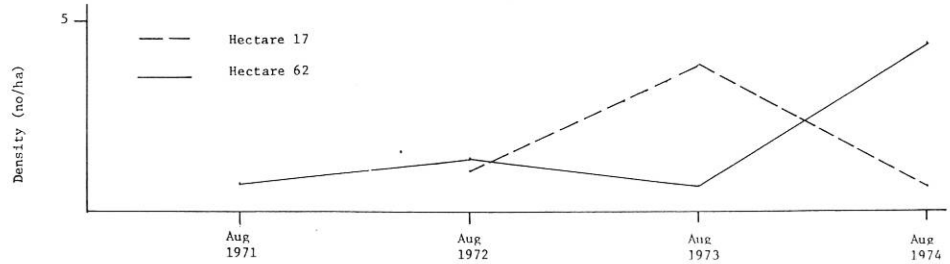

Figure 51. Changes in density of *Peromyscus maniculatus* on the south grass site, hectares 17 and 62, August 1971 through August 1974.

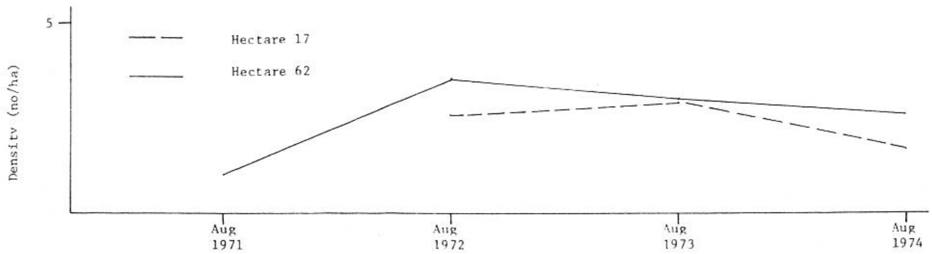

Figure 52. Changes in density of *Perognathus parvus* on the south grass site, hectares 17 and 62, August 1971 through August 1974.

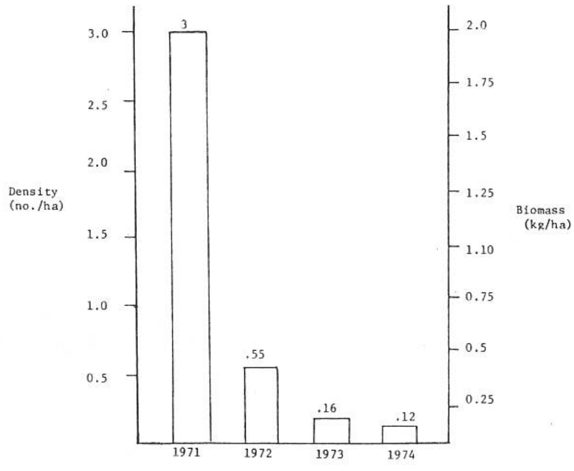

Figure 53. Estimated jackrabbit density and biomass on south shrub site, October 1973 through October 1974.

APPENDIX I

Invertebrate Species List

INSECTA

Collembola - * note same as Coleoptera, use COE

Entomobryidae
Entomobryid #1

Isotomidae
Isotomid #1

Poduridae
Podurid #1

Sminthuridae
Sminthurid #1

Thysanura - * note same as Thysanoptera, use THS

Machilidae
Machilid #1

Odonata

Coenagrionidae
Coenagrion sp. 1

Orthoptera

Acrididae
Aulocara ellioti (Thomas)
Melanoplus sp. 1
Trimerotropis sp. 1
T. bilobata Rhen and Hebb
T. cyaneipennis Bruner
Acridid #1

Gryllacrididae
Ceuthophilus sp. 1
Stenopelmatus fuscus Haldeman

Mantidae
Litaneutria minor (Scud.)

Isoptera

Dermaptera

Forficulidae
Forficula sp. 1

Psocoptera

Liposcelidae
Liposcelis sp. 1

Psocidae
Psocid #1

Psyllipsocidae
Psyllipsocid #1

Thysanoptera

Aeolothripidae
Aeolothrips sp. 1

Phaeothripidae
Leptothrips mali Fitch
Phaeothripid #2

Thripidae
Frankliniella sp. 1
Thripid #4
Thripid #5

Hemiptera

Anthocoridae
Orius tristicolor White

Corixidae - * note same as Corizidae, use COI
Corixid #1

Corizidae
Corizus sp. 1
Corizus sp. 2
Harmortes reflexus Say
Leptocorius trivittatus Say
Stictopleurus plutonius Baker

Cydnidae
Cydnid #1

Lygaeidae
Emblethis vicarius Horr.
Geocoris pallens Stål
Lygaeus kalmii Stål
L. pyrrhopterus Stål
Nysius minutus Uhler
N. sp. 1
Peritrechus saskatchewanensis Barber

Miridae
Atomoscelis modestus (V.D.)
Coquillettia insignis Uhler
Deraecoris bakeri Knight
Irbisia brachycera (Uhler)
Labopidea sericata Uhler
Leptopterna ferrugata (Fallen)
L. sp. 1
Lygus sp. 1
Melanotrichus albocostatus (V.D.)
M. althaeae (Hussey)
M. sp. 2
M. sp. 3
Psallus sp. 1
Scallus sp. 1
Stictopleurus plutoius
Strongylocoris stygicus (Say)
Trigonotylus ruficornis (Geoffroy)
Mirid #1
Mirid #2
Mirid #3
Mirid #4
Mirid #5
Mirid #8
Mirid #9
Mirid #10
Mirid #11
Mirid #12
Mirid #13
Mirid #14
Mirid #15

Nabidae
Nabis alternatus Parsh.
Pagasa fusca Stein

Pentatomidae
Aelia americana Dallas
Chlorochroa sayi Stål.
C. sp. 1
C. sp. 2
Codophila remota Horv.
Holcostethus limbolarius (Stal.)
Prionosoma podopioides Uhler
Thyanta punctiventris V.D.
T. rugulosa Say
T. sp. 1
Pentatomid #1

Piesmatidae
Piesma incisa McA.

Reduviidae
Reduviid #1

Saldidae
Saldid #1

Tingidae
Tingid #1

Homoptera

Aphididae
Aphidid #1
Aphidid #2
Aphidid #3
Aphidid #4
Aphidid #5

Cercopidae
Clastoptera sp. 1

Cicadellidae
Aceratagallia sp. 1
Acinopterus sp. 1
Aplanus albidus (Ball)
A. pauperculus (Ball)
Athysanella sp. 1
A. sp. 2
Auridius sp. 1
Balclutha sp. 1
Ballana sp. 1
B. sp. 2
B. sp. 3
B. sp. 4
Ceratagallia sp. 1
Circulifer tenellus (Baker)
Commellus sp. 1
Dikraneura carneola (Stål)
Empoasca alboneura Complex
E. aspersa
E. typhlocyboides Complex
E. sp. 1
E. sp. 2
Exitianus exitiosus (Uhler)
Hebecephalus sp. 1
Macrosteles fascifrons (Stål)
Mocuellus sp. 1
Parabolocratus sp. 1
Paraphlepsius sp. 1
Psammotettix sp. 1
Texananus sp. 1
Xerophloea sp. 1
Cicadellid #1
Cicadellid #9
Cicadellid #20
Cicadellid #22
Cicadellid #23
Cicadellid #25
Cicadellid #26
Cicadellid #27

Cicadidae - * note same as Cicadellidae, use CID
Magicicada sp. 1

Coccoidea
Coccoidea #1
Coccoidea #4
Coccoidea #5

Pseudococcidae
Pseudococcid #2

Fulgoroidea

Delphacidae
Delphacid #1

Dictyopharidae
Desertana sp. 1

Fulgoridae
Fulgorid #1

Issidae
Aphalonema sp. 1

Membracidae
Membracid #1

Psyllidae
Aphalara angustipennis Crawf.
A. artemisiae Frost
A. minutissima Crawf.
A. nubecula Patch.
A. sp. 1
A. sp. 2
Calophya triozoma Schw.

Neuroptera

Chrysopidae
Chrysopid #1

Coniopterygidae
Coniopterygid #1

Hemerobiidae
Micromus variolosus Hag.

Myrmeleontidae
Myrmeleontid #1

Coleoptera

Alleculidae
Mycetochara sp. 1

Anthicidae
Anthicus sp. 1
Ischyropalpus sp. 1
Notoxus calcaratus Horn
Tanarthrus salicola Lec.

Buprestidae
Agrilus sp. 1
Chrysobothris sp. 1

Carabidae
Calasoma sp. 1
Harpalus oblongus Csy.
Lebia sp. 1
Tecnophilus croceicollis Menc.
Carabid #1
Carabid #2
Carabid #3
Carabid #4
Carabid #5

Cerambycidae
Centrodura nevadica Lec.
Crossidens allgewahri Lec.

Lepturini #1

Chrysomelidae
Cryptocephalus sp. 3
C. sp. 5
Disonycha quinquerutata Fisher
Longitarsis sp. 1
Metachroma sp. 1
Monoxia consputa Lec.
M. sp. 2
Pachybrachys sp. 1
Psylliodes punctulata Melsh.
Stenopodius sp. 1
Trirhabda nitidicollis Lec.

Cicindelidae
Cicindela longilabris Say

Cleridae
- *Monophylla* sp. 1
- Clerid #1

Coccinellidae
- *Brachyacantha felina* Melsh.
- *Esochomus septontrionis* Weise
- *Hippodamia convergens* Guer.
- *Hyperaspis tetraneura* Csy.
- *H. nevadica* Csy.
- *H.* sp. 1
- *Scymnus uteanus* Csy
- Coccinellid #1
- Coccinellid #2
- Coccinellid #4

Crytophagidae
- *Atomaria* sp. 1

Cucujidae

Curculionidae
- *Anthomomus tenius* Fall.
- *Apion carifrons* Lec.
- *Cercopeus artemisiae* Pierce
- *Ceutorhynchus* sp. 1
- *Cleonus quadrillineatus* Chev.
- *Cylindrocopturus adspersus* Lec.
- *Epimechus* sp.
- *Hypera postica* (Gyll.)
- *Lixus* sp. 1
- *Phytobius* sp. 1
- *Scythropus* sp. 1
- Curculionid #1
- Curculionid #3
- Curculionid #5
- Curculionid #8

Dascillidae
- Dascillid #1

Dasytidae
- *Listrus interruptus* Lec.
- *Trichochrous* sp. 1
- Dasytid #2

Elateridae
- *Aeolus* sp. 1
- *Heteroderes* sp. 1
- *H.* sp. 2
- Elaterid #3

Histeridae
- *Hister* sp. 1
- *Saprinus desertorum* Mars.
- *S. insertus* Lec.

Lathridiidae

Leiodidae
- Leiodid #1

Malachiidae
- *Attalus* sp. 1
- *Collops bipunctatus* Say
- *C. utahensis* Schf.

Meloidae
- *Epicauta ferruginea* Say
- *E. normalis* Werner
- *Gnathias* sp. 1
- *Lytta vulnerata* Lec.
- *L. megister* Horn
- *Meloe* sp. 1

Mordellidae
- *Anaspis* sp. 1
- *Mordellistena* sp. 1

Mycetophagidae
- *Typhaea stercorea* L.

Pedilidae
- *Mastoremus longicornis* Casey
- Pedilid #1

Phalacridae
- *Phalacrus* sp. 1

Scaphidiidae - * note same as Scarabaeidae, use SCD
- Scaphidiid #1

Scarabaeidae
- *Aphodius* sp. 1
- *Ataenius* sp. 1
- *Glaresis* sp. 1
- *Pleurophoras caesus* Greute
- *Serica anthracina* Lec.
- Scarabaeid #1

Silphidae
- *Necrophorous* sp.
- *Silpha surinamensis* Fab.

Staphylinidae
- Staphylinid #1
- Staphylinid #2

Tenebrionidae
- *Araeoschizus* sp. 1
- *Blapspinus* sp. 1
- *Cnemeplatia sericea* Horn
- *Coniotus* sp. 1
- *Eleodes concinna* Blais.
- *E. hispilabris* Say
- *E. pilosa* Horn
- *Embaphion* sp. 1
- *Stenomorpha* sp. 1
- Tenebrionid #4
- Tenebrionid #5
- Tenebrionid #6
- Tenebrionid #7
- Tenebrionid #8

Lepidoptera

Coleophoridae
- *Coleophora* sp. 1
- Coleophorid #1

Geometridae
- *Platea* sp. 1

Hesperiidae
- *Hesperia* sp. 1

Lycaenidae
- *Mitoura siva* Edwards

Noctuidae
- *Euxoa auxillaris* Grt.
- *E. citricola* Grt.
- *Feltia ducens* Wlk.

Pieridae
- *Pieris occidentalis* Reakirt
- *P. protodice* Boisduval and LeConte

Pyralidae
- Pyralid #1

Scythrididae
- Scythridid #1

Tineidae
- *Bucculatrix* sp.

Microlepidoptera
- Microlepidoptera #1
- Microlepidoptera #2
- Microlepidoptera #3
- Microlepidoptera #4
- Microlepidoptera #5
- Microlepidoptera #6
- Microlepidoptera #8
- Microlepidoptera #9
- Microlepidoptera #11
- Microlepidoptera #13

Diptera

Agromyzidae
- Haplomyza sp. 1
- Liriomyza sp. 1
- L. sp. 2
- L. sp. 3
- Melanagromyza vireus (Loew)
- Ophomyia sp. 1
- Phytagromyza sp. 1
- P. sp. 2
- P. sp. 3
- P. sp. 4
- P. sp. 5
- P. sp. 6
- P. sp. 7
- P. sp. 8
- P. sp. 9

Anthomyidae
- Hylomyia sp. 1
- Scatophaga stercoraria (L.)
- Schoenomyza sp. 1

Asteiidae
- Asteia sp. 1

Asilidae
- Asilus cumbipilosus Adis.
- Efferia benedict Brul.
- Eucyrtopogon sp. 1
- Mallophorina guildiana Will.
- Ospriocerus abdominalis Martin
- Scleropogon neglectus (Brom.)
- Asilid #1

Bibionidae
- Bibio albipennis (Say)

Bombyliidae
- Anastoechus barbatus O.S.
- Conophorus obesulus
- C. sp. 1
- Exoprosopa calyptera Say
- E. doris O.S.
- E. sp. 1
- Geron sp. 1
- G. sp. 2
- Mythicomyia atra Cresson
- M. sp. 1
- M. sp. 2
- M. sp. 3
- Phthirea sulfurea Loew
- P. sp. 1
- P. sp. 2
- Poecilanthrax willistoni Coq.
- Villa lateralis Say
- V. syrtis Coq.

Calliphoridae

Cecidomyiidae
- Cecidomyiid #1
- Cecidomyiid #2
- Cecidomyiid #3
- Cecidomyiid #4
- Cecidomyiid #5
- Cecidomyiid #6
- Cecidomyiid #7
- Cecidomyiid #8
- Cecidomyiid #94
- Cecidomyiid #95
- Cecidomyiid #96
- Cecidomyiid #97
- Cecidomyiid #98
- Cecidomyiid #99

Ceratopogonidae
- Dasyhelea sp. 1
- D. sp. 2
- D. sp. 3
- D. sp. 4
- Forcipomyia sp. 1
- Leptoconops torrens (Townsend)
- Ceratopogonid #4
- Ceratopogonid #8

Chamaemyiidae
- Chamaemyia juncorum (Fallen)
- Leucopis sp. 1
- L. sp. 2
- Pseudodinia sp. 1

Chironomidae
- Chironomid #1

Chloropidae
- Olcella sp. 1
- O. sp. 2
- O. sp. 3
- Oscinella frit (L.)
- O. sp. 1
- O. sp. 2
- O. sp. 5
- Siphonella neglecta Becker
- S. sp. 1
- S. sp. 2
- Thaumatomyia appropluqua (Adams)
- Tricimba sp. 1

Conopidae
- Thecophora propinqua (Adams)
- Zodion fulvifrons Say

Culicidae
- Aedes dorsalis (Meigen)

Dolichopodidae
- Dolichopodid #1

Empididae
- Drapetis sp. 1
- D. sp. 2
- D. sp. 3
- Platypalpus sp. 1

Ephydridae
- Ephydra cinerea Jones
- Hydrellia sp. 1
- H. sp. 2
- Lamproscatella sibilans (Haliday)
- Philygria debilis Loew
- P. sp. 1
- Psilopa olga Cress.
- Scatella paludum (Meigen)

Heleomyzidae
- Heleomyzid #1
- Heleomyzid #2

Lauxanidae
- Camptoprosopella sp. 1

Milichiidae
- Leptometopa halteralis (Coq.)
- Madiza glabera (Fallen)

Muscidae
- Coenosia sp. 1
- Haematobia irritans (L.)

Otitidae
- Euxesta fervida Cun.
- E. sp. 1
- Otitid #1
- Otitid #2
- Otitid #3

Phoridae
- Phorid #1
- Phorid #2

Pipunculidae
- Pipunculus subopacus Lw.
- P. sp. 1
- Prothecus sp. 1

Psychodidae
- Psychodid #1

Sarcophagidae
- Sarcophaga sp. 1
- S. sp. 2
- S. sp. 3
- Senotainia flavicornis (Townsend)
- S. rubriventris Macquart
- S. sp. 1

Scenopinidae
- Scenopinus albifasciatus (Hardy)
- Scenopinid #1

Sciaridae
- Sciarid #1
- Sciarid #2
- Sciarid #3
- Sciarid #4

Sepsidae
- Sepsid #1

Sphaeroceridae
- Leptocera sp. 1

Stratiomyidae
- Hedriodiscus truquii (Bellardi)
- Nemotelus communis Hason
- Odontomyia tumida Banks

Syrphidae
- Eupeodes volucris O.S.
- Mesograpta marginata Say
- Syritta pipiens (L.)

Tachinidae
- Cylindromyia sp. 1
- Gymnosma sp. 1
- Hyalomya aldrichi Townsend
- Microchaetina valida (Townsend)
- Nowickia sp. 1
- Paradidyma sp. 1
- Periscepsia sp. 1
- Stomatomyia parvipalpis (Wulp)
- Tachinid #1
- Tachinid #2
- Tachinid #3

Tephritidae
- Acinrina ferruginea Doane
- Eutreta oregona Curr.
- Neaspilota sp. 1
- Neotephritus finalis Loew
- Paroxynia clathrata Loew
- Paroxynia sp. 1
- Procecidochares sp. 1
- Tephritus araneosa Coq.
- Trupanea bisetosa Coq.
- T. jonesi Curr.
- T. nigricornis Coq.
- Tephritid #2
- Tephritid #3
- Tephritid #8

Tethinidae
- Pelomyiella mallochi (Sturt.)
- P. melanderi (Sturt.)

Therevidae
- Psilocephala aldrichi Coq.
- P. costalis Loew
- P. sp. 1

Tipulidae
- Tipulid #1

Trixoscelidae
- Trixoscelis sp. 1

Hymenoptera

Andrenidae
- Andrena piperi Vier.
- A. sp. 1
- A. sp. 2
- Perdita similis Timb.

Anthophoridae
- Epeolus sp. 1
- Melissodes agilis Cr.
- M. dagosa Ckll.
- M. glenwoodensis Ckll.
- M. menuachis Cress.
- M. subagilis Ckll.
- M. utahensis LaB.
- Triepeolus sp. 1
- T. sp. 2

Bethylidae
- Bethylid #1
- Bethylid #2
- Bethylid #3
- Bethylid #4
- Bethylid #5

Braconidae
- Adialytus sp. 1
- Agathis gibbosa (Say)
- A. sp. 1
- Apanteles sp. 1
- A. sp. 2
- A. sp. 4
- A. sp. 5
- A. sp. 7
- Bracon gelechiae Ashm.
- B. sp. 1
- B. sp. 2
- B. sp. 3
- B. sp. 4
- B. sp. 6
- B. sp. 7
- B. sp. 10
- Chelonus (Microchelonus) sp. 1
- C. sp. 2
- C. sp. 3
- C. sp. 4
- Contharoctonus sp. 1
- Cremnops vulgaris (Cress.)
- Dacnusa sp. 1
- D. sp. 2
- D. sp. 3
- D. sp. 4
- Hormius sp. 1
- Lysaphidus sp. 1
- Lysiphlebus sp. 1
- Meteorus leviventris (Wesm.)
- Microbracon sp. 4
- M. sp. 9
- Microctonus sp. 1
- Microplitis brassicae Mues.
- M. sp. 1
- Opius sp. 1
- O. sp. 2
- O. sp. 3
- O. sp. 5
- O. sp. 6

Orgilus ferus Mues.
O. sp. 1
O. sp. 2
Tetrasphaeropyx sp. 1
Trioxys sp. 1
Braconid #1

Ceraphronidae
Ceraphron sp. 13
C. sp. 15

Chalcididae
Euchalcidia sp. 1
Haltichella sp. 3
H. sp. 4
H. sp. 5
Spilochalcis side (Wlkr.)
S. leptis Burks

Chrysididae
Hedychridium taylori (Bod.)
Hedychrum violaceum Brulle
Holopyga ventralis Say
Omalus sp. 1
Chrysidid #1

Colletidae
Colletes dissoptus Timb.
C. simulans nevadensis Swenk.
C. sp. 1

Cynipidae
Aspicera sp. 1
Charips sp. 1
Ganaspidium sp. 1
Gillettia sp. 1
Hexacola sp. 1

Dryinidae
Dryinid #1

Elasmidae
Elasmus nigripes How.
E. sp. 17

Encyrtidae
Encyrtid #1
Encyrtid #2
Encyrtid #3
Encyrtid #4
Encyrtid #5
Encyrtid #6
Encyrtid #7
Encyrtid #8
Encyrtid #9
Encyrtid #10
Encyrtid #12
Encyrtid #13
Encyrtid #16
Encyrtid #17
Encyrtid #19
Encyrtid #20
Encyrtid #21
Encyrtid #22
Encyrtid #23
Encyrtid #24

Eulophidae
Achrysocharella sp. 24
A. sp. 48
A. sp. 49
Chrysocharis ainsleyi Cwfd.
Chrysontomyia sp. 2
C. sp. 3
Cirrospilus flavoviridis Cwfd.
C. sp. 1
C. sp. 5
Diaulinopsis callichroma Cwfd.
Diglyphus begini (Ashm.)
D. intermedius (Girault)
D. websteri (Cwfd.)
Elachertus sp. 66
Emersonopsis sp. 58
Entedon bigeloviae Ashm.
Euderus sp. 3
E. sp. 53
E. sp. 55
E. sp. 62
E. sp. 72
Galeopsomyia sp. 86
Necremnus duplicatus Gah.
Sympiesis sp. 56
Tetrastichus sp. 25
T. sp. 27
T. sp. 36
T. sp. 37
T. sp. 69
T. sp. 75
T. sp. 77
Zagrammosoma sp. 4
Eulophid #5
Eulophid #30
Eulophid #35
Eulophid #45
Eulophid #47
Eulophid #64
Eulophid #68
Eulophid #73
Eulophid #87
Eulophid #90

Eupelmidae
Calosota metallica (Gahan)
Eupelmus sp. 10

Eurytomidae
Eudecatoma sp. 14
Eurytoma sp. 1
E. sp. 2
E. sp. 8
E. sp. 10
E. sp. 12
E. sp. 13
Rileya cecidomyiae Ashm.
Tetramesa sp. 3

Formicidae
Camponotus sp. 1
Formica cinerea lepida Wheeler
F. fusca L.
F. manni Wheeler
Lasius sp. 1
Leptothorax sp. 1
Myrmica americana Weber
Pogonmyrmex sp. 1
Formicid #1
Formicid #2
Formicid #3
Formicid #5
Formicid #7
Formicid #9
Formicid #11

Halictidae
Agapostemon femoratus Cwfd.
Dialictus sp. 1
Evylaeus sp. 1
Lasioglossum sisymbrium (Ckll.)
Sphecodes sp. 1

Ichneumonidae
Anomalon sp. 3
Campoplex sp. 1
Cratichneumon sp. 1
Cremastus sp. 1
C. sp. 2
Diadegma sp. 1
Diasparsis sp. 1
Enetastes dichromus
Gelis sp. 1
G. sp. 2
Glypa sp. 1
G. sp. 3

Horogenes plutellae (Vier.)
Ichneumon sp. 1
Netelia sp. 1
Temelucha sp. 1
Vulgichneumon sp. 1

Mutillidae
Cryphotes sp. 1
Sphaeropthalma sp. 1
Typhoctes sp. 1
Mutillid #1
Mutillid #2
Mutillid #3

Mymaridae
Gonatocerus sp. 2
Polynema sp. 1
Mymarid #4
Mymarid #6
Mymarid #20

Perilampidae
Perilampus sp. 1

Platygasteridae
Inostemma sp. 4
Isostasius sp. 3
Platygaster rohweri Fouts.
P. utahensis (Ashm.)
Platygaster sp. 1
P. sp. 2
Synopeas sp. 2

Pompilidae
Anoplius sp. 1
A. sp. 2
Aporus sp. 1
Ceropales sp. 1
Priocnemis oregona Bks.
Pompilid #1
Pompilid #2
Pompilid #3
Pompilid #4
Pompilid #5

Procototrupidae
Procototrupes sp. 1
Procototrupid #1
Procototrupid #2
Procototrupid #3

Pteromalidae
Habrocytus sp. 8
H. sp. 10
H. sp. 12
H. sp. 42
H. sp. 61
H. sp. 65
H. sp. 85

Pteromalidae (cont.)
Halticoptera sp. 2
H. sp. 20
H. sp. 70
Heteroschema sp. 3
Homoperus sp. 46
Pachyneuron syrphi (Ashm.)
Pteromalus sp. 4
P. sp. 41
Tridymus sp. 2
Pteromalid #57
Pteromalid #59
Pteromalid #76
Pteromalid #82
Pteromalid #84
Pteromalid #90
Sphegegasterinae #1

Scelionidae
Gyron sp. 8
Idris sp. 1
Telenomus sp. 2
T. sp. 6
T. sp. 7
T. sp. 9
T. sp. 11
T. sp. 16
Trissolcus utahensis (Ashm.)

Scoliidae
Campsoscolia alcione (Ashm.)

Sphecidae
Ammophila cleopatra Menke
A. dysmica Menke
Astata bakeri Parker
Bembix americana comata Parker
Cerceris bicornuta Gue.
C. convergens V. & C.
C. rufinoda Cress.
C. sextoides Bks.
Diodontus sp. 1
Diploplectron ferrugineus Ashm.
Dryudella immigrans (Williams)
Ectemnius dilectus Cr.
Eucerceris superba Cr.
Mimesa sp. 1
Nysson sp. 1
Philanthus multi-maculatus Cam.
Podalonia luctuosa (Sm.)

Sphecidae (cont.)
Podalonia mexicana (Sauss)
Prionyx atrata Lep.
P. canadensis Prov.
Solierella sp. 1
S. sp. 2
Stizoides unicinctus Say
Tachysphex ashmedii Fox
T. tarsatus (Say)
Tachytes fulviventris Cr.

Thysanidae
Thysanus niger (Ashm.)

Tiphiidae
Paratiphia sp. 1

Torymidae
Microdontomerus anthonomi (Crawford)
Pseuderimus sp. 4
P. sp. 6
Torymus aeneoscapus (Huber)
T. capillaceus albitarsus (Huber)
T. koebelei (Huber)
T. pallidicornis Boheman
T. thalassinus (Huber)

Trichogrammatidae
Trichogrammatid #1
Trichogrammatid #2
Trichogrammatid #3
Trichogrammatid #4
Trichogrammatid #5
Trichogrammatid #10

Vespididae
Pterocheilus quinquefasciatus Say
Rygchium annulatum sulphureum (Sauss.)
Stenodynerus blandoides Bohart
S. noticeps Bohart
S. valliceps Bohart

CHILOPODA

Geophilomorpha
Geophilomorpha #1
Geophilomorpha #2

ARACHNIDA

Scorpionida

Vejovidae
Vejovis boreus

Solpugida
Solpugid #1

Pseudoscorpionida

Cheliferidae
Dactylochelifer silvestris

Acarina
Acarina #1
Acarina #2
Acarina #3
Acarina #4
Acarina #5
Acarina #6
Acarina #7
Acarina #8
Acarina #9
Acarina #10
Acarina #11
Acarina #12
Acarina #13

Araneida

Araneidae
Agriope trifasciata

Pholcidae
Pholcus sp. 1

Salticidae
Phidippus apacheanus

Theridiidae
Latrodectus hesperus

Araneida #1
Araneida #2
Araneida #3
Araneida #4
Araneida #5