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Curlew Valley Validation Site Report

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1975 PROGRESS REPORT

CURLEW VALLEY VALIDATION SITE REPORT

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ABSTRACT

Abiotic measurements at Curlew Valley included air temperature, soil temperature, soil water, precipitation, solar radiation, relative humidity, wind speed and evaporation. The maximum air temperatures were recorded in July and were more moderate than those of 1974. As in 1974, minimum temperatures were recorded in January and below-freezing temperatures occurred during 9.5 months of the year. Soil temperature data concur with 1974 measurements; decreasing with depth in the summer and increasing with depth in the winter. These measurements were taken from two vegetation types, both in interspaces and under cover. Soil water potential was also measured in two vegetation types in interspaces and under canopies at four depths. Mean daily solar radiation was greatest in July, concurring with 1974 measurements. Relative humidity was monitored bihourly. The minimum was recorded in September, in contrast to 1974 low readings in June and July. The highest relative humidities were recorded in December and January. Mean monthly precipitation (both rain and snow) was 21.5 mm, with the greatest amount occurring in April and the least in August. Total precipitation was 258 mm, 50 mm more than in 1974. Weekly wind-speed readings at 0.5 and 2 m concurred with 1974 findings; the greatest in April and the least in December. Evaporation peaked in August and was lowest in June, contrasting with 1974 data.

Plant validation studies were conducted in two vegetation types; *Artemisia-Atriplex-Sitanion* and *Agropyron*. Continuing the 1973 and 1974 studies, the frequent harvest method was again used on the ART-ATR-SIT type, to investigate net primary production, energy flow and nutrient cycling. Above-ground dormant biomasses were about 300, 150 and 15 g/m^2, respectively, while plant densities averaged 1, 2 and 7 plants/m^2. Spring root biomass was estimated at 3000 g/m^2, bringing the root:shoot biomass to about 6:1. Accumulated litter necromass was approximately 625 g/m^2. Below-ground production was measured by frequent core-sampling techniques and net primary production for the year was estimated to be 946 g/m^2. A second set of studies investigated the impact of herbivores on *Artemisia tridentata*. These studies showed that herbivores have little impact on net primary production and that the impact is indirect, rather than direct.

The small mammal populations in Curlew Valley were monitored in two plant associations in 1975, the ART-ATR-SIT and AGRDES, and were censused in August in the ANNUALS, HALGLO-ARTTRI and off-site AGRDES types. Population estimates were based on the number of animals actually captured in Sherman live traps, which were checked every 24 hr for five consecutive days. Data were analyzed for seasonal and geographical differences in diversity. The ART-ATR-SIT type supported the highest density and peaked in June, with *Perognathus parvus*, *Eutamias minimus* and *Onychomys leucogaster* representing peaks in granivore, omnivore and carnivore trophic levels. *Dipodomys* spp. (*ordii* and *microps*) peaked in August. *Peromyscus maniculatus* peaked in May. *Artemisia tridentata* was always a proportional factor in terms of capture numbers. In the AGRDES vegetation type, both rodent density and species diversity were smaller. *Dipodomys* spp. and *E. minimus* were virtually absent and the maximum density, which occurred in May, was 2.08. Reproduction activity was measured by inspection of females for vaginal plugs and enlarged mammary glands. Capture stress was determined by the state of the captured animal when released. Home range areas were also evaluated in terms of the various species and of the sex of the animals.

In 1975, an expanded invertebrate sampling program was used to enrich the Curlew species list. Methods employed were D-Vac, pitfall, emergent and soil-core (methods previously utilized) with the addition of a natural history analysis of plant feeders. Plant phenological codes and data accompany the results of each method. Calibration of the D-Vac equipment showed the largest amount of invertebrates at 0800 and the fewest at 1200 hr MDT for three 24-hr sample dates. These data are considered preliminary and monthly calibration will be taken in 1976 to deduce more accurate efficiency percentages and revised population estimates. The greatest invertebrate biomass and density from regular vacuuming was again found on *Atriplex confertifolia*. The greatest species diversity on *A. confertifolia* occurred during November, as opposed to a September peak in 1974. *Artemisia tridentata* also showed a difference in maximum diversity from 1974 (September) to 1975 (October). These dissimilarities might be attributed to inclusion of more taxa, resulting from the new methodology. Emergent trap data results indicate that seeded *Agropyron desertorum* showed the greatest invertebrate densities during the field season. Tenebrionidae, previously quite prevalent in Curlew Valley, were conspicuously absent in 1975, probably because of their inability to climb. Other taxa probably are not susceptible to emergent trapping because of the same limitation.

Soil seed reserves at Curlew Valley were sampled in 1975 to determine the seed biomass available for seedling production and for granivore food. Soil samples were collected four times (during summer and fall) within the ART-ATR-SIT vegetation type, under *Artemisia tridentata* and *Atriplex confertifolia* and in the interspaces. The soil samples, after being processed in the laboratory, showed that seeds are not distributed randomly, but are correlated with date and location. *A. tridentata* seeds were poorly dispersed, while *A.*

confertifolia had a slightly greater dispersion. *Descurainia pinnata* seeds were mostly under shrubs, as were the seeds of *Sitanion hystrix*. It was found that *A. confertifolia* and *S. hystrix* contribute the greatest biomass while, surprisingly, *A. tridentata* contributes very little. Also, *A. confertifolia* seeds contribute the greatest amount of energy to the system even though they contain the fewest calories per gram of seed. Contrary to findings of researchers in other desert systems, the Curlew Valley studies did not show a great impact on seed reserves by mammalian seed predation.

ACKNOWLEDGMENTS

Individuals contributing to the Curlew Valley Validation Site work in 1975 are listed below.

Category	Assistance in laboratory or field	Authorship in report
Abiotic	M. Merritt, M. J. Perlmutter, R. S. Shinn	M. Merritt
Plants	R. D. Anderson, M. J. Perlmutter, R. S. Shinn	R. S. Shinn
Invertebrates	C. Haggas, W. Osborne, M. Schwartz, M. Kearney	W. Osborne
Vertebrates	L. McLain, T. Timkin, C. Passavant, R. D. Anderson, R. S. Shinn, M. Merritt	M. Merritt
Soil Seed Reserves	M. Merritt, S. Ratavongsa	M. Merritt
Data processing	K. Marshall, C. Romesburg	

DATA COLLECTION DESIGN

SYSTEM COMPONENT and parameters measured	DSCODE A3U-	North shrub		North grass		South shrub			South grass			Reported on page
		1973	1974	1973	1974	1973	1974	1975	1973	1974	1975	
METEOROLOGICAL												
Weather	BJM4											10-12
Air temperature					end Sep	X	X	X	X	X	X	
Relative humidity					end Sep	X	X	X	X	X	X	
Wind speed (2 m					end Sep	X	X	X	X	X	X	
Wind speed (.5 m)					end Sep	X	X	X	X	X	X	
Precipitation (recording gauge, rain)					end Sep	X	X	X	X	X	X	
Precipitation (overflow cans, snow)					end Sep	X	X	X	X	X	X	
Soil surface temperature					end Jul	X	X		end Jul	X		
Soil temperature (7 depths at weather station)									X	X		
Evaporation rate (recording meter)							X	X		X	X	
Temperature profile												10-12
Air temperature profile (recording thermographs; several heights; shaded, plant canopy, interspaces, 9 locations)							X	X		X	X	
Soil temperature profile (recording thermographs; 4 depths)							X	X		X	X	
SOILS												
Soil temperature and water potential (thermocouple psychrometers)	BJP5					X	X			X		10-12
2 vegetation types (shaded and interspace, 4 depths)						X						
4 vegetation types (shaded and interspace, 4 depths)							X	X		X	X	
Soil seed reserves	BJS9							X			X	35-38
VEGETATION												
ABOVE-GROUND												
Biomass (off-site)	BJC3,4					X			X			13-14
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 wt						X			X			
Biomass dynamics of shrub components	BJS3	X				X	X					13-14
Species (ARTTRI and ATRCON)		X				X	X	X				
Actual size (cm)		X				X	X	X				
Basal area (cm^2)		X				X	X	X				
Dry wt woody stems (g)		X				X	X	X				
Dry wt young stems (g)		X				X	X	X				
Dry wt leaves (g)		X				X	X	X				
Dry wt inflorescence (g)		X				X	X	X				
Dry wt seeds (g)		X				X	X	X				
Dry wt deadwood (g)		X				X	X	X				
Total dry wt (g)		X				X	X	X				
Estimated age (yr; ARTTRI only)		X				X	X	X				
Biomass dynamics of grass components	BJY4								X	X	X	13-14
Species									X	X	X	
Dry wt new growth									X	X	X	
Dry wt old growth									X	X	X	
No. seed heads									X	X	X	

Data Collection Design, continued

SYSTEM COMPONENT and parameters measured	DSCODE A3U-	North shrub		North grass		South shrub			South grass			Reported on page
		1973	1974	1973	1974	1973	1974	1975	1973	1974	1975	
ACCUMULATED LITTER												
Necromass dynamics of litter components	BJD3,4					X	X	X	X	X	X	13-14
Dry wt wood (g)						X	X	X	X	X	X	
Dry wt > 2 mm (g)						X	X	X	X	X	X	
Dry wt < 2 mm (g)						X	X	X	X	X	X	
Dry wt fecal litter (g)						X	X	X	X	X	X	
Total dry wt						X	X	X	X	X	X	
Litter traps	BJD5							X			X	
BELOW-GROUND												
Dynamics of root biomass	BJE3,4					X	X	X	X	X	X	13-14
Species						X	X	X	X	X	X	
Type						X	X	X	X	X	X	
Dry wt, 0-20 cm (g)						X	X	X	X	X	X	
Dry wt, 21-40 cm (g)						X	X	X	X	X	X	
Dry wt, 41-60 cm (g)						X	X		X	X		
ELEMENTAL ANALYSES												
Nutrient analysis for each plant part by species	MM01					X	X		X	X	X	13-14
Calories/g dry wt						X	X	X	X	X	X	
Ash content (%)						X	X	X	X	X	X	
Ash free calories/g						X	X	X	X	X	X	
% protein						X	X	X	X	X	X	
% carbohydrates						X	X	X	X	X	X	
% fat						X	X	X	X	X	X	
Chemical analysis for each plant part by species	MM2A,B					X	X		X	X		13-14
Phosphorus (%)						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 plot synthesis	BJC5					X			X			13-14
Biomass (g/m^2)						X			X			
INVERTEBRATES												
Biomass - soil (2500-cc sample, biweekly)	BJX4					X		X	X		X	15-28
Invertebrate taxa						X		X	X		X	
Number						X		X	X		X	
Stage						X		X	X		X	
Feeding type						X		X	X		X	
Dry wt						X		X	X		X	
Vegetation species						X		X	X		X	
Soil surface temperature (°C)						X		X	X		X	
Air temperature, 10 cm (°C)						X		X	X		X	
Relative humidity, 10 cm						X		X	X		X	
Time of day						X		X	X		X	

Data Collection Design, continued

SYSTEM COMPONENT and parameters measured	DSCODE A3U-	North shrub 1973	North shrub 1974	North grass 1973	North grass 1974	South shrub 1973	South shrub 1974	South shrub 1975	South grass 1973	South grass 1974	South grass 1975	Reported on page
Biomass - surface (pitfall sample, weekly)	BJX3					X		X	X		X	15-28
Invertebrate taxa						X		X	X		X	
Number						X		X	X		X	
Stage						X		X	X		X	
Feeding type						X		X	X		X	
Dry wt						X		X	X		X	
Vegetation species						X		X	X		X	
% cover						X		X	X		X	
Biomass - above-ground (D-Vac sample, biweekly)	BJX1					X		X	X		X	15-28
Invertebrate taxa						X		X	X		X	
Number						X		X	X		X	
Stage						X		X	X		X	
Feeding type						X		X	X		X	
Dry wt						X		X	X		X	
Vegetation species						X		X	X		X	
Plant height						X		X	X		X	
Width, 2 heights						X		X	X		X	
Length, 2 heights						X		X	X		X	
% cover						X		X	X		X	
Soil surface temperature (°C)						X		X	X		X	
Air temperature, 10 cm (°C)						X		X	X		X	
Relative humidity, 10 cm						X		X	X		X	
Time of day						X		X	X		X	
Insect emergence (weekly)	BJX2					X		X	X		X	15-28
Invertebrate taxa						X		X	X		X	
Number						X		X	X		X	
Stage						X		X	X		X	
Feeding type						X		X	X		X	
Dry wt						X		X	X		X	
Vegetation species						X		X	X		X	
Height						X		X	X		X	
% cover						X			X			
Biomass - soil (2500-cc sample, biweekly)	BJX4						X	X		X	X	15-28
Invertebrate taxa							X	X		X	X	
Number							X	X		X	X	
Stage							X	X		X	X	
Feeding type							X	X		X	X	
Dry wt							X	X		X	X	
Vegetation species							X	X		X	X	
Relative humidity, 10 cm							X	X		X	X	
Time of day							X	X		X	X	
Biomass - surface (pitfall traps, 3 days/wk)	BJX3						X	X		X	X	15-28
Invertebrate taxa							X	X		X	X	
Number							X	X		X	X	
Stage							X	X		X	X	
Feeding type							X	X		X	X	
Dry wt							X	X		X	X	
Vegetation species							X	X		X	X	
Time of day							X	X		X	X	
Biomass - above-ground (D-Vac sample, weekly)	BJX1						X	X		X	X	15-28
Invertebrate taxa							X	X		X	X	
Number							X	X		X	X	
Stage							X	X		X	X	
Feeding type							X	X		X	X	
Dry wt							X	X		X	X	
Vegetation species							X	X		X	X	
Plant height							X	X		X	X	
Width, 2 heights							X	X		X	X	
Length, 2 heights							X	X		X	X	
% cover												
Phenology							X	X		X	X	
Relative humidity, 10 cm							X	X		X	X	
Time of day							X	X		X	X	

Data Collection Design, continued

SYSTEM COMPONENT and parameters measured	DSCODE A3U-	North shrub		North grass		South shrub			South grass			Reported on page
		1973	1974	1973	1974	1973	1974	1975	1973	1974	1975	
Insect emergence (sampled biweekly)	BJX2						X	X		X	X	15-28
Invertebrate taxa							X	X		X	X	
Number							X	X		X	X	
Stage							X	X		X	X	
Feeding type							X	X		X	X	
Dry wt							X	X		X	X	
Vegetation species							X	X		X	X	
% cover							X	X		X	X	
Time of day							X	X		X	X	
VERTEBRATES												
RODENTS												
Biomass - on-site	BJH3,4	X		X		X	X	X	X	X	X	29-34
Periodic samples (Apr, Jun, Aug)		X		X		X	Aug only	X	X	Aug only	X	
Species		X		X		X	X		X	X		
Sex		X		X		X	X	X	X	X	X	
Age		X		X		X	X	X	X	X	X	
Nipple condition		X		X		X	X	X	X	X	X	
Vaginal condition		X		X		X	X	X	X	X	X	
Testicle condition		X		X		X	X	X	X	X	X	
Wt		X		X		X	X	X	X	X	X	
Density		X		X		X	X	X	X	X	X	
LAGOMORPHS												
Jackrabbit biomass	BJI1					X	X					
Density (drive count)						X	X					

FINDINGS

ABIOTIC

M. Merritt

Air Temperature

Bihourly hygrothermograph readings continuously monitored thermal flux in Curlew Valley (Table 1). Below-freezing temperatures were recorded 9.5 months of the year, with January reporting the lowest temperature of —21 C. Maximum temperatures of 36 C were recorded in July. Mean air temperatures were more moderate during 1975 than during 1974.

Precipitation

A weighing, recording rain gauge continuously measured rainfall. Snow accumulation was measured weekly. Rain and snow are combined into total precipitation (Fig. 1). Mean monthly precipitation was 21.5 mm, with the greatest amount occurring in April and the least amount in August. Total precipitation measured in 1975 was 258 mm, 50 mm more than in 1974.

Solar Radiation

Radiation was integrated by a star pyrometer into voltage and recorded hourly. Mean daily solar radiation was greatest in July (Fig. 2), concurring with measurements taken in 1974.

Relative Humidity

Bihourly hygrothermograph readings continuously monitored percent relative humidity. A two-variable parabolic regression ($r^2 = 0.63$, $P \leqslant .005$) indicates that relative humidity was least in September (Fig. 3). This is in contrast with 1974, when the least percentage of relative humidity was recorded in June.

Wind Speed

Totalizing anemometers at heights of 0.5 and 2 m were read weekly. Wind speeds averaged 3.8 km/hr more at the 2-m height (Fig. 4). The greatest speeds were recorded in April, and the least in December, concurring with the previous year's measurements.

Soil Water

Thermocouple psychrometers measured soil water potential in two vegetation types, both in the interspaces and under plant cover, at depths of 5, 15, 30 and 50 cm. These measurements were averaged per depth and appear in Table 2. As summer progressed, the shallow depths experienced the greatest decrease in water potential. Soil moisture fluctuated least at the greater depths. These data are similar to those of 1974.

Soil Temperature

Soil temperature measurements were taken in conjunction with soil water potential measurements. Readings from two vegetation types were averaged per depth (Table 3). Temperatures were greatest at the surface and decreased as depth increased. These data concur with 1974 readings.

Evaporation

A bihourly recording evaporimeter, located in the shade 30 cm above ground level, continuously monitored evaporation. Evaporation was greatest in August and least in June (Fig. 5.). These data are in contrast with those of 1974, when the greatest amount of evaporation occurred between June and July.

Table 1. Biweekly air temperature (°C)

Month	Minimum	Maximum	Mean
1	-20.6	4.4	- 5.4
	-21.1	11.1	- 4.1
2	-13.3	7.2	.9
	-15.6	7.8	- 3.0
3	- 2.8	11.1	4.2
	- 7.8	14.4	2.9
4	- 8.3	15.6	4.3
	- 2.2	17.8	6.1
5	- 2.8	26.1	9.2
	- 2.2	27.8	11.7
6	0.0	30.0	16.7
	1.1	31.1	15.9
7	2.8	35.6	22.9
	7.8	36.1	21.5
8	4.4	35.6	20.5
	- 1.1	31.1	16.1
9	- 1.1	28.9	14.6
	- 6.7	25.6	9.8
10	-10.6	18.9	4.1
	-14.4	12.2	- 3.1
11	-14.4	7.8	- 5.1
	-18.3	7.8	- 7.1
12	-13.3	6.7	- 4.2
	-18.9	1.1	- 7.5

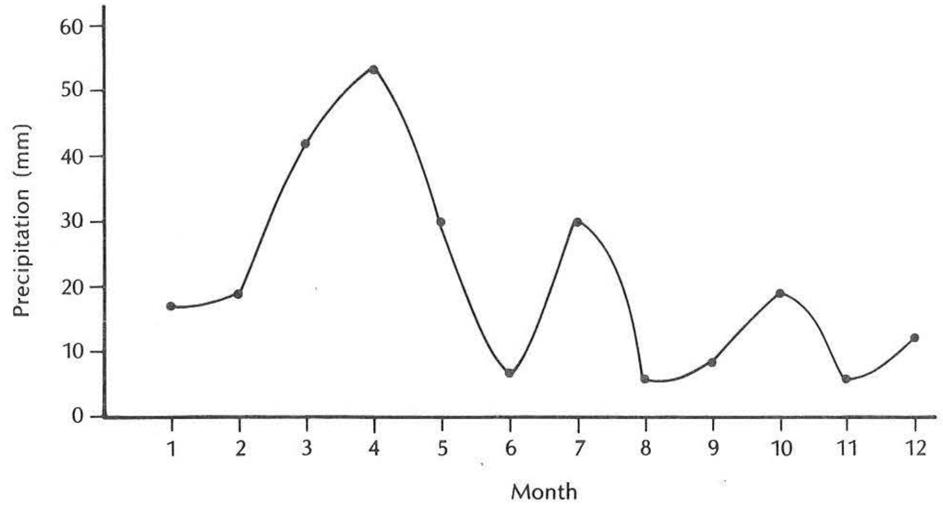

Figure 1. Monthly summary of precipitation (mm).

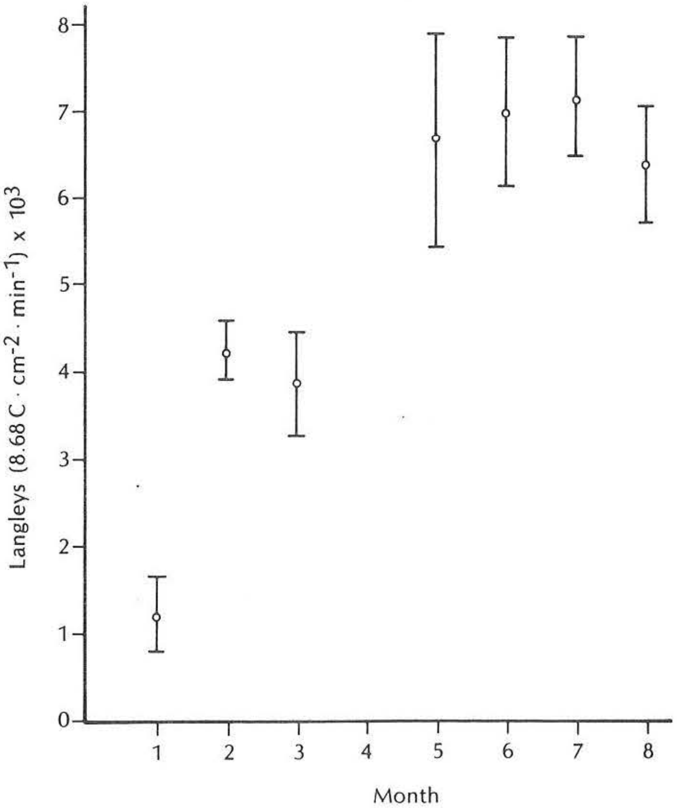

Figure 2. Mean daily solar radiation per month at Snowville, Utah (langleys). No data are included for April (4).

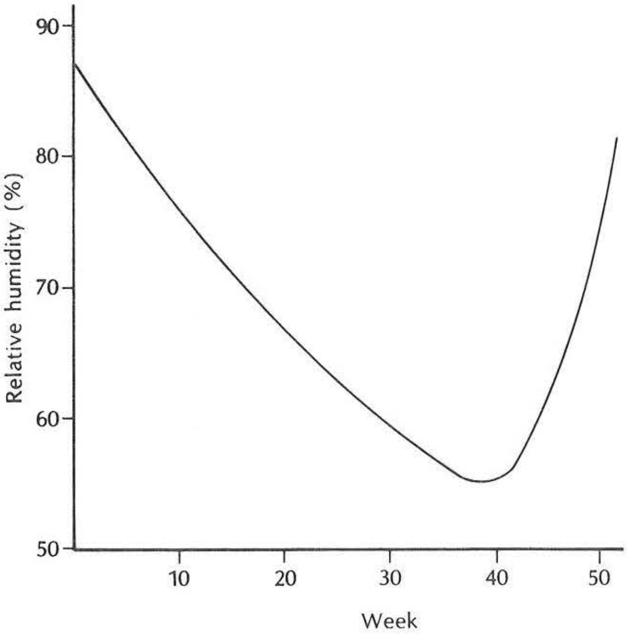

Figure 3. Two-variable parabolic regression of percent relative humidity ($r^2 = 0.63$, $P \leqslant .005$).

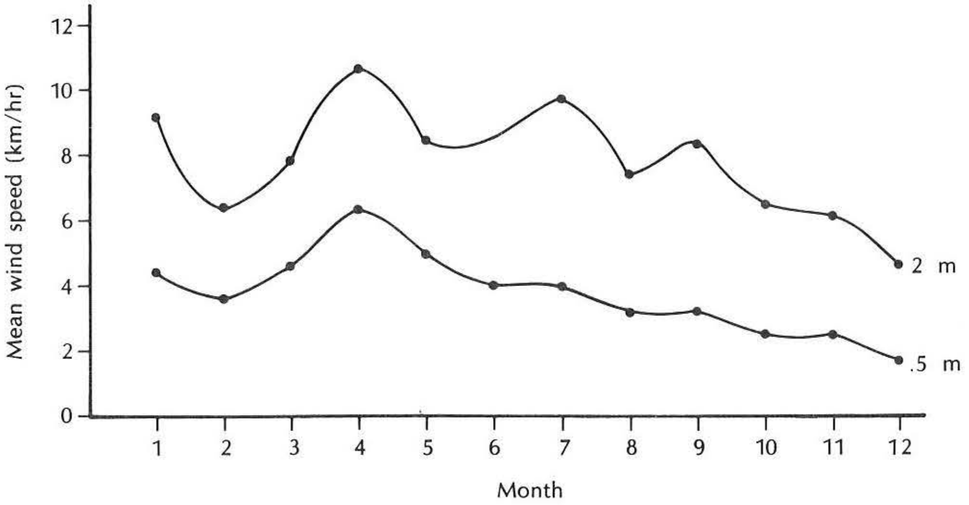

Figure 4. Monthly summary of wind speed at 2- and .5-m heights (km/hr).

Table 2. Soil water potential summary (negative bars)

Date (1975)	Depth(cm)			
	5	15	30	50
6/24	16	11	10	23
6/27	12	17	5	34
6/30	16	7	6	23
7/1	12	25	20	23
7/15	5	6	20	26
7/22	27	20	23	26
7/29	-	29	32	32
8/5	34	32	32	33
8/11	-	49	42	36
8/14	-	44	40	32
8/19	-	51	46	37
8/27	-	51	38	37
9/9	-	54	48	40
9/16	47	17	50	42
9/30	-	56	48	40

Table 3. Soil temperature summary (°C)

Date (1975)	Depth(cm)			
	5	15	30	50
6/24	19	16	15	14
6/27	19	15	14	14
6/30	26	19	17	15
7/1	26	18	17	15
7/15	26	21	20	18
7/22	26	22	21	19
7/29	25	23	22	20
8/5	23	19	20	18
8/11	23	20	20	19
8/14	21	19	20	19
8/19	21	19	20	19
8/27	21	17	19	18
9/9	17	16	18	17
9/16	20	17	17	17
9/30	21	13	13	14

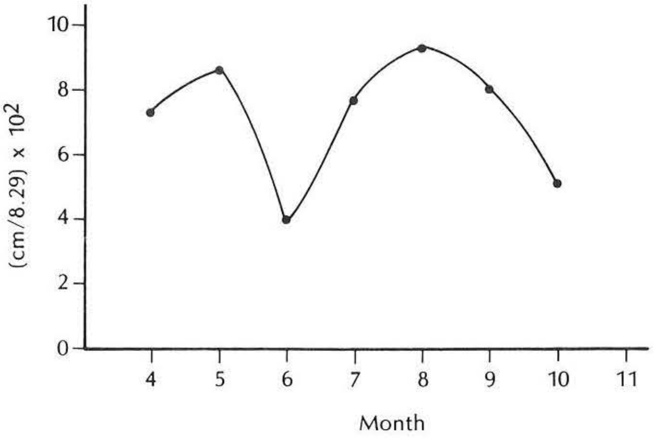

Figure 5. Monthly summary of evaporation.

PLANTS

R. S. Shinn

Plant validation studies for 1975 in Curlew Valley were conducted in two vegetation associations: the *Artemisia-Atriplex-Sitanion* type and the *Agropyron* type.

Artemisia-Atriplex-Sitanion

In 1975, 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 and 1974 on net primary production, energy flow and nutrient cycling in *Artemisia tridentata*, *Atriplex confertifolia* and *Sitanion hystrix*. The second set of studies were experiments designed to determine the extent of impact herbivores have on a field population of *Artemisia tridentata*.

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 two shrubs, *Artemisia tridentata* and *Atriplex confertifolia*, and a grass, *Sitanion hystrix*. Plant densities average one, two and seven plants per m^2, respectively. Above-ground dormant biomasses are about 300, 150 and 15 g/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 of the 1973 and 1974 work were reported by Shinn in Balph et al. (1974) and Shinn et al. (1975).

The 1975 growing season was relatively good, with precipitation patterns and totals similar to the 1973 growing season. As a result, *A. tridentata* produced 102 g/m^2, *A. confertifolia* produced 66 g/m^2 and *S. hystrix* produced 45 g/m^2 of above-ground phytomass. An estimate of below-ground production for 1975, which is methodologically consistent with the 1973 and 1974 estimators, shows the 1975 below-ground net primary production to be 946 g/m^2. Therefore, the combined above- and below-ground NPP for the ART-ATR-SIT association was about 1160 g/m^2 in 1975.

Research during the 1975 field season also included an investigation of herbivore impacts upon productivity and component biomass of *A. tridentata*. This study was carried out similarly to the herbivory investigations made on *A. confertifolia* in 1974 (Shinn et al. 1975).

In April 1975, 40 *A. tridentata* 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 exclosures were also 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 40 plants were harvested at the end of the growing season. Each plant was broken down into its component parts, dried and weighed. T-tests were used to test for differences among components and between treatments.

The only experimental effect detected by this work was a significant reduction ($\alpha = .10$) in flower biomass in treated (27.27 g/plant) and untreated (16.47 g/plant) *A. tridentata*. This result supports the hypothesis made in the previous report that 1) herbivory is generally low (less than 10% of NPP) in semiarid shrub-steppes, 2) overall herbivorous effects are unlikely to be measurable on a year-to-year basis and 3) herbivores have indirect, rather than direct, measurable impacts on net primary production.

In reference to nitrogen cycling, the laboratory analyses have generated percent nitrogen constants for structural components in the ART-ATR-SIT and *Agropyron* associations (Table 4). Together with the component biomass studies, these data provide the basis for comparative tracking of structural nitrogen dynamics in the two communities over a four-year period.

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, as reported in Shinn et al. (1975).

Productivity studies were continued in 1975 using the plant-specific methods outlined for studies on the shrubs and grasses of the ART-ATR-SIT association. The results from these studies show that in 1975 *Agropyron desertorum* produced 231 g/m^2 of above-ground biomass and approximately 584 g/m² of below-ground biomass, yielding about 815 g/m² of total net primary production.

Studies on productivity, energy flow and nutrient cycling will continue through 1976. With a four-year data base and more information on root distribution, resource availability and usage, it may be possible to propose sound models for these functions. Also in 1976, further exclosure studies, calculation of energy requirements of consumer populations on the site and simulations of herbivory in the field will clarify the effects of consumer organisms upon the vegetation in these ecosystems.

Table 4. Percent nitrogen constants for structural components of the Curlew Valley ART-ATR-SIT and *Agropyron* associations

	ART-ATR-SIT association (% N)	*Agropyron* association (% N)
ARTTRI and ATRCON leaves	12.06	
ARTTRI and ATRCON new growth stems	8.32	
ARTTRI and ATRCON woody stems	5.44	
ARTTRI and ATRCON reproductive parts	5.06	
SITHYS new growth	8.50	
SITHYS old growth	5.94	
AGRDES new growth		7.26
AGRDES old growth		5.02
Standing dead	6.07	
Litter	8.40	7.91
Roots	8.77	9.87

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INVERTEBRATES

W. Osborne

INTRODUCTION

Emphasis for invertebrate research during the 1975 field season centered about both proven and expanded sampling methodology. Results from a taxonomic comparison of a Michigan old-field community with that of the Curlew Valley Validation Site (Shinn et al. 1975) indicated that 50% fewer species had been recognized on the Great Basin site as compared to the old-field grassland. The speculation that an expanded sampling program might enrich the Curlew Valley species list provided the impetus for initiating more sampling methods. Attention was also given to calibration of new and old sampling equipment, with the goal of increased accuracy of invertebrate density and biomass estimates. Thus, although a full complement of sampling techniques as reported in previous reports (Balph et al. 1973, 1974; Shinn et al. 1975), were employed over the 1975 season, emphasis of this report will focus on results from expanded sampling methods and calibration of a vacuum sampling device. This report will serve to supplement the report of 1974 results and allow for a more conclusive volume when synthesized with future field results.

METHODS

The five basic techniques employed in 1975 to sample Great Basin Desert invertebrates were D-Vac, pitfall, emergent, soil core and a natural history analysis of plant feeders. All but the last method have been utilized in previous seasons at Curlew Valley and their detailed procedures appear in prior annual reports. Plant phenological codes and data, as shown in Tables 5 and 6 accompany the results of each of the five methods. All of the sampling procedures and phenology revolved around the dominant vegetation of Curlew Valley described by Balph et al. (1973); namely, *Atriplex confertifolia, Artemisia tridentata, Chrysothamnus viscidiflorus, Sitanion hystrix* and *Agropyron desertorum.*

D-Vac

During 1975, vacuum sampling was conducted in three separate programs (DSCODE A3UBJX1). Phase I consisted of individual plant samples taken over a field season and subdivided into three blocks (August, September, October). Ten vacuum samples were extracted from each of four dominant plants during each monthly block. Phase II of vacuum sampling resulted from the random selection of three time periods during which dominant vegetative species were sampled over a 24-hr period. Sampling was done at 4-hr intervals beginning at 0800 hr. Phase III of D-Vac use entailed calibration of the vacuum sampling equipment (D-Vac and Berlese funnel apparatus). This very significant procedure follows several basic steps. First, the target species is vacuumed in a regular and consistent manner conducted for all previous D-Vac samples. Second, the target species is harvested and sealed in an appropriate container. Third, the vacuumed sample is placed in the Berlese funnel apparatus and, after a 72-hr period, the sample and the plant residue remaining in the extractor are sealed in separate containers. These procedures leave the researcher with two laboratory hand-sorting tasks (harvested plant and Berlese residue) as well as the evaluation of the extracted vacuum sample. Thus, efficiency percentages can be calculated for the D-Vac and funnel apparatus on a species basis.

Vacuuming for all three phases of invertebrate sampling was conducted in the exact manner as described in the Invertebrate section of the previous Curlew Valley Validation Site report (Shinn et al. 1975). Density (no./m^3 plant canopy) and biomass (g/m^3 plant canopy), as well as shrub volume determinations (Pianka 1966), also remained identical to previously described procedures.

Emergent Trapping

The seasonal occurrence of emerging invertebrates was sampled on a bimonthly basis, utilizing the apparatus as previously described in Figure 24 of Shinn et al. (1975; A3UBJX2). Eighteen sample dates, ranging from April through December, were recorded for 1975, utilizing an arrangement of five traps in each vegetation type (mixed annuals, shrub, grass; Fig. 6).

Pitfall Trapping

The sampling procedure in 1975 was considerably altered from that previously used in Curlew Valley. Two small (2 x 3 m) grids were established randomly in the grass type (VEG IV) and the shrub area (VEG I). Twelve no. 10 cans were lowered to soil surface depth within each grid. Each 6-m^2 area was bordered by a wall 28 cm high, made of metal flashing as previously used at Curlew for larger grids. Trapping grids were opened and emptied for three consecutive days during each of five months (June-October). Daily catch samples were separated and recorded, along with abiotic parameters (A3UBJX3).

Feeding Analysis

In an attempt to better understand the impact of various plant feeding taxa and their predators on the vegetative species at Curlew, a natural history observation study was initiated in 1975. The design consisted of establishing five line transects made up of 10 randomly marked plants representing the five dominant vegetative species on the site. Data collected during 16 designated observation dates included not only the taxon observed, but also its position on the plant (leaf, stem, etc.), type of activity (feeding, resting, etc.), results of the activity (if determined) and, most importantly, the instar or life stage of the invertebrate. Soil samples were also taken in conjunction with each representative plant species at randomly selected areas located off the validation site. The below-ground sampling placed emphasis on larval stages of Coleoptera and other phytophagous orders, as opposed to Acarina, Collembola, etc. Representative phytophagous types have been catalogued and stored in 95% ETOH. Plant phenology, which accompanies each observation date, follows a modified version as in West and Gunn (1974). Data are stored under DSCODE A3UBJX5.

Table 5. Curlew phenological code

Grass	Shrub
1 = Winter dormancy	1 = Winter dormancy
2 = Growth initiation	2 = Leaves regreening or leaf buds swelling
3 = 2-leaf stage	3 = Twigs elongating and/or new leaf growth
4 = 3-leaf stage	4 = Floral buds developing on reproductive shoot
5 = 4-leaf stage	5 = Flowers opening
6 = 5-leaf stage	6 = Fruit developing (male flowers dying)
7 = Boot	7 = Fruit dissemination (male flowers falling)
8 = Head	
9 = Hard seed	
0 = Seed scatter	

Table 6. 1975 Curlew vegetation phenology

Plant species	Apr	May			Jun			Jul				Aug		Sep		Oct	Nov
	4/22	5/1	5/15	5/29	6/5	6/12	6/26	7/2	7/11	7/17	7/31	8/8	8/21	9/12	9/16	10/15	11/13
CHR VIS	2	2	2	3	3	3	3	3	4	4	5	5	5	5	6	6	6
ART TRI	2	2	3	3	3	3	3	4	4	4	4	4	4	5	5	6	6
ATR CON	4	4	5	5	6	6	6	6	6	6	6	6	6	6	6	7	7
AGR DES	3	3	4	5	6	7	8	8	8	9	9	9	9	0	0	0	0
SIT HYS	3	3	4	5	7	7	8	8	9	0	0	0	0	0	0	0	0

Table 7. 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
    ↑             ↑
    a             b
```

a: 0 = Suborder
1 = Superfamily
2 = Family
3 = Subfamily

b: A = Adult
I = Immature
Numbers 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.

Soil Sampling

A soil arthropod sampling program was initiated in the fall whereby 5 x 8 cm cores were extracted from an area as close as possible to the base of the target plant. This procedure follows closely the recommendations of Bender et al. (1972). Ten cores were extracted from the bases of each of the four dominant plant species, as well as 10 cores from randomly selected areas lying between both shrubs and grasses. All cores were placed in a modified Tullgren system which utilized a cool, flowing water bath, 25-watt bulbs and a minimum time limit of 40 hr. This system was also calibrated by hand-sorting cores after extraction to derive an efficiency percentage (Wallwork 1970; A3UBJX4).

DISCUSSION

An explanation of the coding system used for Curlew flora and fauna can be found in Table 7. The largest noticeable change in data presentation for the 1975 Curlew season is seen in the degree of taxonomic resolution. The species which seemingly were being missed in previous sampling seasons were discovered by implementation of new methodology. The invertebrate feeding analysis program has yielded three new species of Coreidae, as well as 26 species of Cicadellidae. Also, many tenebrionid larvae have been catalogued and will aid in determining future below-ground biomass estimates. The feeding analysis data also emphasized the numbers of aphids present on the dominant vegetation at Curlew since, before this time, vacuum samples had probably destroyed many of the organisms, resulting in lower, inaccurate estimates. Many new spider species have been isolated (especially microaraneids), as a result of net and "hand" sampling employed in taking specimens during the feeding analysis. Specific details, with relationships between plants and insects and groups or feeding guilds (Root 1973), will be discussed in a more conclusive final biome report. Feeding types, as indicated in 1975 data, are interpreted in Table 8.

Pitfall results did not materialize as hoped in 1975. The small grids (2 x 3 m) being moved each month within a vegetation type provided little in the way of usable data. As shown in Tables 9 and 10, the numbers of the most abundant tenebrionid beetles indicate the low densities of surface-dwelling organisms as are normally sampled via pitfall. These small grids were abandoned for the 1976 field season in favor of larger (10 x 10 m) enclosures as were utilized in 1974. The large, permanent grids appear to yield data quite suitable for facilitating population estimates. The results of the small grids may prove useful when used in a presence-absence context as a "bridge" between 1974 and 1976 pitfall results.

D-Vac results, as they pertain to 24-hr sampling, are presented in Tables 11 and 12. Two August sample dates and one sample in mid-September were completed in 1975. Utilizing the numbers of organisms representing the seven primary feeding types, these figures show that the largest amount of invertebrates were sampled at 0800 and the fewest at 1200 hr for the three sample dates. A comparison of numbers taken in light vs. dark periods shows no significant difference. Since average monthly temperatures may have influenced this limited (seven taxa) comparison, monthly, 24-hr sampling will occur in the final 1976 field season with subsequent comparison of all taxa for just a specific sample. Thus, the effect of rising or declining monthly temperatures will be negated. A possible problem in indicating activity patterns, as shown by 24-hr sampling, is that one does not really know from the data whether the organism was actively feeding or simply just present on the vegetation. As with the small pitfall grids, data from 24-hr sampling may prove useful on a presence-absence basis as is required in determining an organism's host plant.

Data from three sampling dates used for calibration of the D-Vac equipment are of a preliminary nature but certain trends can be noticed. The standard vacuuming machine showed less than 90% efficiency in sampling very small and/or soft-bodied organisms, i.e., Aphididae, Coccoidea and Acarina. On all other types, machine efficiency exceeded 90%. The primary area of concern for efficiency in sampling appears to lie with the Berlese funnel system. Groups showing less than 60% efficiency of extraction included minute cicadellids, microaraneida, coleopteran larvae, Aphididae, Acarina and Coccoidea. Since these results are only preliminary, monthly calibration samples will be taken in 1976, with hope of deducing more accurate efficiency percentages and, ultimately, revised population estimates.

The regular plant vacuuming results are shown in Tables 13-27. As was indicated in 1974 results, the shrub *Atriplex confertifolia* again hosted the greatest invertebrate biomass and density when viewed over the entire sampling season. Greatest species diversity (H') for this plant in 1974 was during September, whereas 1975 results indicate a greater diversity of fauna occurring during November. Slight dissimilarities in monthly diversity comparisons from 1974 to 1975 could well be attributed to inclusion of more taxa in the most current analysis. Big sagebrush (*Artemisia tridentata*) also indicated a difference in invertebrate diversity maximum from 1974 (September) to 1975 (October). Although phenological stages for vacuumed plants were not given in Tables 13-27, the obvious comparisions between phenophase and monthly density or biomass can readily be made. Format of results follows a more detailed explanation as presented in the previous annual report (Shinn et al. 1975).

Emergent trap data for 1975 are presented in Tables 28-30. Results indicate that Veg IV, dominated by the seeded crested wheatgrass, *Agropyron desertorum*, showed the greatest invertebrate densities throughout one entire field season. The preponderance of sucking types, i.e., *Nysius ericae* in July, phorid flies in August and pseudococcids in the fall account for the bulk of emerging types.

Conspicuously absent from the entire list of emergent results is the family Tenebrionidae, whose members in previous reports have shown to be quite prevalent in Curlew Valley. This fact is primarily a result of the inability of both tenebrionid larvae and adults to climb either the screen of the trap and/or the enclosed plant species. Thus, it could be said that the darkling or tenebrionid beetles are indeed "true ground-dwelling species." Possibly other taxa also exhibit these characteristics and are not susceptible to emergent trapping. Most reliable results of emergent traps would appear to be derived from species with a high degree of mobility, especially those being able to fly.

A full complement of emergent and D-Vac, as well as pitfall, results will be presented in the final biome report. This report will synthesize the final three years of invertebrate sampling, which in turn should indicate many meaningful trends with respect to the cool desert invertebrate community.

Table 8. General feeding types

CHE = Chewing
SAP = Saprophagous
NEC = Nectar-feeding
NON = Nonfeeding adults
OMN = Omnivorous
PRE = Predaceous
SUC = Sucking

Table 9. Number of tenebrionids sampled by pitfall grids (2 x 3 m)

Species	VEG IV											VEG I										
	Trap #1					Trap #2					Totals	Trap #3					Trap #4					Totals
	Sample dates:					Sample dates:						Sample dates:					Sample dates:					
	1	2	3	4	5	1	2	3	4	5		1	2	3	4	5	1	2	3	4	5	
Eleodes hispilabris	1	5					4				10	1	2									3
E. concinna											0					1		1				2
Coniotus sp. 1			1					1			2											0
Tenebrionid sp. 1									1		1			1								1

Table 10. Key to 1975 sample dates

1 = Jun 17, 18, 19
2 = Jul 22, 23, 24
3 = Aug 22, 23
4 = Sep 10, 11, 12
5 = Oct 9, 10, 11, 12

Table 11. Occurrence of representative species of each feeding type during three 24-hr sample periods

Species and feeding types	Sample dates and sample times																		Totals
	Aug 1-2						Aug 21-22						Sep 17-18						
	1200	1600	2000	2400	0400	0800	1200	1600	2000	2400	0400	0800	1200	1600	2000	2400	0400	0800	
Hymemoptera - Formicidae (OMN)	2	8	-	-	9	6	-	-	-	-	2	-	-	5	1	-	-	-	33
Hemiptera - Piesmatidae (SUC)	4	2	1	12	-	2	9	1	6	2	4	2	5	2	6	8	-	3	69
Coleoptera - Curculionidae (CHE)	4	5	3	5	2	8	-	-	-	-	3	3	-	2	-	-	-	4	39
Collembola - Entomobryidae (SAP)	5	9	6	10	10	14	4	-	21	8	1	35	1	9	3	5	6	9	156
Arachnida - Araneida (PRE)	-	2	1	1	1	2	1	2	1	1	1	1	2	3	1	-	3	2	25
Lepidoptera (NEC)	1	2	-	-	2	-	-	1	1	-	-	-	-	4	-	-	-	1	12
Hymenoptera - Chalcididae (NON)	-	-	1	-	-	1	-	2	-	1	-	1	1	1	-	-	-	2	10
Totals	16	28	12	28	24	33	14	6	29	12	11	42	9	26	11	13	9	21	344

Table 12. Numbers of species sampled during light and dark periods

Dates	Light period	Dark period
	0800, 1200, 1600	2000, 2400, 0400
Aug 1-2	77	64
Aug 21-22	62	52
Sep 17-18	56	33
Totals	195	149

Table 13. Estimated invertebrate densities (no./m³ plant canopy) as sampled from *Agropyron desertorum*

PLANT : AGRDES

INSECT TAXON		TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ACA	ONE		0.00	0.00	0.00	0.00	0.00	58.60	0.00	0.00
ACA	THR		0.00	0.00	0.00	0.00	0.00	10.70	0.00	0.00
ACA	TWO		0.00	0.00	0.00	0.00	0.00	5.65	0.00	0.00
ACA3ORI	FOR		0.00	0.00	0.00	0.00	0.00	7.00	0.00	0.00
ARA		PRE	0.00	0.00	0.00	0.00	9.64	6.84	3.53	0.00
COE2ENT		SAP	0.00	0.00	6.15	0.00	28.82	14.78	0.00	0.00
COE2ENT	TWO	SAP	0.00	0.00	0.00	0.00	0.00	0.00	12.93	0.00
COL		CHE	0.00	0.00	0.00	0.00	3.61	5.17	0.00	0.00
COL2DASLISINT		PRE	0.00	0.00	0.00	0.00	0.00	0.00	5.48	0.00
COL2STA	ONE	PRE	0.00	0.00	3.80	0.00	0.00	0.00	0.00	0.00
COL2TENCONONE		CHE	0.00	0.00	0.00	0.00	4.36	0.00	0.00	0.00
DIP2CEC		NEC	0.00	0.00	0.00	0.00	6.68	0.00	0.00	0.00
DIP2CER		NEC	0.00	0.00	0.00	0.00	18.16	0.00	0.00	0.00
DIP2CHI		NEC	0.00	0.00	0.00	0.00	2.48	0.00	0.00	0.00
DIP2CHLTHA		SAP	0.00	0.00	0.00	0.00	0.00	0.00	13.80	0.00
DIP2CUL		NEC	0.00	0.00	0.00	0.00	7.23	0.00	0.00	0.00
DIP2PHO	ONE	SAP	0.00	0.00	0.00	0.00	4.85	0.00	0.00	0.00
DIP2PSY	ONE	SAP	0.00	0.00	0.00	0.00	7.43	0.00	0.00	0.00
DIP2SCI		SAP	0.00	0.00	0.00	0.00	2.48	4.61	0.00	0.00
HEM2LYGNYSERI		SUC	0.00	0.00	0.00	0.00	0.00	12.04	0.00	0.00
HEM2PIEPIEINC		SUC	0.00	0.00	0.00	0.00	8.14	0.00	0.00	0.00
HOM1COC	ONE	SUC	0.00	0.00	0.00	0.00	0.00	4.52	0.00	0.00
HOM2APH	TWO	SUC	0.00	0.00	0.00	0.00	0.00	6.07	0.00	0.00
HOM2CIC		SUC	0.00	0.00	0.00	0.00	3.61	0.00	0.00	0.00
HOM2CICACETWO		SUC	0.00	0.00	0.00	0.00	0.00	6.07	0.00	0.00
HOM2PSE	TWO	SUC	0.00	0.00	0.00	0.00	0.00	6.07	0.00	0.00
HYM1CHA		NON	0.00	0.00	0.00	0.00	5.01	0.00	0.00	0.00
HYM2FOR	FOR	OMN	0.00	0.00	0.00	0.00	3.61	0.00	0.00	0.00
HYM2FORFORMAN		OMN	0.00	0.00	8.50	0.00	5.79	0.00	6.46	0.00
HYM2FORMYRAME		OMN	0.00	0.00	4.55	0.00	0.00	6.07	0.00	0.00
HYM2MYM	ONE	NON	0.00	0.00	0.00	0.00	0.00	4.52	0.00	0.00
LEP		CHE	0.00	0.00	0.00	0.00	0.00	2.29	0.00	0.00
LEP		NEC	0.00	0.00	0.00	0.00	4.36	0.00	0.00	0.00
ORT2ACR		CHE	0.00	0.00	0.00	0.00	13.32	0.00	0.00	0.00
ORT2ACRMEL		CHE	0.00	0.00	0.00	0.00	4.36	0.00	0.00	0.00
PSE2CHEDACSIL		PRE	0.00	0.00	0.00	0.00	0.00	7.25	0.00	0.00
PSO2LIP		SAP	0.00	0.00	0.00	0.00	11.26	19.76	0.00	0.00
PSO2LIPLIPONE		SAP	0.00	0.00	3.80	0.00	4.42	0.00	0.00	0.00
SOL	ONE	PRE	0.00	0.00	0.00	0.00	0.00	2.96	0.00	0.00
THY2PHL	TWO	SUC	0.00	0.00	0.00	0.00	0.00	4.25	9.83	0.00
PHENOLOGY STAGES										
SPECIES DIVERSITY			0.000	0.000	0.676	0.000	1.218	1.116	0.735	0.000

Table 14. Estimated density (no./m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Agropyron desertorum*

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	0.000	0.000	9.372	4.450	0.000	0.000
FEEDING TYPE	NEC	0.000	0.000	0.000	0.000	10.309	0.000	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	0.000	0.000	5.006	4.522	0.000	0.000
FEEDING TYPE	OMN	0.000	0.000	5.868	0.000	5.066	6.066	6.464	0.000
FEEDING TYPE	PRE	0.000	0.000	3.803	0.000	9.642	6.262	4.504	0.000
FEEDING TYPE	SAP	0.000	0.000	5.370	0.000	22.508	17.262	13.367	0.000
FEEDING TYPE	SUC	0.000	0.000	0.000	0.000	6.628	7.482	9.830	0.000
TOTAL		0.000	0.000	15.042	0.000	68.531	46.044	34.165	0.000

Table 15. Estimated biomass (g/m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Agropyron desertorum*

WEIGHTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	0.000	0.000	13.315	0.132	0.000	0.000
FEEDING TYPE	NEC	0.000	0.000	0.000	0.000	1.702	0.000	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	0.000	0.000	0.060	0.014	0.000	0.000
FEEDING TYPE	OMN	0.000	0.000	0.540	0.000	0.446	0.461	0.705	0.000
FEEDING TYPE	PRE	0.000	0.000	0.126	0.000	4.435	2.186	1.085	0.000
FEEDING TYPE	SAP	0.000	0.000	0.016	0.000	0.071	0.053	0.496	0.000
FEEDING TYPE	SUC	0.000	0.000	0.000	0.000	1.597	0.408	0.029	0.000
TOTAL		0.000	0.000	0.681	0.000	21.626	3.254	2.315	0.000

Table 16. Estimated invertebrate densities (no./m³ plant canopy) as sampled by D-Vac from *Artemisia tridentata*

PLANT : ARTTRI

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ACA FIV		0.00	0.00	0.00	0.00	0.00	0.00	9.26	0.00
ACA ONE		0.00	0.00	0.00	0.00	0.00	36.47	15.40	0.00
ACA SIX		0.00	0.00	0.00	0.00	0.00	0.00	9.53	0.00
ACA SVN		0.00	0.00	0.00	0.00	0.00	0.00	19.29	0.00
ACA THR		0.00	0.00	0.00	0.00	0.00	0.00	6.04	0.00
ACA TWO		0.00	0.00	0.00	0.00	0.00	22.95	3.06	0.00
ACA3ORI FOR		0.00	0.00	0.00	0.00	0.00	4.16	20.26	0.00
ARA	PRE	0.00	0.00	0.00	3.59	2.12	6.50	3.04	0.00
COE2ENT	SAP	0.00	0.00	0.00	17.94	23.99	11.54	0.00	0.00
COE2ENT ONE	SAP	0.00	0.00	0.00	0.00	0.00	0.00	33.81	0.00
COE2ENT TWO	SAP	0.00	0.00	0.00	0.00	0.00	0.00	3.59	0.00
COE2SMI	SAP	0.00	0.00	0.00	7.27	0.00	0.00	0.00	0.00
COL	CHE	0.00	0.00	47.34	0.00	0.00	14.96	3.06	0.00
COL2CHRCRY	CHE	0.00	0.00	0.00	0.00	5.23	0.00	0.00	0.00
COL2CHRMONCON	CHE	0.00	0.00	0.00	0.00	0.00	13.26	0.00	0.00
COL2CHRMONONE	CHE	0.00	0.00	0.00	3.06	0.00	0.00	0.00	0.00
COL2CHRPHY	CHE	0.00	0.00	0.00	0.00	0.00	0.00	3.58	0.00
COL2CHRSTEONE	CHE	0.00	0.00	0.00	7.33	0.00	0.00	0.00	0.00
COL2COC FOR	CHE	0.00	0.00	0.00	0.00	0.00	4.77	0.00	0.00
COL2CUR FIV	CHE	0.00	0.00	0.00	10.60	4.54	0.00	0.00	0.00
COL2CUR FOR	CHE	0.00	0.00	0.00	0.00	0.00	0.00	1.79	0.00
COL2CUR ONE	CHE	0.00	0.00	0.00	0.00	0.00	4.41	0.00	0.00
COL2CUR TWO	CHE	0.00	0.00	0.00	16.85	8.72	6.71	0.00	0.00
COL2CUR TWO	SUC	0.00	0.00	0.00	18.80	0.00	0.00	0.00	0.00
COL2CURAPI	CHE	0.00	0.00	0.00	0.00	3.34	0.00	0.00	0.00
COL2DASLISINT	CHE	0.00	0.00	0.00	0.00	0.00	0.00	3.04	0.00
DIP	CHE	0.00	0.00	0.00	0.00	0.00	18.38	0.00	0.00
DIP	SAP	0.00	0.00	0.00	0.00	5.09	1.76	0.00	0.00
DIP2CEC	NON	0.00	0.00	0.00	0.00	0.00	5.12	0.00	0.00
DIP2CHI	NEC	0.00	0.00	0.00	9.40	0.00	0.00	0.00	0.00
DIP2CUL	NEC	0.00	0.00	0.00	0.00	1.81	0.00	0.00	0.00
DIP2PHO ONE	SAP	0.00	0.00	0.00	3.66	0.00	0.00	0.00	0.00
DIP2SCI	SAP	0.00	0.00	0.00	9.40	5.23	0.00	0.00	0.00
DIP2THE	PRE	0.00	0.00	0.00	0.00	0.00	4.77	0.00	0.00
HEM2CORHARREF	SUC	0.00	0.00	0.00	3.59	0.00	0.00	0.00	0.00
HEM2LYG FIV	SUC	0.00	0.00	0.00	0.00	0.00	2.61	6.64	0.00
HEM2LYGNYSERI	CHE	0.00	0.00	0.00	7.18	0.00	0.00	0.00	0.00
HEM2LYGNYSERI	SUC	0.00	0.00	0.00	47.01	2.43	19.48	0.00	0.00
HEM2LYGPERSAS	SUC	0.00	0.00	0.00	6.56	0.00	0.00	0.00	0.00
HEM2MIR FOR	SUC	0.00	0.00	0.00	0.00	0.00	11.03	0.00	0.00
HEM2MIR TWO	SUC	0.00	0.00	9.47	0.00	0.00	0.00	0.00	0.00
HEM2MIRLYG	SUC	0.00	0.00	0.00	0.00	0.00	0.00	4.27	0.00
HEM2NABNABALT	PRE	0.00	0.00	0.00	0.00	0.00	0.00	5.15	0.00
HEM2PEN	SUC	0.00	0.00	0.00	0.00	0.00	4.70	0.00	0.00
HEM2PIEPIEINC	SUC	0.00	0.00	0.00	19.34	3.40	10.39	3.58	0.00
HOM1COC FOR	SUC	0.00	0.00	0.00	0.00	0.00	0.00	5.94	0.00
HOM2APH ONE	SUC	0.00	0.00	0.00	0.00	0.00	0.00	10.19	0.00
HOM2APH TWO	SUC	0.00	0.00	0.00	0.00	0.00	0.00	5.59	0.00
HOM2CIC	SUC	0.00	0.00	0.00	0.00	4.04	0.00	0.00	0.00
HOM2CIC ONE	SUC	0.00	0.00	0.00	0.00	5.44	0.00	0.00	0.00
HOM2CIC TNS	SUC	0.00	0.00	0.00	0.00	0.00	0.00	9.86	0.00
HOM2CIC TNT	SUC	0.00	0.00	5.22	0.00	0.00	0.00	0.00	0.00
HOM2CICACE	OMN	0.00	0.00	0.00	6.12	0.00	0.00	0.00	0.00
HOM2CICACE	SUC	0.00	0.00	0.00	6.53	0.00	0.00	4.21	0.00
HOM2CICACEONE	SUC	0.00	0.00	0.00	3.59	2.90	4.41	7.16	0.00
HOM2CICACETWO	SUC	0.00	0.00	0.00	0.00	0.00	4.70	0.00	0.00
HOM2CICATHONE	SUC	0.00	0.00	0.00	10.34	0.00	0.00	6.66	0.00
HOM2CICEMPASP	CHE	0.00	0.00	0.00	6.20	0.00	0.00	0.00	0.00
HOM2CICEMPASP	SUC	0.00	0.00	0.00	9.04	0.00	3.68	0.00	0.00
HOM2CICXERONE	SUC	0.00	0.00	0.00	0.00	0.00	4.70	0.00	0.00
HOM2DIC ONE	SUC	0.00	0.00	0.00	0.00	5.90	0.00	0.00	0.00
HOM2DICDES	SUC	0.00	0.00	0.00	4.07	0.00	0.00	0.00	0.00
HOM2PSE	SUC	0.00	0.00	0.00	0.00	6.69	0.00	13.55	0.00
HOM2PSE TWO	SUC	0.00	0.00	0.00	0.00	0.00	5.00	0.00	0.00
HYM1CHA	NON	0.00	0.00	0.00	15.05	2.41	4.19	0.00	0.00
HYM2FOR FOR	OMN	0.00	0.00	0.00	0.00	2.41	0.00	0.00	0.00
HYM2FOR ONE	OMN	0.00	0.00	0.00	0.00	9.15	0.00	0.00	0.00
HYM2FOR SVN	OMN	0.00	0.00	20.87	0.00	0.00	0.00	0.00	0.00
HYM2FOR TWO	OMN	0.00	0.00	0.00	0.00	5.23	0.00	0.00	0.00
HYM2FORFORMAN	OMN	0.00	0.00	12.08	10.00	8.76	6.63	0.00	0.00
HYM2FORLEPONE	OMN	0.00	0.00	12.28	0.00	0.00	0.00	0.00	0.00
HYM2FORMYRAME	OMN	0.00	0.00	10.44	0.00	0.00	0.00	0.00	0.00
HYM2MYM ONE	NON	0.00	0.00	0.00	0.00	5.09	0.00	3.58	0.00
HYM2MYM THR	NON	0.00	0.00	0.00	0.00	0.00	0.00	2.12	0.00
HYM2SCETEL	NON	0.00	0.00	0.00	0.00	0.00	0.00	4.27	0.00
LEP	CHE	0.00	0.00	0.00	0.00	0.00	0.00	7.31	0.00
LEP	NEC	0.00	0.00	0.00	0.00	3.63	0.00	0.00	0.00
LEP2NOC	NEC	0.00	0.00	0.00	0.00	0.00	2.43	0.00	0.00
ORT2ACRMEL	CHE	0.00	0.00	0.00	0.00	3.05	0.00	0.00	0.00
PSE2CHEDACSIL	PRE	0.00	0.00	0.00	11.96	0.00	0.00	3.58	0.00
PSO2LIP	SAP	0.00	0.00	0.00	0.00	11.27	23.39	8.49	0.00

Table 16, continued

PLANT : ARTTRI

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
PSO2LIPLIPONE	SAP	0.00	0.00	0.00	3.59	0.00	0.00	0.00	0.00
PSO2PSY	SAP	0.00	0.00	0.00	0.00	0.00	9.60	3.88	0.00
THY2AEO ONE	SUC	0.00	0.00	0.00	0.00	0.00	2.43	0.00	0.00
THY2PHL FIV	SUC	0.00	0.00	0.00	0.00	0.00	18.79	0.00	0.00
THY2PHL THR	SUC	0.00	0.00	0.00	9.40	0.00	4.05	6.20	0.00
THY2PHL TWO	SUC	0.00	0.00	0.00	0.00	0.00	4.56	0.00	0.00
THY2THR FIV	SUC	0.00	0.00	0.00	0.00	0.00	0.00	3.33	0.00
THY2THR FOR	SUC	0.00	0.00	0.00	0.00	0.00	0.00	4.27	0.00
PHENOLOGY STAGES									
SPECIES DIVERSITY		0.000	0.000	0.738	1.339	1.302	1.390	1.440	0.000

Table 17. Estimated density (no./m^3 plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Artemisia tridentata*

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	47.339	10.609	6.814	10.583	4.160	0.000
FEEDING TYPE	NEC	0.000	0.000	0.000	9.402	2.720	2.428	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	0.000	15.051	3.752	4.501	3.325	0.000
FEEDING TYPE	OMN	0.000	0.000	13.335	8.707	6.864	6.629	0.000	0.000
FEEDING TYPE	PRE	0.000	0.000	0.000	10.566	2.120	6.287	3.571	0.000
FEEDING TYPE	SAP	0.000	0.000	0.000	9.710	18.256	15.048	11.652	0.000
FEEDING TYPE	SUC	0.000	0.000	7.343	12.310	4.112	7.485	7.180	0.000
TOTAL		0.000	0.000	68.017	76.356	44.638	52.962	29.888	0.000

Table 18. Estimated biomass (g/m^3 plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Artemisia tridentata*

WEIGHTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	1.325	3.161	3.510	3.483	0.716	0.000
FEEDING TYPE	NEC	0.000	0.000	0.000	0.301	4.363	6.021	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	0.000	0.181	0.022	0.042	0.096	0.000
FEEDING TYPE	OMN	0.000	0.000	0.658	1.139	0.661	0.723	0.000	0.000
FEEDING TYPE	PRE	0.000	0.000	0.000	0.574	0.975	3.244	1.160	0.000
FEEDING TYPE	SAP	0.000	0.000	0.000	0.037	0.058	0.045	0.048	0.000
FEEDING TYPE	SUC	0.000	0.000	1.517	2.093	0.642	0.655	0.806	0.000
TOTAL		0.000	0.000	3.500	7.485	10.231	14.214	2.826	0.000

Table 19. Estimated invertebrate densities (no./m^3 plant canopy) as sampled from *Atriplex confertifolia*

PLANT : ATRCON

INSFCT TAXON		TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ACA	FIV		0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.66
ACA	ONE		0.00	0.00	0.00	0.00	23.06	108.84	0.00	17.54
ACA	SIX		0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.34
ACA	SVN		0.00	0.00	0.00	0.00	0.00	0.00	0.00	38.96
ACA	THR		0.00	0.00	0.00	0.00	7.02	16.52	0.00	16.41
ACA	TWO		0.00	0.00	0.00	0.00	18.86	196.47	0.00	20.56
ACA3ORI	FOR		0.00	0.00	0.00	0.00	6.90	11.94	0.00	73.76
ARA		PRE	0.00	0.00	11.35	0.00	13.81	7.87	0.00	14.84
COE2ENT		SAP	0.00	0.00	0.00	0.00	105.00	21.75	0.00	41.58
COE2ENT	THR	SAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.68
COE2ENT	TWO	SAP	0.00	0.00	0.00	0.00	0.00	0.00	0.00	56.86
COE2SMI		SAP	0.00	0.00	0.00	0.00	6.42	0.00	0.00	0.00
COL		CHE	0.00	0.00	0.00	0.00	38.49	14.25	0.00	9.41
COL2CHR	TWO	CHE	0.00	0.00	0.00	0.00	0.00	14.01	0.00	4.76
COL2CHRCRYFIV		CHE	0.00	0.00	0.00	0.00	0.00	8.43	0.00	0.00
COL2CHRMET		CHE	0.00	0.00	0.00	0.00	10.80	0.00	0.00	0.00
COL2CHRMON		CHE	0.00	0.00	0.00	0.00	6.90	9.59	0.00	0.00
COL2CHRMON		PRE	0.00	0.00	0.00	0.00	7.92	0.00	0.00	0.00
COL2CHRPHY		CHE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.76
COL2COC	FOR	CHE	0.00	0.00	0.00	0.00	0.00	21.40	0.00	0.00
COL2COC	THR	CHE	0.00	0.00	0.00	0.00	0.00	21.40	0.00	0.00
COL2CUR	THR	CHE	0.00	0.00	14.57	0.00	0.00	0.00	0.00	0.00
COL2CUR	TWO	CHE	0.00	0.00	0.00	0.00	7.41	0.00	0.00	0.00
COL2DAS	ONE	PRE	0.00	0.00	10.49	0.00	0.00	0.00	0.00	0.00
COL2DASLISINT		PRE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.81
DIP		SAP	0.00	0.00	0.00	0.00	20.63	0.00	0.00	0.00
DIP2AGR		NON	0.00	0.00	0.00	0.00	10.90	0.00	0.00	0.00
DIP2CEC		NON	0.00	0.00	0.00	0.00	16.42	0.00	0.00	0.00
DIP2CHI		NEC	0.00	0.00	0.00	0.00	6.90	0.00	0.00	0.00
DIP2CUL		NEC	0.00	0.00	0.00	0.00	5.43	0.00	0.00	0.00
DIP2PSY		SAP	0.00	0.00	0.00	0.00	10.19	0.00	0.00	0.00
DIP2SCI		SAP	0.00	0.00	0.00	0.00	29.47	0.00	0.00	0.00
HEM2LYG	FIV	SUC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	21.61
HEM2LYGEMBVIC		SUC	0.00	0.00	0.00	0.00	6.28	0.00	0.00	0.00
HEM2LYGNYSERI		SUC	0.00	0.00	0.00	0.00	0.00	32.66	0.00	0.00
HEM2LYGPERSAS		SUC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	13.82
HEM2MIR		SUC	0.00	0.00	0.00	0.00	5.65	0.00	0.00	0.00
HEM2PENTHYONE		SUC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.56
HEM2PENTHYPUN		SUC	0.00	0.00	0.00	0.00	8.42	9.01	0.00	0.00
HEM2PENTHYRUG		SUC	0.00	0.00	0.00	0.00	0.00	10.70	0.00	0.00
HEM2PIEPIEINC		SUC	0.00	0.00	0.00	0.00	41.05	22.76	0.00	21.35
HOM1COC	ONE	SUC	0.00	0.00	0.00	0.00	87.19	0.00	0.00	28.38
HOM1COC	THR	SUC	0.00	0.00	0.00	0.00	6.42	0.00	0.00	0.00
HOM1COC	TWO	SUC	0.00	0.00	0.00	0.00	0.00	46.34	0.00	0.00
HOM2CIC	TNS	SUC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.56
HOM2CIC	TWO	SUC	0.00	0.00	0.00	0.00	0.00	26.55	0.00	0.00
HOM2CICACEONE		SUC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	126.82
HOM2CICACETWO		SUC	0.00	0.00	0.00	0.00	16.80	9.26	0.00	9.80
HOM2CICAPLPAU		SUC	0.00	0.00	0.00	0.00	9.01	0.00	0.00	12.56
HOM2CICATHONE		SUC	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.52
HOM2CICAURONE		SUC	0.00	0.00	14.57	0.00	0.00	0.00	0.00	0.00
HOM2CICCOMONE		SUC	0.00	0.00	11.35	0.00	0.00	0.00	0.00	0.00
HOM2CICEMPASP		SUC	0.00	0.00	0.00	0.00	0.00	8.50	0.00	0.00
HOM2CICMOCONE		SUC	0.00	0.00	0.00	0.00	10.59	0.00	0.00	0.00
HOM2PSE		SUC	0.00	0.00	0.00	0.00	381.68	0.00	0.00	62.93
HOM2PSE	TWO	SUC	0.00	0.00	0.00	0.00	0.00	123.16	0.00	0.00
HYM1CHA		NON	0.00	0.00	14.57	0.00	10.39	8.50	0.00	0.00
HYM2BET		PPE	0.00	0.00	0.00	0.00	0.00	9.27	0.00	0.00
HYM2BRA		NON	0.00	0.00	10.49	0.00	0.00	0.00	0.00	0.00
HYM2BRA	SIX	NON	0.00	0.00	0.00	0.00	9.47	0.00	0.00	0.00
HYM2FOR	THR	OMN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.81
HYM2FOR	TWO	OMN	0.00	0.00	14.57	0.00	0.00	0.00	0.00	0.00
HYM2FORCAMONE		OMN	0.00	0.00	0.00	0.00	41.40	0.00	0.00	0.00
HYM2FORFORMAN		OMN	0.00	0.00	11.35	0.00	10.12	8.50	0.00	0.00
HYM2FORLEPONE		OMN	0.00	0.00	11.35	0.00	0.00	25.50	0.00	0.00
HYM2FORMYRAME		OMN	0.00	0.00	21.41	0.00	0.00	8.50	0.00	0.00
HYM2MYM	ONE	NON	0.00	0.00	0.00	0.00	11.90	0.00	0.00	0.00
HYM2MYM	SIX	NON	0.00	0.00	0.00	0.00	3.45	0.00	0.00	0.00
HYM2PTF	THR	NON	0.00	0.00	0.00	0.00	15.38	13.27	0.00	0.00
LEP		CHF	0.00	0.00	0.00	0.00	21.43	16.01	0.00	17.69
LEP		NFC	0.00	0.00	0.00	0.00	14.83	9.16	0.00	0.00
LEPOMIC		NEC	0.00	0.00	0.00	0.00	6.42	0.00	0.00	0.00
ORT2MATLITMIN		PRE	0.00	0.00	192.90	0.00	0.00	0.00	0.00	0.00
PSE2CHEDACSIL		PRE	0.00	0.00	11.35	0.00	0.00	0.00	0.00	12.82
PSO2LIP		SAP	0.00	0.00	0.00	0.00	10.32	37.96	0.00	29.46
PSO2LIP	ONE	SAP	0.00	0.00	0.00	0.00	147.37	0.00	0.00	0.00
PSO2PSY		SAP	0.00	0.00	0.00	0.00	0.00	8.84	0.00	0.00
PSO2PSY	ONE	SAP	0.00	0.00	0.00	0.00	36.15	0.00	0.00	0.00
THS2MAC	ONE	SAP	0.00	0.00	0.00	0.00	4.21	0.00	0.00	0.00
THY2PHL		SUC	0.00	0.00	0.00	0.00	10.59	0.00	0.00	0.00

Table 19, continued

PLANT : ATRCON

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
THY2PHL	FIV SUC	0.00	0.00	0.00	0.00	0.00	29.09	0.00	0.00
THY2PHL	THR SUC	0.00	0.00	0.00	0.00	14.45	14.01	0.00	37.44
THY2PHL	TWO SUC	0.00	0.00	0.00	0.00	55.58	7.00	0.00	0.00
THY2THR	FOR SUC	0.00	0.00	0.00	0.00	8.42	0.00	0.00	27.63
PHENOLOGY STAGES									
SPECIES DIVERSITY		0.000	0.000	0.779	0.000	1.292	1.284	0.000	1.375

Table 20. Estimated density (no./m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Atriplex confertifolia*

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	14.566	0.000	18.097	13.822	0.000	10.860
FEEDING TYPE	NEC	0.000	0.000	0.000	0.000	7.802	9.157	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	12.528	0.000	12.625	10.887	0.000	0.000
FEEDING TYPE	OMN	0.000	0.000	16.015	0.000	16.380	14.169	0.000	10.807
FEEDING TYPE	PRE	0.000	0.000	56.520	0.000	13.028	8.151	0.000	13.662
FEEDING TYPE	SAP	0.000	0.000	0.000	0.000	74.117	25.430	0.000	38.008
FEEDING TYPE	SUC	0.000	0.000	12.956	0.000	113.545	31.518	0.000	36.615
TOTAL		0.000	0.000	112.585	0.000	255.592	113.133	0.000	109.953

Table 21. Estimated biomass (g/m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Atriplex confertifolia*

WEIGHTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	4.370	0.000	1.355	1.091	0.000	0.459
FEEDING TYPE	NEC	0.000	0.000	0.000	0.000	7.373	21.116	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	0.339	0.000	0.152	0.383	0.000	0.000
FEEDING TYPE	OMN	0.000	0.000	1.115	0.000	2.547	0.618	0.000	2.172
FEEDING TYPE	PRE	0.000	0.000	3.388	0.000	5.685	2.967	0.000	3.664
FEEDING TYPE	SAP	0.000	0.000	0.000	0.000	0.232	0.076	0.000	0.114
FEEDING TYPE	SUC	0.000	0.000	0.561	0.000	7.202	2.876	0.000	3.369
TOTAL		0.000	0.000	9.774	0.000	24.546	29.127	0.000	9.777

Table 22. Estimated invertebrate densities (no./m³ plant canopy) as sampled by D-Vac from *Chrysothamnus viscidiflorus*

PLANT : CHRVIS

INSFCT TAXON		TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
ACA	FIV		0.00	0.00	0.00	0.00	0.00	0.00	10.83	0.00
ACA	FOR		0.00	0.00	0.00	0.00	0.00	8.75	0.00	0.00
ACA	ONE		0.00	0.00	0.00	0.00	0.00	38.70	20.37	0.00
ACA	SIX		0.00	0.00	0.00	0.00	0.00	6.54	0.00	0.00
ACA	THR		0.00	0.00	0.00	0.00	0.00	12.65	10.00	0.00
ACA	TWO		0.00	0.00	0.00	0.00	0.00	18.34	23.85	0.00
ACA3ORI	FOR		0.00	0.00	0.00	0.00	0.00	31.11	76.35	0.00
ARA		PRE	0.00	0.00	14.88	0.00	14.82	10.59	7.01	0.00
COE2ENT		SAP	0.00	0.00	14.84	0.00	49.44	36.25	14.01	0.00
COE2ENT	THR	SAP	0.00	0.00	0.00	0.00	0.00	0.00	20.93	0.00
COL		CHE	0.00	0.00	22.24	0.00	0.00	28.39	3.37	0.00
COL2CHR	TWO	CHE	0.00	0.00	0.00	0.00	0.00	0.00	21.15	0.00
COL2CHRMET		CHE	0.00	0.00	0.00	0.00	0.00	0.00	2.80	0.00
COL2COC	FOR	CHE	0.00	0.00	0.00	0.00	3.59	0.00	0.00	0.00
COL2CUR	FIV	CHE	0.00	0.00	0.00	0.00	4.20	0.00	7.02	0.00
COL2CUR	FOR	CHE	0.00	0.00	0.00	0.00	3.88	0.00	0.00	0.00
COL2CUR	TWO	CHE	0.00	0.00	20.58	0.00	8.60	9.63	0.00	0.00
COL2CURPHY		CHE	0.00	0.00	0.00	0.00	0.00	0.00	14.10	0.00
COL2TEN	SVN	CHE	0.00	0.00	0.00	0.00	5.47	0.00	0.00	0.00
DIP		SAP	0.00	0.00	0.00	0.00	4.87	0.00	0.00	0.00
DIP2CEC		NON	0.00	0.00	14.88	0.00	0.00	0.00	0.00	0.00
DIP2CHI		NEC	0.00	0.00	0.00	0.00	3.07	0.00	0.00	0.00
DIP2CUL		NEC	0.00	0.00	20.58	0.00	5.81	0.00	0.00	0.00
DIP2EPH	ONE	SAP	0.00	0.00	0.00	0.00	3.89	0.00	0.00	0.00
DIP2SCI		SAP	0.00	0.00	0.00	0.00	5.47	0.00	0.00	0.00
HEM2COR		SUC	0.00	0.00	0.00	0.00	0.00	0.00	2.80	0.00
HEM2COR	ONE	SUC	0.00	0.00	0.00	0.00	7.33	0.00	7.43	0.00
HEM2CORHARREF		SUC	0.00	0.00	0.00	0.00	0.00	10.68	0.00	0.00
HEM2LYGNYSERI		SAP	0.00	0.00	0.00	0.00	0.00	0.00	11.93	0.00
HEM2LYGNYSERI		SUC	0.00	0.00	0.00	0.00	2.88	2.62	14.47	0.00
HEM2LYGPERSAS		SUC	0.00	0.00	0.00	0.00	0.00	6.03	13.95	0.00
HEM2MIR	TWO	SUC	0.00	0.00	0.00	0.00	20.58	0.00	0.00	0.00
HEM2NABNABALT		PRE	0.00	0.00	0.00	0.00	0.00	1.95	6.98	0.00
HEM2PIEPIEINC		SUC	0.00	0.00	22.20	0.00	10.92	24.62	10.50	0.00
HOM1COC	ONE	SUC	0.00	0.00	0.00	0.00	0.00	0.00	2.80	0.00
HOM2APH	ONE	SUC	0.00	0.00	0.00	0.00	0.00	9.63	12.77	0.00
HOM2APH	TWO	SUC	0.00	0.00	0.00	0.00	0.00	0.00	11.93	0.00
HOM2CIC		SUC	0.00	0.00	25.17	0.00	8.68	0.00	0.00	0.00
HOM2CIC	ONE	SUC	0.00	0.00	0.00	0.00	2.98	0.00	0.00	0.00
HOM2CICACE		SUC	0.00	0.00	0.00	0.00	7.06	0.00	0.00	0.00
HOM2CICACEONE		SUC	0.00	0.00	0.00	0.00	4.70	6.21	2.75	0.00
HOM2CICATHONE		SUC	0.00	0.00	0.00	0.00	0.00	0.00	7.90	0.00
HOM2CICEMPASP		SUC	0.00	0.00	0.00	0.00	0.00	5.79	0.00	0.00
HOM2PSE		SUC	0.00	0.00	0.00	0.00	5.17	18.01	36.45	0.00
HOM2PSE	TWO	SUC	0.00	0.00	0.00	0.00	0.00	7.17	0.00	0.00
HYM1CHA		NON	0.00	0.00	14.80	0.00	4.51	9.63	0.00	0.00
HYM2BRA		NON	0.00	0.00	14.80	0.00	0.00	0.00	0.00	0.00
HYM2CHA		NON	0.00	0.00	14.88	0.00	0.00	0.00	0.00	0.00
HYM2FOR	FIV	OMN	0.00	0.00	0.00	0.00	3.07	0.00	0.00	0.00
HYM2FOR	FOR	OMN	0.00	0.00	29.60	0.00	8.14	0.00	4.39	0.00
HYM2FOR	TWO	OMN	0.00	0.00	14.88	0.00	9.31	0.00	0.00	0.00
HYM2FORFORMAN		OMN	0.00	0.00	20.58	0.00	2.88	0.00	0.00	0.00
HYM2FORLEPONE		OMN	0.00	0.00	163.67	0.00	0.00	0.00	0.00	0.00
HYM2FORMYRAME		OMN	0.00	0.00	14.88	0.00	0.00	0.00	12.13	0.00
HYM2MYM		NON	0.00	0.00	14.88	0.00	0.00	0.00	0.00	0.00
HYM2MYM	ONE	NON	0.00	0.00	0.00	0.00	0.00	0.00	2.80	0.00
HYM2SCETEL		NON	0.00	0.00	0.00	0.00	0.00	0.00	7.05	0.00
HYM2VES	ONE	NEC	0.00	0.00	14.80	0.00	0.00	0.00	0.00	0.00
LEP		CHE	0.00	0.00	0.00	0.00	0.00	30.39	4.47	0.00
LEP		NEC	0.00	0.00	0.00	0.00	4.30	0.00	0.00	0.00
PSE2CHEDACSIL		PRE	0.00	0.00	0.00	0.00	3.77	1.95	4.96	0.00
PSO2LIP		SAP	0.00	0.00	0.00	0.00	7.65	83.10	9.63	0.00
SOL	ONE	PRE	0.00	0.00	0.00	0.00	0.00	9.01	0.00	0.00
THS2MAC	ONE	SAP	0.00	0.00	0.00	0.00	5.53	0.00	0.00	0.00
THY2PHL		SUC	0.00	0.00	0.00	0.00	0.00	1.95	0.00	0.00
THY2PHL	THR	SUC	0.00	0.00	0.00	0.00	0.00	0.00	8.89	0.00
THY2PHL	TWO	SUC	0.00	0.00	0.00	0.00	43.84	0.00	0.00	0.00
THY2THR	FOR	SUC	0.00	0.00	0.00	0.00	0.00	0.00	9.79	0.00
PHENOLOGY STAGES										
SPECIES DIVERSITY			0.000	0.000	1.077	0.000	1.305	1.238	1.393	0.000

Table 23. Estimated density (no./m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Chrysothamnus viscidiflorus*

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	21.687	0.000	5.553	26.753	7.482	0.000
FEEDING TYPE	NEC	0.000	0.000	17.690	0.000	4.373	0.000	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	14.849	0.000	4.513	9.627	4.927	0.000
FEEDING TYPE	OMN	0.000	0.000	48.723	0.000	6.542	0.000	10.191	0.000
FEEDING TYPE	PRE	0.000	0.000	14.879	0.000	12.612	7.895	6.320	0.000
FEEDING TYPE	SAP	0.000	0.000	14.841	0.000	33.928	56.749	11.263	0.000
FEEDING TYPE	SUC	0.000	0.000	23.686	0.000	9.169	10.909	12.455	0.000
TOTAL		0.000	0.000	156.355	0.000	76.690	111.933	52.638	0.000

Table 24. Estimated biomass (g/m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Chrysothamnus viscidiflorus*

WEIGHTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	3.913	0.000	2.370	1.352	0.725	0.000
FEEDING TYPE	NEC	0.000	0.000	4.226	0.000	5.277	0.000	0.000	0.000
FEEDING TYPE	NON	0.000	0.000	0.237	0.000	0.054	0.116	0.180	0.000
FEEDING TYPE	OMN	0.000	0.000	1.356	0.000	0.371	0.000	0.714	0.000
FEEDING TYPE	PRE	0.000	0.000	6.845	0.000	5.477	3.009	1.999	0.000
FEEDING TYPE	SAP	0.000	0.000	0.045	0.000	0.114	0.170	0.117	0.000
FEEDING TYPE	SUC	0.000	0.000	3.471	0.000	1.442	2.035	0.812	0.000
TOTAL		0.000	0.000	20.093	0.000	15.106	6.682	4.548	0.000

Table 25. Estimated invertebrate densities (no./m³ plant canopy) as sampled by D-Vac from *Sitanion hystrix*

PLANT : SITHYS

INSECT TAXON	TYPE	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
HOM2CIC	SUC	0.00	0.00	30.69	0.00	0.00	0.00	0.00	0.00
HYM2FOR TWO	OMN	0.00	0.00	17.78	0.00	0.00	0.00	0.00	0.00
HYM2FORFORMAN	OMN	0.00	0.00	8.90	0.00	0.00	0.00	0.00	0.00
HYM2FORLASONE	OMN	0.00	0.00	106.51	0.00	0.00	0.00	0.00	0.00
PSE2CHEDACSIL	PRE	0.00	0.00	15.34	0.00	0.00	0.00	0.00	0.00
THS2MAC ONE	SAP	0.00	0.00	30.69	0.00	0.00	0.00	0.00	0.00
PHENOLOGY STAGES									
SPECIES DIVERSITY		0.000	0.000	0.625	0.000	0.000	0.000	0.000	0.000

Table 26. Estimated density (no./m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Sitanion hystrix*

COUNTS

FEEDING TYPES		APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE	CHE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE	NEC	0.000	0.000	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	0.000	0.000	37.817	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE	PRE	0.000	0.000	15.343	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE	SAP	0.000	0.000	30.686	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE	SUC	0.000	0.000	30.686	0.000	0.000	0.000	0.000	0.000
TOTAL		0.000	0.000	114.532	0.000	0.000	0.000	0.000	0.000

Table 27. Estimated biomass (g/m³ plant canopy) of invertebrates per feeding type as sampled by D-Vac from *Sitanion hystrix*

WEIGHTS

FEEDING TYPES	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV
FEEDING TYPE CHE	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE NEC	0.000	0.000	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	0.000	0.000	1.497	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE PRE	0.000	0.000	0.460	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE SAP	0.000	0.000	0.491	0.000	0.000	0.000	0.000	0.000
FEEDING TYPE SUC	0.000	0.000	0.614	0.000	0.000	0.000	0.000	0.000
TOTAL	0.000	0.000	3.062	0.000	0.000	0.000	0.000	0.000

Table 28. Number of taxa emerged from ART-ATR-SIT vegetation type

VEG TYPE I

MONTH	TAXA	FEED TYPE	# EMERGED
APRIL	ARA	PRE	1
	HYM2FORFORMAN	OMN	3
MAY	ARA	PRE	3
	ARA ETN	PRE	1
	COE2SMI	SAP	1
	DIP2CEC	NEC	5
	HYM2FORFORMAN	OMN	3
	LEP2NOC		5
JUNE	ARA	PRE	3
	COE	SAP	1
	COE2SMI	SMI	1
	COL	CHE	1
	COL2ELAAEO	CHE	2
	DIP2SCI	SAP	11
	HEM2MIR FOR	SUC	1
	HOM2CIC	SUC	1
	HYM1CHA	NON	3
	HYM2FOR TWO	OMN	1
	HYM2FORFORMAN	OMN	1
	HYM2FORLEPONE	OMN	1
	LEP	CHE	3
	LEP	NEC	69
JULY	ARA	PRE	21
	COL2ANTISC	CHE	1
	COL2ANTNOTCAL	CHE	1
	COL2CHRMON	CHE	3
	COL2CHRMONCON	CHE	1
	COL2CLE ONE	CHE	1
	DIP2DOL	PRE	1
	DIP2EMP ONE	PRE	3
	DIP2PHO ONE	SAP	12
	HEM	SUC	1
	HEM2LYGNYSERI	SUC	650
	HEM2MIR FOR	PRE	1
	HEM2MIRLABSER	PRE	1
	HOM2CIC TNS	SUC	2
	HOM2CIDMAGONE	SUC	2
	HYM1CHA	NON	5
	HYM1PRO	NON	1
	HYM2FOR TWO	OMN	1
	HYM2FORFORMAN	OMN	8
	HYM2FORLEPONE	OMN	8
	HYM2MUT FIV	PRE	1
	HYM2MUTCRYONE	PRE	1
	HYM2TIP	NON	1
	LEP	CHE	3
	LEP	NEC	67
	LEP2AEG	NEC	1
	SOL ONE	PRE	1
AUG.	ARA	PRE	16
	COL2CURAPI	CHE	2
	COL2NIT ONE	SAP	1
	DIP2PHO ONE	SAP	44
	HEM2LYGNYSERI	SUC	4
	HEM2MIR FOR	PRE	1
	HOM2PSE	SUC	1
	HYM1CHA	NON	2
	HYM2FOR ONE	OMN	1
	LEP	NEC	22

Table 28, continued

VEG TYPE I

MONTH	TAXA	FEED TYPE	# EMERGED
SEPT.	ARA	PRE	7
	DIP2PHO ONE	SAP	34
	HEM2NABNABALT	PRE	1
	HOM2PSE TWO	SUC	58
	HYM1CHA	NON	1
	HYM2FOR FOR	OMN	1
	LEP	NEC	2
OCT.	ACA TWO		2
	ACAOORI FOR		1
	ARA	PRE	1
	COE2ISO	SAP	7
	DIP	SAP	2
	DIP2ASI TWO	PRE	1
	DIP2PHO ONE	SAP	18
	HOM1COC TWO	SUC	80
	HOM2PSE TWO	SUC	34
	HYM2EUL	NON	1
NOV.	ACA SIX		23
	ARA	PRE	4
	HOM2APH TWO	SUC	1
	HOM2PSE TWO	SUC	4
DEC.	ACA SIX		4
	ARA	PRE	1

Table 29. Number of taxa emerged from ANNUALS vegetation type

VEG TYPE II

MONTH	TAXA	FEED TYPE	# EMERGED
APRIL	DIP2PHO ONE	SAP	1
MAY	ARA	PRE	8
	COL		1
	DIP2PHO ONE	SAP	1
	HYM2FORFORMAN	OMN	1
JUNE	ARA	PRE	1
	DIP2CHI	NEC	1
	DIP2EMP	PRE	1
	HEM2MIR FOR	SUC	3
	HYM1CHA	NON	1
	LEP	NEC	1
JULY	ARA	PRE	23
	COE2SMI	SAP	10
	COL2CAR	PRE	1
	COL2CHRMET	CHE	24
	COL2CHRMONCON	CHE	1
	COL2CHRPHY	CHE	2
	COL2DAC ONE	SAP	1
	COL2STA ONE	CHE	1
	DIP2ASIASIONE	PRE	1
	DIP2DOL	PRE	4
	DIP2EMP ONE	PRE	28
	DIP2PHO ONE	SAP	8
	HEM2LYG	SUC	2
	HEM2LYGEMBVIC	PRE	1
	HEM2LYGNYSERI	SUC	30
	HEM2LYGPERSAS	PRE	1
	HEM2LYGPERSAS	SUC	58

Table 29, continued

VEG TYPE II

MONTH	TAXA	FEED TYPE	# EMERGED
	HEM2MIR FOR	PRE	24
	HEM2MIR FOR	SUC	15
	HOM2CIC TNS	SUC	1
	HOM2CIDMAGONE	SUC	1
	HYM1CHA	NON	2
	HYM2CHRMONCON	PRE	1
	HYM2SPH ONE	NON	1
	LEP	CHE	2
	LEP	NEC	16
	ORT2ACR	CHE	3
	SOL ONE	PRE	7
	THY2AEO ONE	SUC	1
	THY2PHL THR	SUC	1
	THY2THR FOR	SUC	2
AUG.	ARA	PRE	10
	COE2SMI	SAP	1
	COL2CHRPHY	CHE	1
	COL2CRY TWO	CHE	1
	COL2DAS TWO	PRE	1
	DIP2CEC	NON	1
	DIP2EMP ONE	PRE	2
	DIP2MILMADGLA	NON	1
	DIP2PHO ONE	SAP	24
	HEM2LYGGEOFOR	PRE	5
	HEM2LYGNYSERI	SUC	16
	HEM2LYGPERSAS	SUC	172
	HEM2MIR FOR	PRE	4
	HOM2PSE	SUC	7
	LEP	NEC	1
	ORT2ACRMEL	CHE	2
	SOL ONE	PRE	1
SEPT.	ARA	PRE	19
	COL	CHE	1
	DIP2CEC	PRE	2
	DIP2EMP	PRE	1
	DIP2PHO ONE	SAP	18
	HEM2LYG	SUC	10
	HEM2LYGNYSERI	SUC	2
	HEM2MIR FOR	PRE	2
	HOM2PSE TWO	SUC	49
	HYM1CHA	NON	18
OCT.	ARA	PRE	8
	COL2ANT THR	CHE	1
	COL2CHRPHY	CHE	1
	DIP2PHO ONE	SAP	6
	HEM2LYGPERSAS	SUC	2
	HEM2MIR FOR	PRE	1
	HOM2PSE TWO	SUC	3
	HYM1CHA	NON	1
NOV.	ACA SIX		1
	ACA SIX	PRE	1
	ARA	PRE	3
	DIP2PHO ONE	NON	1
DEC.			

Table 30. Number of taxa emerged from AGRDES vegetation type

VEG TYPE IV

MONTH	TAXA	FEED TYPE	# EMERGED
APRIL			
MAY	ARA	PRE	9
	COE2SMI ONE	SAP	1
	COL2TEN FIV	CHE	1
JUNE	ARA	PRE	2
	ARA THR	PRE	15
	COE2SMI	SAP	6
	DIP2SCI	SAP	13
	LEP	CHE	1
	LEP	NEC	2
	NEU2HEMMICVAR	PRE	1
JULY	ARA	PRE	22
	COE2SMI	SAP	14
	COL	CHE	1
	COL2ALLMYC	OMN	4
	COL2CAR	PRE	2
	COL2CARTECCRO	PRE	1
	COL2CHRMET	CHE	1
	COL2CLE ONE	CHE	1
	COL2COC TWO	PRE	1
	COL2CUC	PRE	2
	COL2DAC ONE	CHE	4
	COL2MALCOLUTA	PRE	1
	COL2MOR	CHE	2
	COL2SCA ONE	OMN	2
	COL2STA ONE	CHE	5
	COL2STA ONE	PRE	1
	DIP2CEC	NON	1
	DIP2CHI	NEC	2
	DIP2EMP ONE	PRE	7
	DIP2PHO ONE	SAP	62
	DIP2SCI	SAP	1
	HEM2LYGNYSERI	SUC	543
	HYM1CHA	NON	1
	HYM2BRA NIN	NON	1
	HYM2FORFORMAN	OMN	1
	HYM2MUTSPHONE	PRE	1
	ISO	CHE	1
	LEP	CHE	12
	LEP	NEC	51
	LEP2COL	CHE	3
	ORT2GRYSTEFUS	CHE	1
	PSO2LIP	SAP	36
	SOL ONE	PRE	1
	THY2PHL THR	SUC	8
AUG.	ARA	PRE	35
	COE2SMI	SAP	1
	COL2CAR TWO	PRE	1
	COL2CHRMET	CHE	3
	COL2CLE ONE	PRE	3
	COL2CUR THR	CHE	1
	COL2DAS TWO	PRE	1
	DIP2CEC	NON	1
	DIP2EMP ONE	PRE	1
	DIP2MILMADGLA	NON	1
	DIP2PHO ONE	SAP	170
	HEM2LYGNYSERI	SUC	73
	HOM2PSE	SUC	1
	HYM1CHA	NON	1
	HYM2BRA NIN	NON	1
	HYM2BRA THR	NON	3
	HYM2FOR FOR	OMN	1
	HYM2SYN	NEC	1
	HYM2TIP	NON	2
	LEP	NFC	34
	NEU2HEMMICVAR	PRE	1
	SOL ONE	PRE	1
	THY FOR	SUC	22
	THY2PHL THR	SUC	2
SEPT.	ARA	PRE	29
	COL	CHE	1
	COL2CAR	PRE	1
	COL2CLE TWO	PRE	3
	DIP2PHO ONE	SAP	32
	HOM2PSE TWO	SUC	96
	HYM1CHA	NON	7
	LEP	NEC	2
	LEP2GEL ONE	NEC	1
OCT.	ARA	PRE	15
	DIP2PHO ONE	SAP	19
	HOM2PSE TWO	SUC	209
	HYM1CHA	NON	6
	HYM2ENC	NON	1
	HYM2ICH SIX	NEC	1
	THY2AEO ONE	SUC	1
	THY2PHL TWO	SUC	1
NOV.	ARA	PRE	4
	DIP2PHO ONE	SAP	2
	HOM1COC TWO	SUC	10
	HOM2PSE TWO	SUC	3
	HYM2ENC ONE	NON	1
	HYM2FORLASONE	OMN	1
	THY2THR FOR	SUC	1
DEC.	ACA SIX		9
	ARA	PRE	2
	HOM2PSE TWO	SUC	1

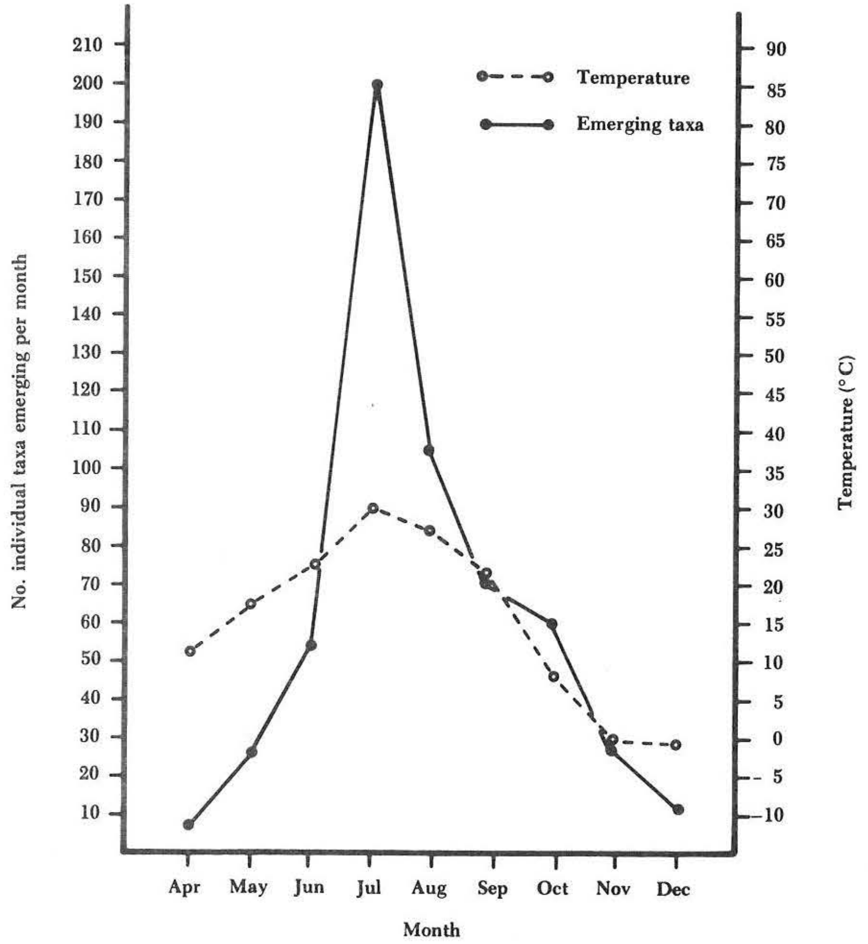

Figure 6. General trend in Curlew emergent trapping vs. mean maximum monthly temperature (°C).

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MAMMALS

M. Merritt

Introduction

Demographic parameters of small mammal populations were continuously monitored in the ART-ATR-SIT and AGRDES vegetation associations during 1975. Populations were also censused in the ANNUALS, HALGLO-ART, ARTTRI and off-site AGRDES vegetation types during August.

Methods

Sherman live traps were placed in a 12 x 12 station grid, two traps per station. The total grid area was 2.72 km^2. Traps were set in the early morning and checked every 24 hr for five consecutive days. Bait was provided at the beginning of the trapping period and after every capture as a source of energy and preformed and metabolic water. Cotton was provided as nesting material to decrease temperature extremes within the trap. Animals were marked by toe amputation, weighed, sexed and examined for reproductive and physiological condition.

Anderson's suggestion (in Shinn et al. 1975) to base all population estimates on the number of animals actually captured, rather than on a calculated estimate, was followed. Data were analyzed for seasonal and geographical differences in density, number of reproductive cycles per species, capture sex structure, diversity and vulnerability of a species to trap mortality. Home-range caculations were based on the determinant of the capture-point covariance matrix (Jennrich and Turner 1969). The probability $P \leqslant .95$ measures the confidence placed on all data termed "significant."

Because of the difficulty in distinguishing between two species of *Dipodomys* (*ordii* and *microps*), and their relatively low numbers, data for these species were grouped.

Results and Discussion

Length of Trapping Period

While the IBP proposes a five-day trapping period (Balph et al. 1973), Olsen (1975) supports the criticisms of Gentry et al. (1968) that five days is insufficient. Only 59% of the animals in an enclosed community were taken by Olsen in five days. To determine if new animal captures in Curlew Valley significantly decreased by the fifth day, a linear regression of the capture-extinction data for all trapping periods was calculated (Fig. 7). Although the correlation was low ($r^2 = -0.41$), the fit was significant. The regression line indicates that additional new captures were possible past the fifth day. Extrapolation resulted in an x-intercept of 6.5 days, indicating that the five-day trapping period was insufficient. Nevertheless, IBP policy was followed to supply continuity in the data-gathering process.

Density

Density was calculated by dividing the mean number of animals trapped per day by the estimated area sampled (Turner et al. 1971). Geographical and seasonal changes in density were analyzed to determine areas receiving heavy use. Areas supporting greater density may offer larger food reserves, a more diverse niche structure or greater species compatibility (e.g., a higher degree of coevolution).

The region supporting the greatest density was the ART-ATR-SIT vegetation type (Table 31).

During August, density was 24% less in the ARTTRI vegetation type, 49% less in the HAL-ART, 51% less in the AGRDES, 58% less in the off-site AGRDES type and 83% less in the ANNUALS. The vegetation types supporting the greatest density were communities composed of various proportions of *A. tridentata*. Vegetative height and density are major discernible factors between the communities composed of *A. tridentata* and those composed of grasses or annuals. Since cover is important to small mammals subjected to predation, it is hypothesized that the vegetative physiognomy is a major determinant of density distribution in Curlew.

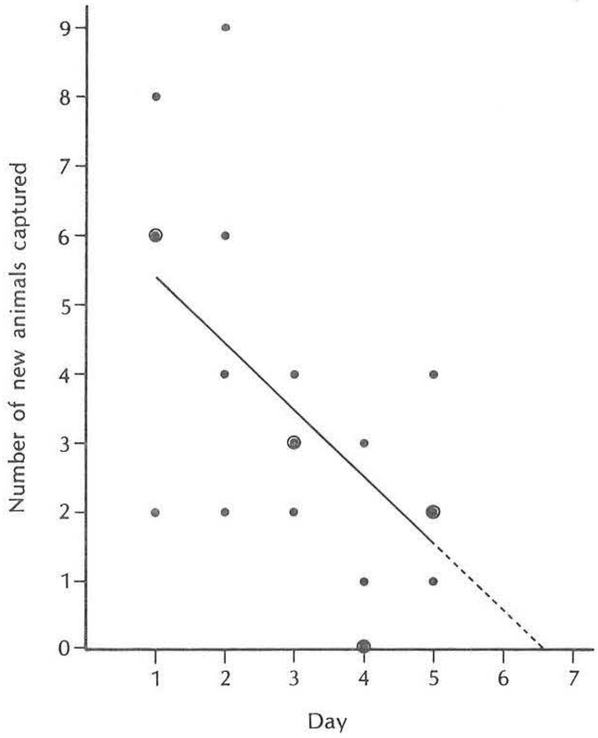


Figure 7. Linear regression of the capture-extinction data.

Vegetative physiognomy has been correlated with mammal density and diversity by various authors. Rosenzweig and Winakur (1969) hypothesized that the vegetative height diversity allowed a community of desert rodents to coexist. Montgomery (1976) correlated Great Basin rodent species density and diversity with shrub height density and diversity. Brown et al. (1972) correlated distribution and abundance of rodents with cactus density. All of the above authors postulate that protection from predation is a factor relating rodent density and diversity with vegetative architecture.

Seasonal utilization of the ART-ATR-SIT vegetation type peaked during June (Table 32). Species exhibiting peaks of abundance at this time were *Perognathus parvus, Eutamias minimus* and *Onychomys leucogaster*, representing three different trophic levels: granivore, omnivore and carnivore. *Dipodomys* density peaked in August, producing staggered times of maximum abundance between the two heteromyids. *Peromyscus maniculatus* density peaked in May, resulting in offset times of maximum abundance between the two omnivores.

The rate of immigration by a species can be dependent upon the degree of competition it encounters (Watson and Jenkins 1968; Connell 1961). It is hypothesized that the degree to which *Dipodomys* utilizes the ART-ATR-SIT vegetation association depends upon the amount of competition it receives from its trophic level analog, *P. parvus*. Further, the utilization of this vegetation type by *E. minimus* could be dependent upon the level of competition offered by *P. maniculatus*.

The AGRDES vegetation association, less diverse in plant composition and architecture than the ART-ATR-SIT vegetation type, was also monitored for seasonal density changes (Table 33). Not only was rodent density less, but species diversity as well. The only species present in appreciable numbers were those occupying different trophic levels; *Dipodomys* and *E. minimus* were very rare.

Reproduction

Reproductive activity was ascertained by inspection of female genitalia. Swollen mammary glands were indicative of reproductive activity in *Perognathus* and *Peromyscus* (O'Farrell 1975). Females possessing enlarged mammary glands were assumed to be in some phase of reproductive activity, although no distinction could be made between estrus, pregnancy or lactation. Vaginal plugs in *Dipodomys merriami* (Chew 1958), *Dipodomys deserti* (Butterworth 1961) and *Perognathus penicillatus* (Wilken and Ostwald 1968) are also indicative of reproductive activity. Plugs are formed either from sloughed vaginal tissues during estrus or, after copulation, from semen. Copulatory plugs last up to 18 days. The presence of either plug type was assumed to be a sign of reproductive activity, although no distinction between the two types was made. Testicle descension was not considered in the analysis of reproductive activity because of the difficulty encountered in distinguishing between inguinal and scrotal testes.

Table 31. Density estimates of mammals for various plant associations during August 1975 (no./ha)

Species	Vegetation types					
	ART-ATR-SIT	ARTTRI	HAL-ART	AGRDES	Off-site AGRDES	Annuals
P. parvus	1.77	0.76	0.58	0.74	0.56	0.34
P. maniculatus	0.11	0.66	0.30	0.55	0.62	0.08
E. minimus	0.37	0.56	0.64	0	0	0
Dipodomys	0.59	0.39	0.10	0.03	0.02	0.11
O. leucogaster	0.34	0.04	0	0.26	0.14	0
Total	3.18	2.41	1.62	1.58	1.34	.53

Table 32. Density estimates of mammals for the ART-ATR-SIT plant association (no./ha)*

Species	Month						
	4	5	6	7	8	10	11
P. parvus	1.06	4.31	4.79	2.47	1.77	1.98	0.16
P. maniculatus	0.47	0.76	0.68	0.46	0.11	0.07	0.28
E. minimus	0.77	0.51	1.04	0.36	0.37	0.38	0.12
Dipodomys	0.07	0	0.09	0.38	0.59	0.18	0.14
O. leucogaster	0.15	0.31	0.52	0.37	0.34	0.06	0.07
Total	2.52	5.89	7.12	4.04	3.18	2.67	0.77

* No data for September (9).

Table 33. Density estimates of mammals for the AGRDES plant association (no./ha)*

Species	Month					
	5	6	7	8	10	11
P. parvus	1.52	0.95	0.99	0.74	1.16	0
P. maniculatus	0.48	0.96	0.69	0.55	0.26	0.29
Dipodomys	0	0	0	0.03	0	0
O. leucogaster	0.08	0	0.02	0.26	0	0.02
Total	2.08	1.91	1.70	1.58	1.42	.31

* No data for September (9).

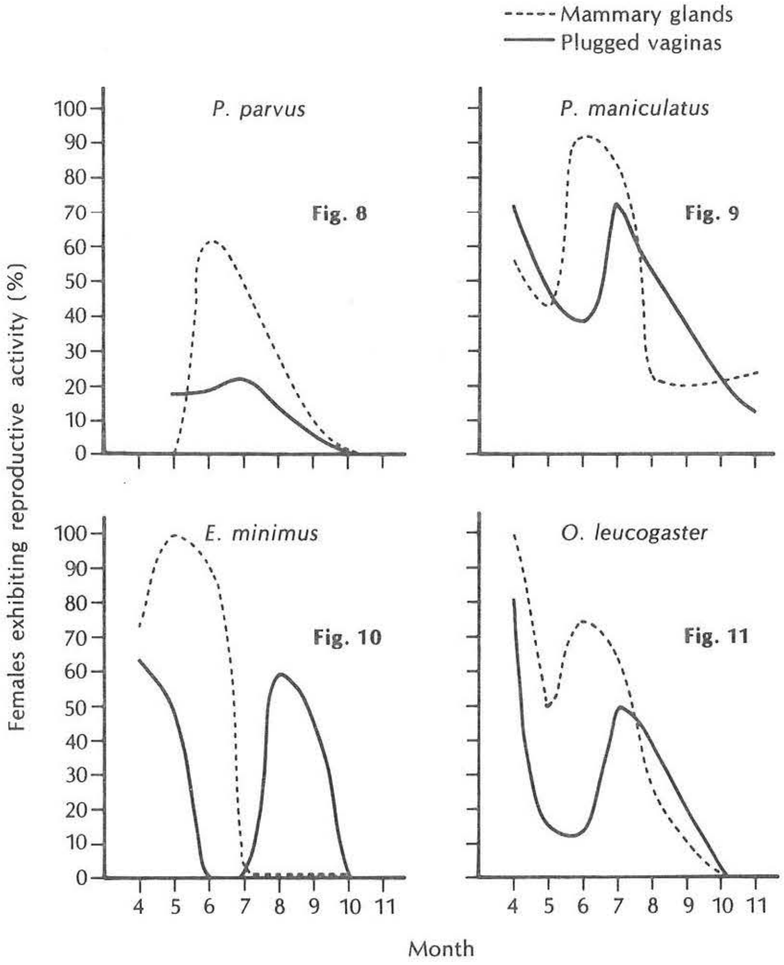
The seasonal pattern of enlarged mammary glands relative to plugged vaginas is illustrated in Figures 8-11. The percentage of *P. parvus* females exhibiting plugs was low, but a definite peak in those possessing enlarged glands was observed in June. The demonstration of only one peak in reproductive activity suggests that *P. parvus* breeds once per year. This suggestion is supported by Killpack (1956). *O. leucogaster* and *P. maniculatus* females demonstrated peaks in reproductive activity in spring and again in summer, suggesting that these species are polyestrous. While females of other species discontinue reproductive activity by October, *P. maniculatus* females continue reproducing through winter, although at a much lower rate.

Although *E. minimus* females demonstrated two peak periods of plugged vaginas, only one peak of enlarged mammary glands was noted. The discrepancy between the two indices of reproductive activity can be explained with the following hypothesis: the second peak in reproductive activity failed to produce young. If young had been produced, some indication of lactating females would have been observed.

The hypothesized failure of the second reproductive attempt might be correlated with its time of occurrence. The second peak of reproductive activity in *E. minimus* occurred a month later than the second attempts of *P. maniculatus* and *O. leucogaster*. Assuming a gestation length of 31 days (Asdell 1964), young would be born in September. Plant and soil moisture in Curlew is greatly reduced by September. Hodgkinson et al. (in press) have measured water potentials in *A. tridentata* and *A. confertifolia* as low as —50 bars. Franz et al. (1973) and Chew and Turner (1974) have associated the presence of continued rainfall and succulent vegetation with enhanced reproductive ability in desert rodents. Perhaps lack of moisture contributed to the hypothesized failure of the second reproductive attempt by chipmunks.

Capture Sex Structure

Male captures did not significantly differ from female captures. The balanced capture sex ratio infers a combination of the following: a 1:1 litter sex structure; equal mortality rates with age; and an equal capture probability.



Figures 8-11. Pattern of reproductive activity in females (%). *P. parvus* (Fig. 8); *P. maniculatus* (Fig. 9); *E. minimus* (Fig. 10); *O. leucogaster* (Fig. 11).

Trap Torpidity and Mortality

The state of an animal's health upon release was the criterion used in judging capture stress. An active animal with normal pelage appearance indicated good health. Animals exhibiting sluggish movements and matted, wet fur around the jaws and neck indicated torpor, probably temperature-induced. Moribund animals indicated an extreme amount of capture stress. The degree of stress was calculated for each species with a one-way analysis of variance. No significant differences in trap vulnerability between species groups were found. Thus, trapping does not appear to introduce pressure on one specific group.

Animals exhibiting torpor in October significantly differed from all other months. Since food is always placed within traps after each capture, torpor would not result from starvation, but rather temperature extremes. Subjection to cold night temperatures would result in torpidity as a survival mechanism.

Diversity

Small mammal diversity in desert systems has been correlated with vegetative physiognomy (Rosenzweig and Winakur 1969; Montgomery 1976). Curlew vegetative associations varying in architecture were analyzed for diversity to test this correlation. The Shannon-Weaver measure produced significantly different estimates of diversity between associations. Diversity was greatest in the ART-ATR-SIT association, while the monoculture of crested wheatgrass demonstrated low diversity. Perhaps variations in vegetative height and food sources in the ART-ATR-SIT association created greater niche diversity, allowing greater small mammal diversity.

Estimated Area Sampled

The extent to which the trapping grid actually censuses a region is considered by the estimated area sampled, which was determined in the following manner:

$$EAS = [\sqrt{(A/\pi)} + 165\ m]^2$$

"A" is the pooled home range area for that species, as calculated from the method developed by Jennrich and Turner (1969), and 165 m is the length of one side of the trapping grid. This formula differs from that erroneously presented by Anderson in Shinn et al. (1975) in that the radius of the home range circle is added to the side of the trapping grid, rather than the diameter. The results (Table 34) were used in calculation of density estimates.

Home Range

Home range is defined as the smallest subregion within which an animal spends 95% of its time (Jennrich and Turner 1969). The area of this subregion can be estimated with a minimum of three different capture points, assuming that the points are a random sample of the animal's distribution. Home range areas for each individual were calculated using a bivariate covariance matrix developed by Jennrich and Turner (1969), which assumes that animal activity is distributed according to the bivariate normal distribution. While most models, such as those proposed by Calhoun and Casby (1958) and Dice and Clark (1953) demand an assumption of circularity, Jennrich and Turner's model (1969) considers elliptical home range shapes, thus increasing the model's flexibility.

The elliptical model is not without its drawbacks. A home range area calculated from an elliptical model will be smaller than one calculated from a circular formula, thus increasing density estimates (Turner et al. 1971). Also, an elliptical model suffers from a sample size bias (Koeppl et al. 1975), although Van Winkle (1975) contends that the Jennrich and Turner model (1969) is free of such bias.

Intraspecific Comparisons of Home Range Area

Kleiber (1961) related a mammal's basal metabolic rate to its body weight with the equation $M = 70W^{.75}$. McNab (1963) proposed a similar relationship between a mammal's home range size and its body weight with the equation $A = 6.7\ W^{.63}$. McNab found no significant difference between the two exponents, and concluded that home range size is proportional to metabolic rate.

To determine if McNab's proposed relationship applied to the small mammals in Curlew, a correlation matrix was developed relating home range size to body weight. An analysis of a six-year accumulation of data showed no significant correlation between home range size and animal size ($r^2 \leqslant 0.21$). These results concur with those of Maza et al. (1973), which showed that among heteromyid rodents, home range size and body weights are not significantly correlated.

Home range size significantly differed between the sexes. Males of all species possessed a mean home range size of 1.75 ± .10 ha, while females possessed a home range size of 1.06 ± .10 ha. Thus, males exhibited a 60.60% greater home range area than females. This relationship concurs with the findings of Maza et al. (1973), which demonstrated a significant difference in home range size between sexes. Body weights of sexes did not significantly differ, so the males' larger home range size is probably not a function of body weight. Males have a greater exploratory nature (Franz et al. 1973) and conduct more frequent excursions outside the home range area (Maza et al. 1973). It is hypothesized that the male behavior pattern is a major contributing cause to the difference in home range size between the sexes.

Interspecific Comparisons of Home Range Area

Predators have larger home ranges than herbivores of the same weight, because they require a larger area in which to find food (Turner et al. 1969; Chew and Chew 1970). A correlation matrix relating home range size to species over a six-year period showed significant interspecific differences. *O. leucogaster*, an insectivore-carnivore, has a larger home range than the omnivores *P. maniculatus* and *E. minimus*, who, in turn, have larger home ranges than the granivore-herbivores *P. parvus* and the *Dipodomys* spp. (Table 35). Thus, home range area is proportional to the trophic level.

Table 34. Estimated area sampled for all species during 1975

	P. parvus	*Dipodomys*	*E. minimus*	*P. maniculatus*	*O. leucogaster*
Hectares	5.06	5.71	6.50	7.24	8.12

Table 35. Mean home range area for each species over a six-year period

	Dipodomys		*P. parvus*		*P. maniculatus*		*E. minimus*		*O. leucogaster*	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Hectares	0.21	0.46	0.59	0.23	1.50	0.25	1.64	0.20	3.10	0.37

Home Range Activity Center Distribution

Center of activity may be defined as the average of points of capture (Koeppl et al. 1975). To determine if activity centers in Curlew were arranged in specific patterns, a nearest neighbor analysis (Clark and Evans 1954) was performed. All species exhibited significantly aggregated activity centers. Aggregation is probably due to the sharing of burrow systems by individuals. Aggregated centers would provide a greater probability for interaction and communication. Increased communication would facilitate the finding of mates and the evolution of predator alarm calls. It is hypothesized that the pattern of activity center spacing may be an index of social behavior.

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SOIL SEED RESERVES

M. Merritt

INTRODUCTION

In compliance with the data-gathering efforts of the Desert Biome validation sites, soil seed reserves were sampled in Curlew Valley. Seed reserves were censused to provide data on the amount of seed biomass available for seedling production and as a food source for granivores.

METHODS

Soil samples, obtained over a span of 1-2 days, were collected four times during the summer and fall of 1975. Collection sites were 6-ha plots within the *Artemisia-Atriplex-Sitanion* vegetation type. During each sample period, 10 decihectares per hectare were chosen randomly. At the northwest corner of each decihectare, soil samples were taken in three different locations: under the nearest *A. confertifolia* plant, under the nearest *A. tridentata* plant and in a plant interspace. The technique of sampling was as follows: a metal ring, 98 ml in volume, was pushed into the soil until its edge was flush with the surface. A metal plate was then pushed under the ring until its surface was flush with the ring's subterranean edge. The soil sample was lifted and placed in labeled plastic bags for analysis.

In the lab, soil samples were placed in a Dacron organdy bag, soaked in warm water for 1 hr and kneaded under a stream of water until no soil remained and the wash water was clear. Samples were then dried on filter paper. Dried samples were examined microscopically for seeds. Unidentified seeds comprised 4.56% of the total. While the disregard of their numbers is a source of error, it is assumed that these species are not an important component of the system.

Since some seeds are inevitably lost during the washing and/or examination, known seed numbers of each species were processed to determine the percentage of loss. All numbers presented are corrected for loss.

Caloric content of seeds was determined with a Phillipson microbomb calorimeter.

RESULTS

Seeds are not distributed randomly, but are correlated with date and location (Table 36). A split-plot analysis of variance test determined that all seed species except *A. tridentata* vary in number over time. Seed numbers also differ according to their location. The majority (94%) of *A. tridentata* seeds were found under parent shrubs, suggesting poor dispersion. *A. confertifolia* demonstrated slightly higher dispersion, distributing 67% of its seeds under parent shrubs and 33.3% under *A. tridentata* shrubs. Seeds of the annual *Descurainia pinnata* were concentrated under shrubs, with only 15% found in interspaces. *Sitanion hystrix* seeds were also concentrated under shrub cover, distributing only 12% of its seeds throughout interspaces. Conversely, *Halogeton glomeratus* had no significant concentration of dispersion, being equally concentrated both under shrubs and in interspaces.

The minimum number of seeds per hectare per month (Table 37) was calculated as follows:

$$[(\text{no.}\cdot\text{sample area}^{-1}\cdot\text{location}^{-1}) \times (\text{area encompassed by location/ha})] / (\text{sample area})$$

where

sample area = 0.2126 m^2

and (Shinn et al. 1975):

interspace area/ha = 7800 m^2
A. tridentata cover/ha = 1000 m^2
A. confertifolia cover/ha = 900 m^2

Seed density estimates can be calculated only for those locations sampled; therefore, the 300 m^2 of plant cover remaining per hectare have no seed density estimates. The seed data presented herein constitute minimum estimates.

Kilograms of seeds per hectare vary markedly between species (Fig. 12). *A. confertifolia* and *S. hystrix* contribute the greatest biomass to the system, while *A. tridentata*, a dominant species in Curlew Valley, surprisingly contributes very little. *D. pinnata* exhibits a peak reserve in July, while *A. confertifolia* and *S. hystrix* seed reserves peak in August. *H. glomeratus* is not an important component of the vegetation type sampled; its fluctuations are slight and relatively insignificant.

The disparity between species is further exemplified when the amount of energy stored within the seeds of each species is examined (Table 38). *A. confertifolia* contributes the greatest energy to the system, followed by *S. hystrix* and then by *D. pinnata. A. tridentata* stores very little energy in the form of seeds. Interestingly, on a per-seed basis, *A. confertifolia* contains the fewest calories per gram of seed, while *A. tridentata* has a relatively high amount of energy content (Table 39).

DISCUSSION

Seed concentration under plant cover is common within desert systems. Chew et al. (1973) calculated that seed densities of perennials and annuals at Rock Valley, Nevada, are all significantly higher under shrubs than in interspaces. In fact, density decreases as distance from the shrub base increases. Childs and Goodall (1973) noted that seeds at Silverbell, Arizona, also concentrated at the base of shrubs. In contrast, Reichman (1976) determined that no differences in seed numbers between interspaces and under plant cover occur in Sonoran Desert soils. It is hypothesized that the widely spaced, high-canopy-height vegetative community of the Sonoran Desert may account for the seed concentration pattern observed by Reichman. It would be interesting to correlate different desert communities with their seed concentration patterns, to determine to what extent vegetative physiognomy affects the distribution of seeds.

Table 36. Significance of seed distribution as correlated with time of year and location

Species	Month	Location
ART TRI	0	*
ATR CON	*	*
DES PIN	*	*
HAL GLO	*	0
SIT HYS	*	*

* At the 95% significance level.

Table 37. Seed number estimates per hectare to 4.611 cm below ground

Species	June	July	August	October
ART TRI	793,500	924,700	254,000	247,400
ATR CON	30,163,200	51,094,500	65,033,000	63,400,300
DES PIN	8,391,300	23,174,900	12,230,000	15,631,200
HAL GLO	754,900	735,700	92,200	378,700
SIT HYS	2,570,000	3,556,900	14,906,800	11,730,000

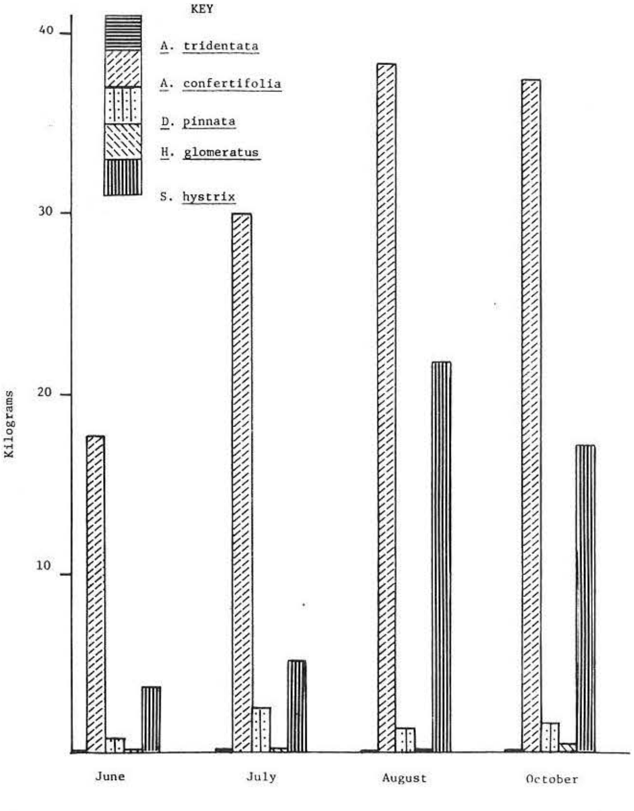

Figure 12. Kilograms of seeds per hectare, to a depth of 4.6 cm. Monthly changes in biomass are shown.

Table 38. Estimates of seed-stored energy (kcal/ha) to a depth of 4.611 cm below ground

Species	June	July	August	October
ART TRI	903	1,055	288	282
ATR CON	59,379	100,585	128,023	124,811
DES PIN	5,632	15,550	8,209	10,488
HAL GLO	1,244	1,219	150	2,282
SIT HYS	15,249	21,100	88,434	69,585
Total	82,407	139,509	225,104	207,448

Table 39. Ash and caloric content of each seed species

Species	Caloric content (cal/g) ± deviation from the mean	Ash content (%) ± S.D.
ART TRI	5,634.8 ± 36.8	6.34 (one sample only)
ATR CON	3,342.9 ± 20.7	19.65 ± 3.31
DES PIN	6,062.5 ± 8.5	7.15 ± 2.17
HAL GLO	5,185.3 ± 2.6	8.04 ± 1.62
SIT HYS	4,057.7 ± 30.6	5.44 ± 4.80

Seeds lodged under plant cover are exposed to more favorable germination conditions since the soil moisture (Patten and Smith 1974) and organic matter (Chew et al. 1973) are greater than in interspaces. Since seeds aggregate around mother plants (Major and Pyott 1966), the pattern of seed concentration under canopies is perpetuated. Thus, *D. pinnata*, a species requiring moisture to germinate, perpetuates best under plant cover. In contrast, *H. glomeratus*, a more drought-resistant species, extends into interspaces. This difference in water requirements may explain the clumped pattern of *D. pinnata* and the random dispersion of *H. glomeratus* observed in Curlew Valley seed reserves.

The minimum seed biomass in Curlew Valley varied monthly: 22.9 kg/ha in June; 38.3 kg/ha in July; 61.6 kg/ha in August; and 56.7 kg/ha in October. The Silverbell Validation Site in Arizona possesses a slightly greater seed biomass of 83 kg/ha (Childs and Goodall 1973), while the Rock Valley Validation Site in Nevada shows a relatively small seed biomass of 4.2 kg/ha (Chew et al. 1973). At the Jornada Validation Site in New Mexico, small seed biomass estimates of 5.9 kg/ha were calculated for the bajada; the playa demonstrated a greater seed biomass of 38.2 kg/ha (Goodall and Morgan 1974). Sonoran Desert soils were calculated to have 70 kg/ha of seeds (Reichman 1976).

Various authors have stated that mammalian seed predation greatly affects soil seed reserves and thus, ultimately, plant production. Mares (1976) believes mammals are the most important seed removers in North America. Reichman (1976) concurs, citing a 300% increase

Table 40. Monthly changes in mammalian energy requirements[1]

Species	Month	$\bar{x}$ kcal/day^2	Assim. %^{2}	% seeds in diet
ONY LEU	6	10.0	92.6	11^3
	7	9.7	92.0	
	8	9.7	91.5	
	10	15.0	85.5	
PER PAR	6	6.8	93.0	68^4
	7	5.7	91.0	
	8	5.9	91.0	
	10	5.6	89.0	
PER MAN	6	10.0	88.9	22^4
	7	9.4	94.6	
	8	9.9	--	
	10	14.0	82.5	
EUT MIN	6-10	13.3^6	84.8^6	34^4
DIP spp.^{8}	6	37.2^7	92.0^6	78^5
	7	17.6^7	--	
	8	6.1^7	--	
	10	2.7^7	--	

1. Unless indicated otherwise, all data are from Schreiber 1973. No standard error estimates are given.
2. Male and female averaged.
3. Schmidt-Nielsen and Haines 1964.
4. Johnson 1961.
5. Reichman 1975.
6. Schreiber and Johnson 1972.
7. Mullen 1971.
8. Dipodomys ordii and D. microps are combined.

Table 41. Minimum density* for the trappable mammal population in ART-ATR vegetation, Curlew Valley, 1975

	PER PAR	PER MAN	ONY LEU	EUT MIN	DIP spp.
Jun	4.79	0.68	0.52	1.04	0.09
Jul	2.47	0.46	0.37	0.36	0.38
Aug	1.77	0.11	0.34	0.37	0.59
Oct	1.98	0.07	0.06	0.38	0.18

*Number of individuals trapped per day per estimated area sampled

Table 42. Seed-stored energy (kcal) per hectare required by rodents*

Species	June	July	August	October
PER PAR	700	308	230	248
PER MAN	51	31	8	8
ONY LEU	19	13	12	[illegible]
EUT MIN	165	56	58	61
DIP spp	85	166	90	12
Total	1020	574	398	333

* Assimilation efficiency is included in calculations

in seed biomass when rodents and ants were excluded from Sonoran Desert plots for one year. Soholt (1973) noted that *Dipodomys merriami*, a granivore, is potentially food-limited in the Mohave Desert and concluded that desert herbivores in general are food-limited.

It was decided to correlate the amount of energy available in seed reserves with the amount of kcal required by the trappable mammal population in Curlew Valley to determine the impact mammals exert upon seed reserves. Note that seed reserves experienced predation prior to sampling, resulting in overestimation of the rodents' impact.

Energy requirements for each species per month, assimilation efficiency and the percentage of seeds in the diet are show in Table 40. Table 41 presents the minimum density estimates of mammals in Curlew Valley, 1975. When the kcal of seeds required per month by each species is multiplied by the estimated species density, the minimum seed-stored energy required by the trappable mammal population is obtained (Table 42). The percentage of energy mammals remove from the seed reserves is 1.24% in June, 0.41% in July, 0.18% in August and only 0.16% in October. Thus, contrary to the findings of researchers working in other desert systems, mammalian seed-predators in Curlew Valley appear to exert no great impact upon soil seed reserves.

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