Technical Report No. 250

ABIOTIC AND HERBAGE DYNAMICS STUDIES AT COTTONWOOD, 1971

Jerrold L. Dodd, James K. Lewis, H. L. Hutcheson and Clayton L. Hanson

Animal Science Department
South Dakota State University
Brookings, South Dakota

Animal Science Department
South Dakota State University
Brookings, South Dakota

Botany-Biology Department
South Dakota State University
Brookings, South Dakota

and

Agricultural Research Service
Rapid City, South Dakota

GRASSLAND BIOME

U.S. International Biological Program

April 1974

TABLE OF CONTENTS

ABSTRACT

Above- and below-ground herbage biomass, mulch, and abiotic factors were studied in a permanent exclosure in high range condition and in a temporary exclosure in low range condition at the Cottonwood Range Field Station, 75 miles east of Rapid City. The permanent exclosure was fenced from a pasture with a history of light grazing in 1963. This area appears to be approaching stability. The temporary exclosure was fenced from a pasture with a history of heavy grazing in the spring of 1971. Both exclosures are located on gentle, northeasterly slopes with silty clay soils. Mean annual precipitation is 15.1 inches of which about 75% is received from April through September .

Precipitation, total solar radiation, wind movement at 2 m, air temperature and relative humidity in a standard weather bureau instrument shelter were measured daily near the study areas. Evaporation and soil temperatures at 10, 20, 50, 100, and 150 cm were measured at about 3 day intervals in exclosures near to and very similar to the study areas. Soil water was determined gravimetrically on the clip plots at each sample date by 10 cm increments to 60 cm. Total soil water to 60 cm was about 15 cm on April 2 and increased to about 21 cm in both exclosures in early May. Rapid depletion began in mid-June and continued through late August with a seasonal low of about 10 cm. By October 1, the soil water level was back to about 16 cm. Precipitation for the year was 5.76 inches above normal.

Above-ground herbage standing crop was estimated on April 2, April 16, May 4, May 21, June 8, June 22, July 6, July 20, August 3, August 17, September 2, October 1, and November 12 by clipping 10 0.5 m^2 plots in each of two replications in each of the two exclosures. Botanical composition by species separated as live, recent dead, old dead, and live and dead crowns and stolons was estimated in the laboratory. The dominant species was Agropyron smithii in high range condition and Bouteloua gracilis in low range condition. In the high range condition exclosure, the standing crop of live plus recent dead of all species increased to a peak of 300 g/m^2 in early August and to a second peak of 312 on October 1 while the low range condition exclosure increased to a peak of 166 g/m^2 in early July and then declined. Mulch was vacuumed from the plots, washed, and ash determined. Fresh mulch increased from 337 g/m^2 oven dry, ash-free weight in early April to 424 in early June and then declined in the high range condition exclosure, while in low range condition it was more erratic but increased to a peak of 187 g/m^2 in early August, declined to 128 on October 1 and then increased to 188 g/m^2.

Transfer of material from the herbage to the mulch layer was measured by carefully removing fallen material from ten 15 x 15 cm plots in each replicate at intervals during the growing season. A minimum of 11 g was transferred in high range condition and 19 g in low.

Below-ground plant weight was measured by taking ten 4.2 cm cores to a depth of 30 cm in each clipped plot at each sampling date and to 60 cm on April 2, April 16, June 8, July 6, August 3, and September 2.

Cores were cut into 10 cm segments to 60 cm. In the high range condition exclosure, below-ground plant standing crop to 60 cm increased from 1395 g/m^2 oven dry, ash-free weight in early April to a peak of 1675 g/m^2 in early July. In the temporary exclosure, below-ground plant standing crop increased from 1859 g/m^2 in early April to a peak value of 2832 in early July. In both exclosures, values declined after the peak and increased until early October. Fifty-five and 57% of the total below-ground plant standing crop was in the top 10 cm in the high and low range condition exclosures, respectively. Root turnover calculated from the standing crop values was .301 and .434 for the high and low range condition exclosures, respectively. During the year below-:above-ground plant standing crop ratios ranged from 3.1 to 2.7 to 1 and from 6.2 to 10.4 to 1 in high and the low range condition exclosures, respectively.

INTRODUCTION

The Cottonwood Comprehensive Network site is located at the Cottonwood Range Field Station operated by the South Dakota Agricultural Experiment Station, 75 miles east of Rapid City in west central South Dakota. This contributing project to the Grassland Biome subprogram was initiated in 1970 comparing the herbage dynamics above- and below-ground, numbers of above-ground invertebrates, and decomposer activity in a permanent exclosure in high range condition and in a temporary exclosure in low range condition. Each exclosure was subdivided into two replications. The exclosures were located in the pastures of a summer grazing study with cattle initiated in 1942. The current phase of this study is South Dakota Agricultural Experiment Station project 539 directed by James K. Lewis. The climate, vegetation, pasture locations, stocking rates, and bibliography from 1942 through 1969 were reported by Lewis (1970a).

The permanent exclosure in high range condition containing about 5 acres was fenced in 1963 from pasture three which has been lightly grazed and is now in good + range condition (Fig. 1). The exclosure is located on a gentle northeasterly slope with silty clay soils typical of the area. This exclosure was slightly enlarged and gravel placed along the west and north sides in 1970. The vegetation and mulch appear to have reached approximate stability following exclusion from grazing. Vegetation pattern appears to be due primarily to succession following pocket gopher activity. The temporary exclosure adjacent to the previous year's temporary exclosure and containing about 2 acres was fenced in 1971 from similar soils and slope in pasture one which has been heavily grazed and is now in fair - range condition. Special care was taken to collect as much data on the same plots within treatments at the same time as possible.

Small mammal studies were conducted in pasture three outside the permanent exclosure on a grazed area with similar vegetation and soils but with more variation in topography. Bird studies were conducted on larger grazed areas in both pastures one and three.

A portion of the abiotic data was collected by Clayton Hanson, Agricultural Research Service, in connection with line project S. Dak. C-69-1 entitled "Evapotranspiration from native rangeland" and line project S. Dak. C-62-1 entitled "Determination of the relationship between intensity of grazing and runoff from rangeland on fine-textured soils." Locations of these study areas are shown in Fig. 1.

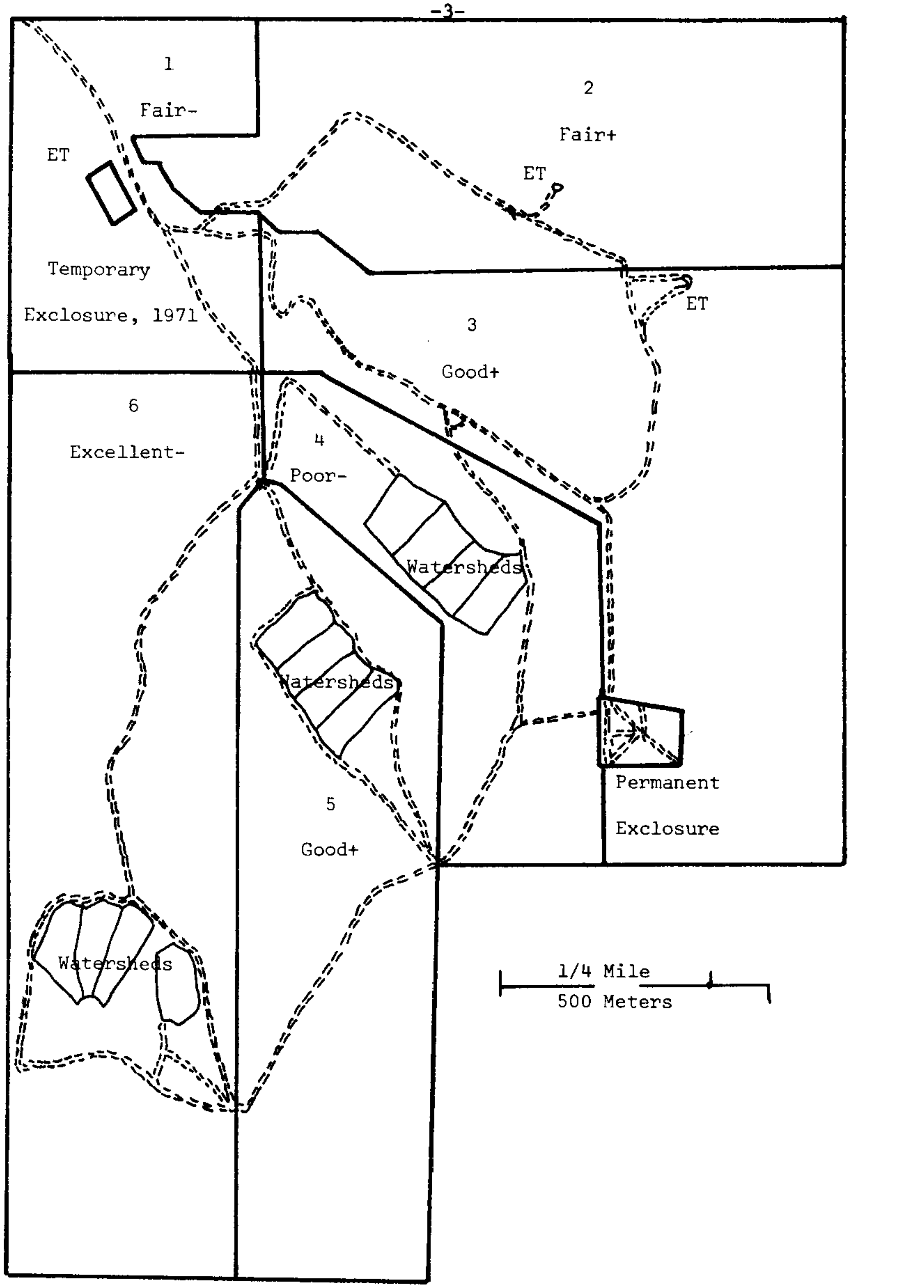

Fig. 1. Map of the summer grazing study pastures showing pasture number, range condition, location of Grassland Biome permanent and temporary exclosures, evapotranspiration plots, experimental watersheds, and trails. Cottonwood, 1971.

ABIOTIC STUDIES

Climatic and Microclimatic Studies (Clayton L. Hanson and Jerrold L. Dodd)

The data for this section of the report were obtained from the following instrumentation:

A. Evapotranspiration plot, pasture two

Air temperature and relative humidity data were obtained from a recording hygrothermograph that was in a standard U. S. Weather Bureau instrument shelter.

The two meter wind data were obtained from a direction and velocity recording anemometer. The one meter wind data were obtained from a totalizing anemometer.

Incoming radiation was recorded with an Eppley pyrheliograph at the evapotranspiration plot in pasture two.

B. Evapotranspiration plots, pastures one and three

Class "A" pan evaporation, pan wind, precipitation and soil temperatures were obtained daily at about 0800. Thermocouples located in the center of the evapotranspiration plots were used to obtain the soil temperatures.

C. Watersheds

Precipitation for the ungrazed area was obtained from recording rain gages RH-3 and RH-4 in pasture four. Other data collected from the watersheds are not included.

Precipitation was above normal in April, May, September, and October and below normal precipitation in June and July (Table 1). Total precipitation was about 2 inches above normal during the growing season (April-September). The precipitation from October 1970 through March 1971 was 0.34 inches below normal.

Cumulative precipitation and Class A pan evaporation from April 1 through November 30 are shown in Fig. 2. Daily precipitation and evaporation from January 1 through November 30 is in Table 1 and Appendix Table 1. These data show that the annual evaporation was 51.29 inches. This is about 4 inches below the average evaporation at the field station headquarters (Spuhler et al. 1969).

Daily air and soil temperature, relative humidity, incoming radiation, wind, precipitation, and Class A pan evaporation are listed in Appendix Table 1. These same data are summarized by sampling dates in Table 2. These data show that the average daily maximum temperature was above 90° for the periods prior to three sampling dates. There were nine days of 100° and over. Seven of these days were in August. There was heavy precipitation prior to the early June, early September, and October sampling periods. In general, it was very dry from mid-June until the end of August.

A summary of soil temperatures by weeks from April 20 through October 15 at the 10, 20, 50, 100, and 150 cm depths is presented in Table 3. The temperature of the 20 cm depth in pasture one varied from 44° at the beginning of the season to 76° in mid-August. The 50 cm depths vary from 44° F in early May to a high of 74° about mid-August. The 20 and 50 cm depths in pasture three were 1 to 2° cooler than those in pasture one. In both pastures, the 20 cm temperature was warmer than the

Table 1. **YEARLY SUMMARY OF DAILY** PRECIPITATION (Precipitation or Runoff) **(INCHES)**[a/]

Location Cottonwood, South Dakota Period, 19 71 ~~xx18xxx~~ Station Average of rain gages RH-3 and RH-4 (Name or number)

Type of measuring equipment

Day	January	February	March	April	May	June	July	August	September	October	November	December	Remarks
1										.25		d/	
2										.09			a/ 2400 to 2400 readings.
3		.09		.03	.16								
4							.16		2.22				b/ Average of RH-3 and RH-4.
5		.01							.12				
6						.16	.08						
7									.20				c/ Average precipitation at Cottonwood Range Field Station, 1910-1967.
8	T	T							.11				
9	.03				.05	.12							
10	.01	.05			.02	.10							
11	.03					.30							
12	.01												d/ Precipitation for December, 1971, not shown here.
13													
14	T										.04		
15	T									.02	.25		
16					.15	.15				.14	.05		
17	.10		.03	.21			.09			1.10			
18		.15		.08				.14	.05	.11			Note: Snow; January through April 3 and April 26; October 28 through November 30.
19		.01		1.95							.01		
20	.12	.01		.59					.07				
21		.01	.03	.11				.23					
22			.01		.14								
23					1.39								
24				.02									
25				.04		.35	.24				.08		
26		.67	.06	.51		.11					.03		
27				.04							.10		
28			.02						.16	.09	.03		
29	.03			.05	.53	.11				.04	.03		
30	.06				.68			1.31			.01		
31	.06												
Monthly Totals	0.43	1.00	0.15	3.63	3.72	1.40	0.57	1.68	2.93	1.84	0.63		= 17.98
1970[b/] Monthly Totals	0.31	0.16	0.40	1.80	0.99	1.14	3.06	1.41	1.76	0.43	0.68	0.16	= 12.30
Annual Average[c/]	0.42	0.38	0.75	1.76	2.78	2.99	1.81	1.56	1.13	0.89	0.40	0.35	= 15.22

SWC FORM 24
FEB 1955

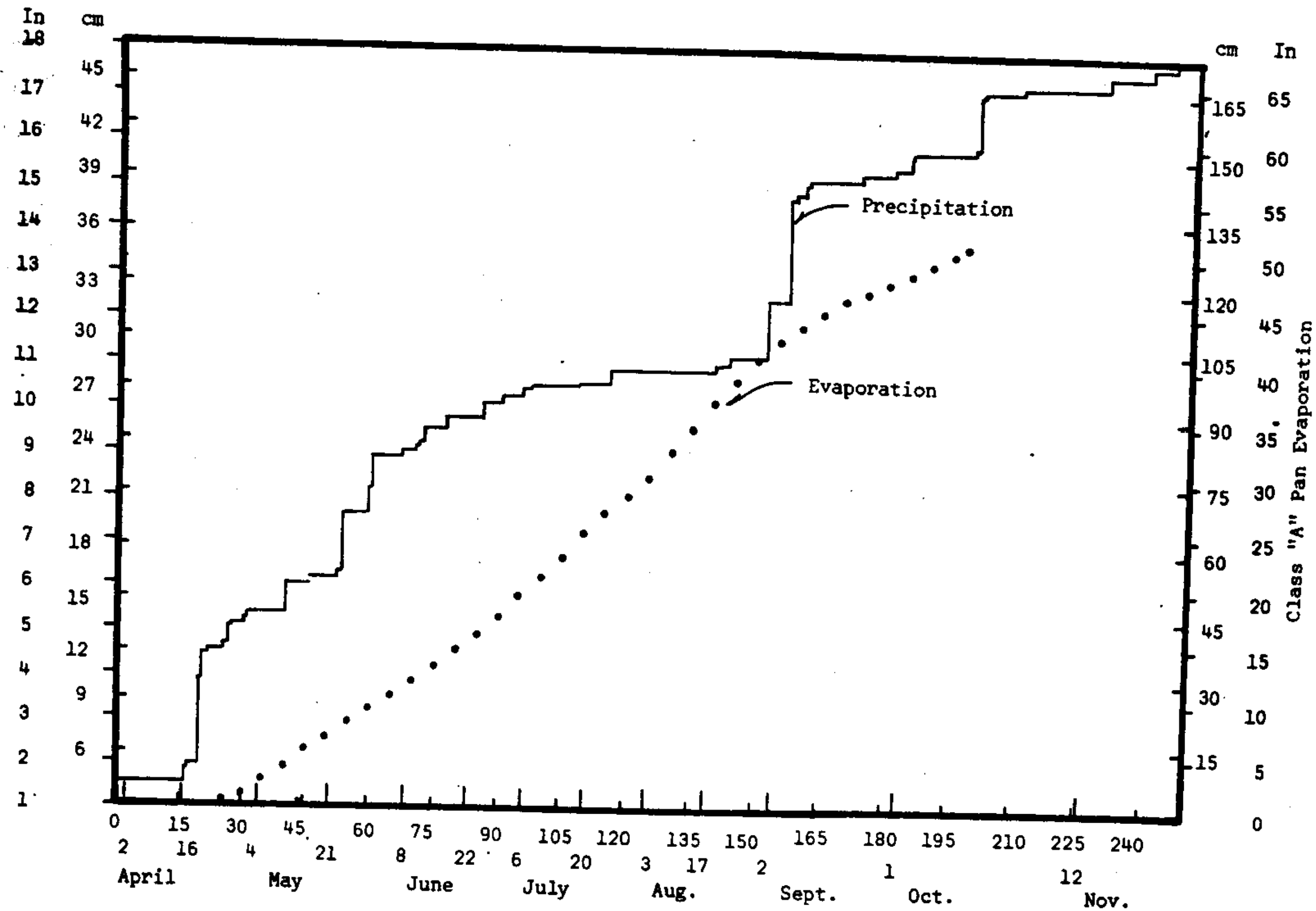

Fig. 2. Cumulative daily precipitation and class "A" pan evaporation, Cottonwood, 1971.

Table 2. Summary of Air and Soil Temperatures, Relative Humidity, Solar Radiation, Wind, Precipitation and Class "A" Pan Evaporation by Sampling Periods - Cottonwood, South Dakota - 1971

Date	Pasture 2 Data Common to Pastures 1 and 3: Air Temperature[a/] Max	Air Temperature[a/] Min	Air Temperature[a/] Av	Relative Humidity[a/] Av	Relative Humidity[a/] 11 AM	Radiation[a/] Langleys	2 meter wind[b/] MPH	Pasture 1[b/]: Evaporation Inches	Precip.[b/] Inches	Pan Wind MPH	Soil Temps 10 cm	Soil Temps 20 cm	Pasture 3[b/]: Evaporation Inches	Precip.[b/] Inches	Pan Wind MPH	Soil Temps 10 cm	Soil Temps 20 cm
3/15-4/3	46	22	34	72	59	367.04											
4/4-4/17	69	31	51	47	34	505.41											
4/18-5/5	60	40	50	76	64	393.84	6.82[c/]	.15[c/]	2.97[c/]	4.61[c/]	45[c/]	46[c/]	.15[c/]	3.13[c/]	4.24[c/]	47[c/]	47[c/]
5/6-5/22	67	43	56	67	50	537.04	7.63	.27	0.73	5.02	54	55	.26	0.84	4.66	53	54
5/23-6/9	71	50	61	78	66	502.79	7.56	.24	3.03	4.82	59	59	.24	3.13	4.41	59	59
6/10-6/23	84	58	71	74	57	618.05	4.76	.29	0.74	2.92	69	69	.28	0.67	2.40	68	68
6/24-7/7	85	58	72	65	50	607.63	2.43	.35	0.92	4.26	72	73	.34	0.79	3.63	71	71
7/8-7/21	91	56	75	50	35	602.90	6.17	.38	0.03	3.73	73	74	.36	0.06	3.19	73	73
7/22-8/4	85	51	69	53	35	554.63	6.11	.35	0.28	3.38	70	72	.33	0.27	3.36	69	71
8/5-8/18	95	61	79	48	34	565.99	6.83	.46	0.00	4.14	76	76	.45	0.00	3.79	75	75
8/19-9/2	93	59	75	53	41	492.92	5.89	.36	1.99	3.60	72	74	.36	1.86	3.28	71	72
9/3-10/1	71	46	58	66	47	387.46	6.82	.22	3.15	4.47	59	61	.21	3.16	3.86	58	60
10/2-11/12	57	33	44	70	51	281.09	8.99[d/]	.19[d/]	0.45[d/]	6.28[d/]	52[d/]	54[d/]	.18[d/]	0.47[d/]	5.53[d/]	52[d/]	54[d/]

a/ Observations from 2400 to 2400.
b/ Observations from 0800 to 0800.
c/ Data from 4/20 to 5/5.
d/ Data from 10/2 to 10/15.

Table 3. Weekly Soil Temperature (°F) in Pastures 1 and 3 for the 10, 20, 50, 100, and 150 Centimeter Depths - Cottonwood, South Dakota - 1971. Observations at 0800.

Date	Pasture 1 Depth (cm)					Pasture 3 Depth (cm)				
	10	20	50	100	150	10	20	50	100	150
4/20-4/26	44	44	44	40	38	46	47	45	42	40
4/27-5/3	42	44	44	43	41	45	46	45	43	42
5/4-5/10	51	52	50	46	43	51	51	50	46	45
5/11-5/17	54	55	53	48	45	53	53	52	48	46
5/18-5/24	54	55	54	50	47	53	54	54	51	49
5/25-6/30	55	56	55	52	48	56	56	55	52	50
6/1-6/7	61	61	59	53	50	61	61	58	53	51
6/8-6/14	66	65	62	55	51	65	65	61	56	52
6/15-6/21	70	70	66	58	53	68	68	65	58	54
6/22-6/28	72	73	69	62	56	71	71	68	62	57
6/29-7/5	70	71	69	63	58	70	70	68	63	59
7/6-7/12	72	72	70	65	59	72	72	69	64	60
7/13-7/19	73	74	72	66	60	72	72	71	65	60
7/20-7/26	73	74	72	67	61	73	73	72	66	61
7/27-8/2	66	69	70	67	62	65	67	69	66	61
8/3-8/9	73	74	71	65	62	72	73	70	65	62
8/10-8/16	75	76	73	68	62	75	75	72	66	62
8/17-8/23	73	75	74	68	63	72	73	73	68	64
8/24-8/30	72	74	73	68	64	71	72	72	68	64
8/31-9/6	69	70	72	69	65	68	69	71	69	65
9/7-9/13	62	64	66	67	65	62	64	66	66	65
9/14-9/20	57	60	64	65	64	55	58	63	65	64
9/21-9/27	55	57	60	63	62	55	57	60	62	62
9/28-10/4	54	56	59	61	61	53	55	58	61	61
10/5-10/11	51	53	57	60	60	52	54	57	60	61
10/12-10/15	53	55	57	59	60	52	54	56	59	60

50 cm temperature until early September when the 20 cm temperature became cooler than the 50 cm temperature.

Soil Water Studies (Jerrold L. Dodd)

Soil water was determined gravimetrically at 10 cm increments to a depth of 60 cm. Determinations were made on five samples per replication per treatment for each depth at each sampling date. Total soil water was calculated using average bulk density data for each depth in each replication. The bulk densities were determined from samples taken with a 4.2 cm diameter hydraulic probe on October 2, 1970. Soil bulk density data for each depth increment within each of 10 plots/replicate are presented in Appendix Table 2. Bulk density increased with depth from an average of about 1.00 g/cm^3 at the 0-5 cm depth to an average of about 1.50 g/cm^3 at the 50-60 cm depth. Little or no difference was evident between the grazing treatments.

Fig. 3 shows the change in total soil water to a depth of 60 cm between sampling dates for the exclosures in high and low range condition. Only small differences between treatments are apparent for most of the sampling periods. Both treatments held about 15 cm total water (0-60 cm depth) on April 2 and peaked at about 21 cm in early May. A rapid rate of soil water depletion began in mid-June and continued through late August to the seasonal low of about 10 cm. By October 1 the soil water level had built back up to about 16 cm.

Total soil water is summarized by treatment and depth increment in Table 4.

Due to mechanical failure soil water data were not included for the November 12 collection date.

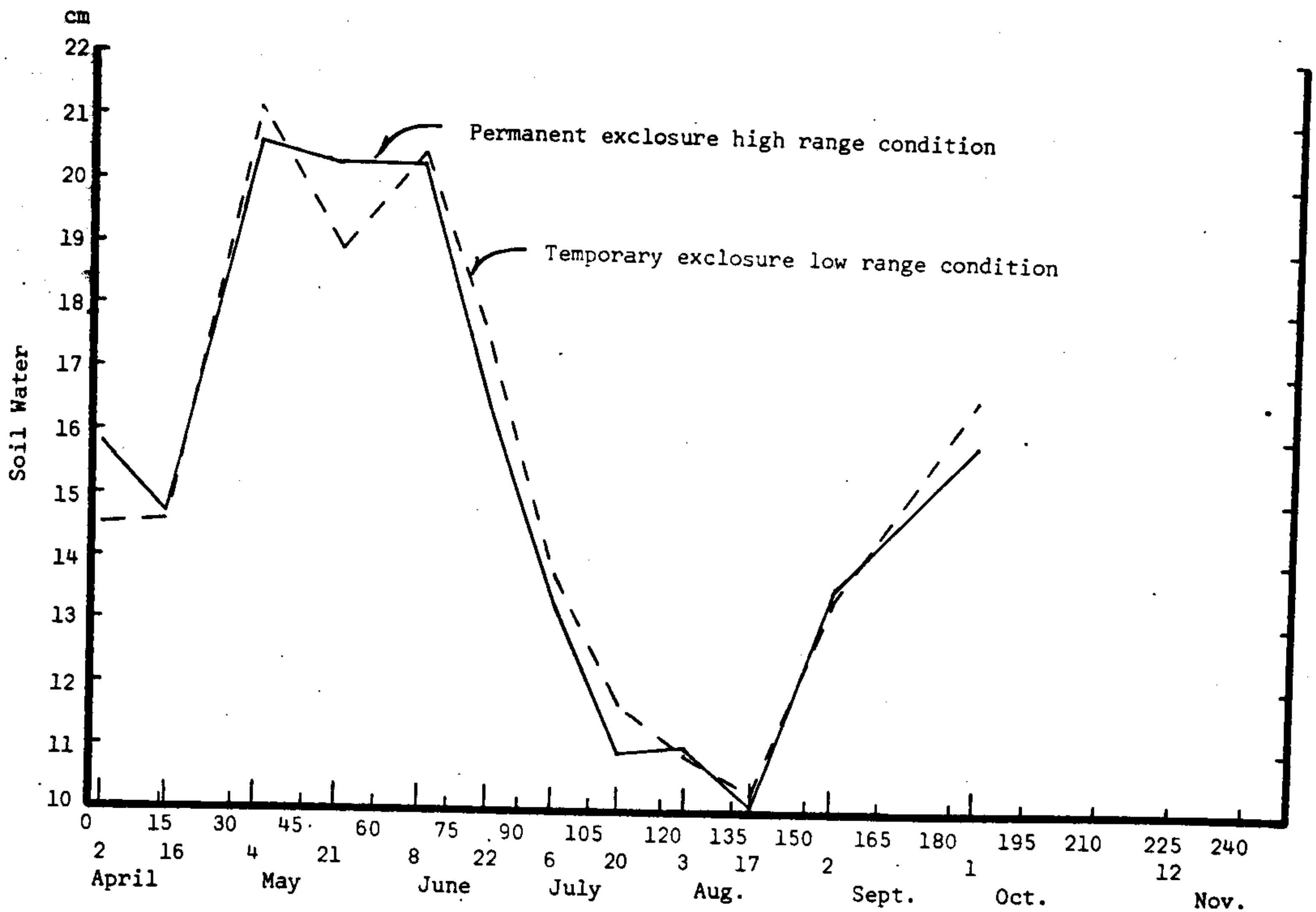

Fig. 3. Total soil water, 0-60 cm, Cottonwood, 1971.

Table 4. Total Soil Water (cm) by Depth, Treatment, and Sampling Date, Cottonwood, 1971a/

Month	April		May		June		July		August		Sept.	Oct.
Day / Depth cm	2	16	4	21	8	22	6	20b/	3	17	2	1
Permanent Exclosure High Range Condition												
0-10	3.23	2.47	3.43	2.48	3.04	1.91	1.43	0.94	0.96	0.87	3.04	2.37
10-20	3.19	3.22	3.79	3.33	3.58	2.65	2.11	1.78	1.89	1.65	2.30	3.52
20-30	2.45	2.39	3.65	3.55	3.55	2.76	2.25	2.01	1.96	1.80	1.92	3.14
30-40	2.53	2.36	3.77	3.86	3.77	3.08	2.51	2.19	2.12	1.97	2.10	2.57
40-50	2.23	2.08	3.11	3.56	3.36	2.98	2.44	1.96	2.00	1.85	2.00	2.10
50-60	2.21	2.16	2.85	3.55	3.04	3.03	2.52	2.00	2.09	1.93	2.12	2.17
0-60	15.84	14.68	20.60	20.33	20.34	16.41	13.26	10.88	11.02	10.07	13.48	15.87
Temporary Exclosure Low Range Condition												
0-10	3.17	2.80	3.50	2.32	2.86	1.84	1.75	1.19	1.20	1.01	2.89	2.63
10-20	2.64	3.09	3.66	3.16	3.50	2.57	2.13	1.85	1.78	1.67	2.32	3.25
20-30	2.16	2.27	3.86	3.62	3.83	3.05	2.33	2.04	1.94	1.88	2.10	3.34
30-40	2.01	2.14	3.57	3.42	3.60	3.16	2.29	1.99	1.89	1.82	1.99	2.60
40-50	2.20	2.16	3.52	3.44	3.50	3.44	2.61	2.21	2.05	1.95	2.06	2.62
50-60	2.28	2.15	3.04	2.97	3.16	3.38	2.67	2.35	2.05	2.00	2.04	2.15
0-60	14.46	14.61	21.15	18.93	20.45	17.44	13.78	11.63	10.91	10.33	13.40	16.59

a/ Values are means of 5 cores per replicate, 2 replicates per treatment.
b/ Values for this date are means of 5 cores per replicate, 1 replicate (II) per treatment.

A comparison of the soil water changes in 1971 with those of the 1970 growing season (Technical Report 111) indicates that 1971 was by far the most favorable year. Total soil water was near 21 cm for both treatments in both years in early May. High rates of soil water depletion began immediately after this date in 1970 but were delayed until late June in 1971. During both years soil water levels near 10 to 11 cm were reached in August. Recovery from the late summer lows was made by early September in 1971 but not until early November in 1970. In summary, both years had severe mid-summer soil droughts, while 1971 had higher soil water levels of longer duration in spring, early and late summer, and fall.

HERBAGE DYNAMICS

Methods and Procedures (James K. Lewis, Jerrold L. Dodd, and H. L. Hutcheson)

Field procedures

1. Exclosure layout. Because of the small size of the permanent exclosure and the need to use wheeled vehicles, access trails were made and plots were located within each replication by restricted randomization along access trails (Fig. 4). No plot was allowed adjacent to an existing plot. All plot locations in the permanent exclosure were permanently marked with 3/8 x 12 inch rods and labeled with metal eartags. Plot locations were mapped and a permanent record is kept. Plot locations more than one plot width off of the access trails are available for selection after the first row has been used. In this way a minimum area is damaged by trampling and vehicle use. In the temporary exclosure in low range condition alleyways were provided for travel and the plots were marked for one year only (Fig. 5).

2. Sampling dates. Ten plots were sampled in each replication at each sample date. Two days were allotted for field sampling. One replicate of each treatment was sampled one day and the other replicate the following day. Above-ground herbage and mulch samples were taken approximately biweekly in April, May, June, July, and August and approximately monthly in September, October, and November for a total of 13 sample dates. Below-ground plant biomass samples were taken at each sampling date except in November to a depth of 30 cm and on 6 of these dates to a depth of 60 cm.

3. Routine. A flow chart of the field operations is shown in Fig. 6. Plots were located prior to the sampling date and the Quick Traps were hung on their tripods by 4 to 8 p.m. M.S.T. of the day before sampling.

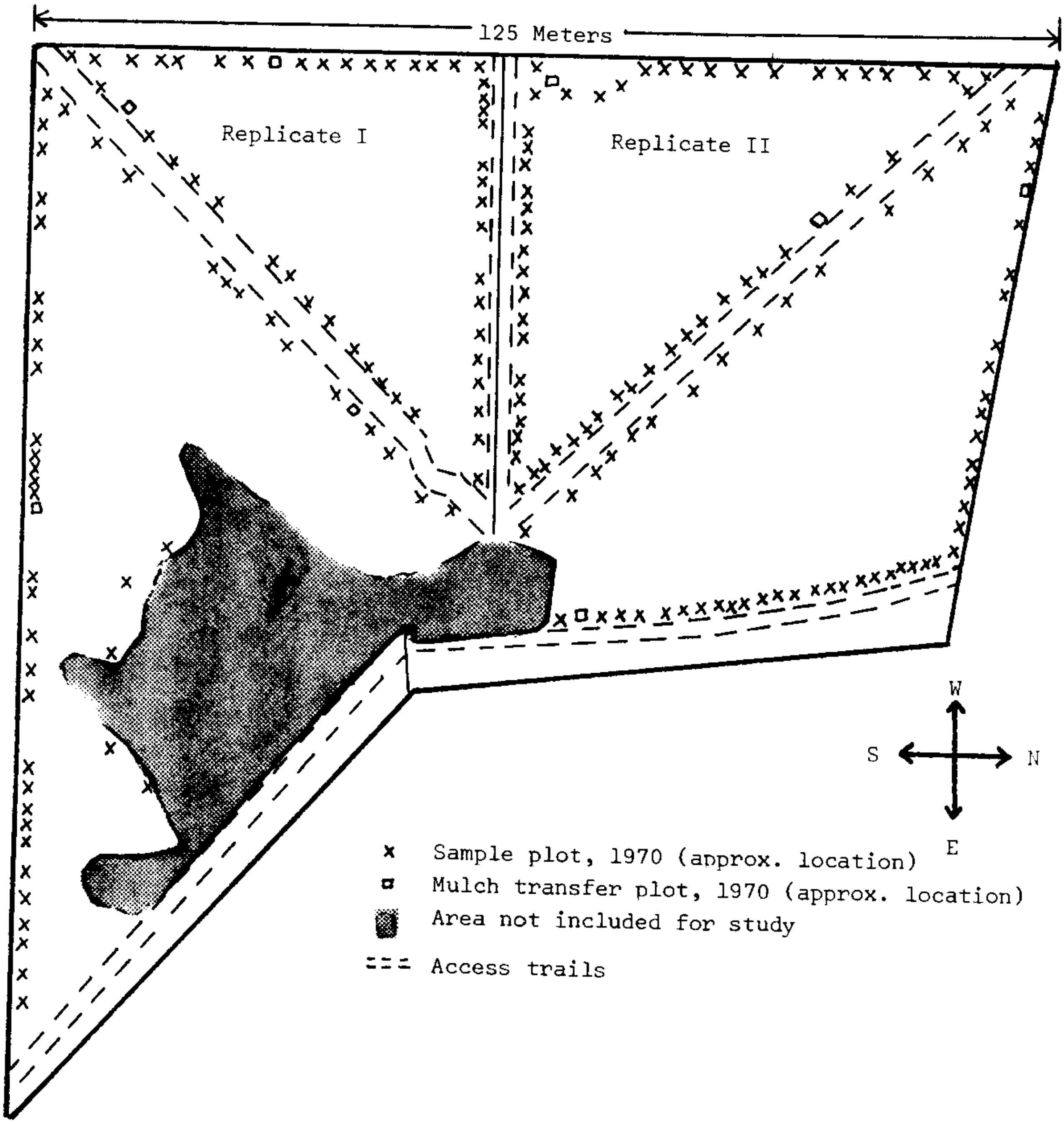

Fig. 4. Map of the portion of the permanent exclosure in high range condition used for sampling showing replicates, access trails, and typical plot locations along access trails. Cottonwood, 1970. Plot locations for 1971 are not shown but are similarly located in second and third tiers of plots inward from access trails.

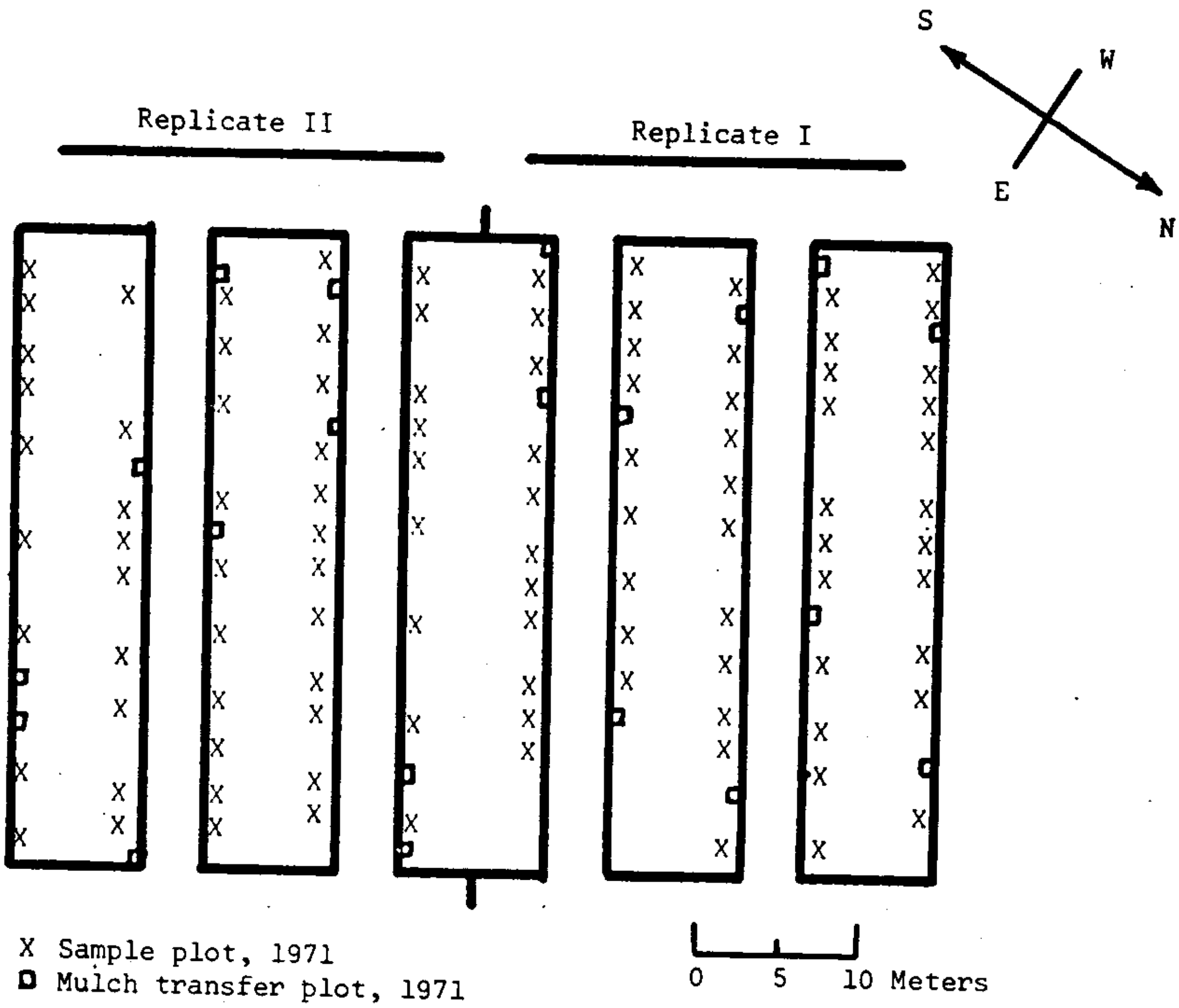

Fig. 5. Map of the temporary exclosure in low range condition showing alleyways, sampling areas, and typical plot locations, Cottonwood, 1971.

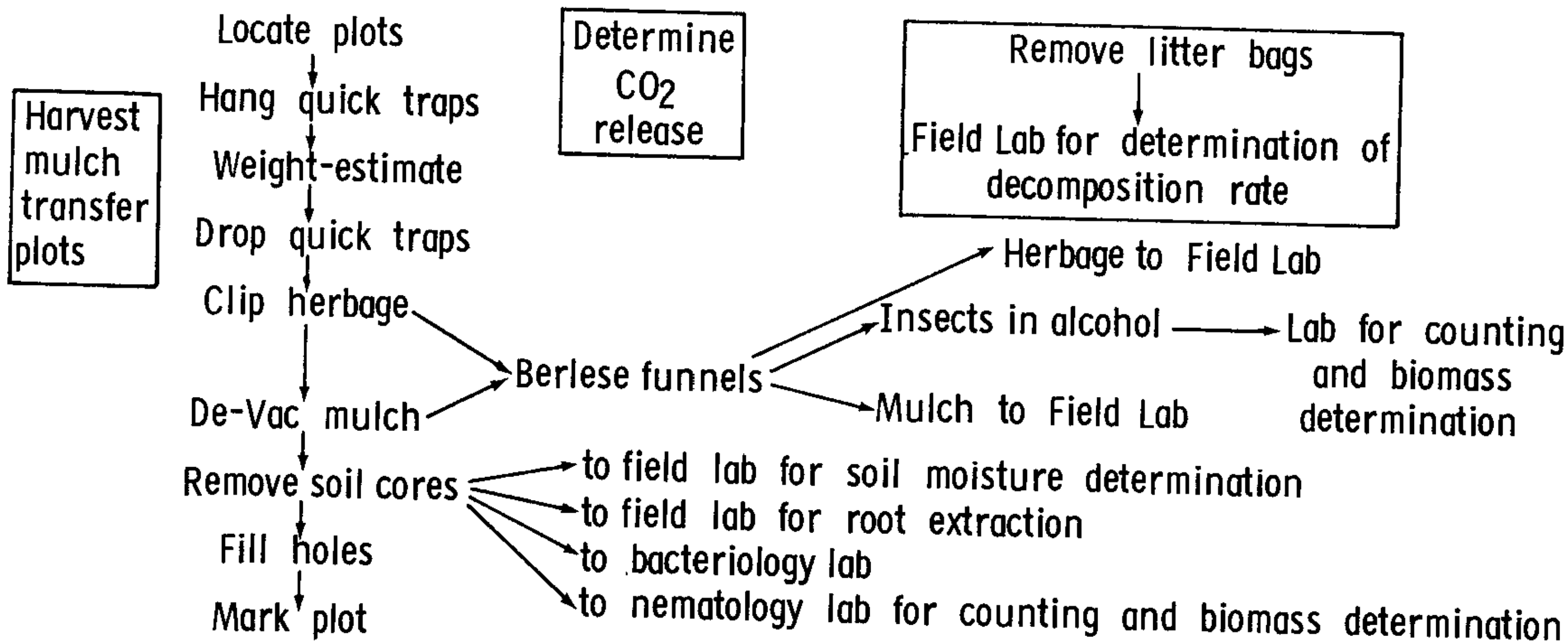

Fig. 6. Flow chart of field sampling operations. Cottonwood, 1971.

Plots beneath the Quick Traps were then weight-estimated. Other plots were weight-estimated immediately before or after the two-day sampling period. Quick Traps were dropped at 9 a.m. M.S.T. (traps were not used on April 1 or in November). Precise plot alignment was possible by using a circular plot frame when estimating and clipping inside the circular Quick Trap. In 1970, high winds drifted the Quick Traps and prevented exact register of the plots weight-ranked and the plots clipped. Accordingly, in 1971, a nylon cord was stretched from a pin in the center of the plot to the tripod and when released the trap slipped down the cord to provide better alignment. Herbage inside the trap was clipped to ground level with electric shears and placed in a paper bag inside the trap. The mulch was vacuumed with the De-Vac. The bag of herbage and the De-Vac bag of mulch were taken to the laboratory for arthropod extraction in berlese funnels. When below-ground biomass and soil moisture were sampled, a tractor-mounted hydraulic core sampler was positioned over the plot and one or more 4.2-cm or 6.5-cm cores were removed, sectioned, and placed in polyethylene bags. The holes from which the cores were removed were later filled with soil from a similar site and the plots were marked. Litter bags located on transects within each replicate were removed between sample dates for convenience. Transfer plots were read between sample dates.

4. Above-ground herbage biomass. Ten 0.5 m^2 plots were weight-estimated and clipped in each replication in each treatment for a total of 40 plots from June on. Five times as many plots were weight-estimated as were clipped, making a total of 160 that were weight-estimated only and 40 that were weight-estimated and clipped at each sample date.

See section entitled Above-Ground Herbage Biomass: Field, Laboratory, and Analytical Procedures for details.

5. Mulch. After clipping the mulch was thoroughly removed by vacuuming on each of the 10 plots per replicate and bagged in prelabeled paper bags.

6. Below-ground plant biomass. Ten 4.2-cm or 6.5-cm cores were taken at all sampling periods from April through October to a depth of 30 cm using a hydraulic coring machine mounted on a tractor. Samples were taken to 60 cm on April 1, April 16-17, June 8-9, July 6-7, August 3-4, and September 1-2. The 6.5 cm diameter tube was used when ground conditions permitted, but otherwise the 4.2 cm tube was used. The cores were removed from the tube, sectioned into 0-10, 10-20, 20-30, 30-40, 40-50, and 50-60 cm increments, bagged in polyethylene bags, labeled, and then frozen until the below-ground plant parts were washed from the soil cores in the laboratory.

Laboratory procedures

1. Routine. A flow chart of laboratory operations is presented in Fig. 7. Detailed procedures as well as departures from these operations from May through July are described below.

2. Above-ground herbage biomass. See section entitled Above-Ground Herbage Biomass: Field, Laboratory, and Analytical Procedures.

3. Mulch. Some mulch was contained in the above-ground herbage biomass samples; however, the major part was removed from the plots by vacuuming. After this material was removed from the berlese funnels, it was stirred vigorously in a 12 liter vessel. The floating material was removed, oven-dried, and weighed. A subsample was taken from

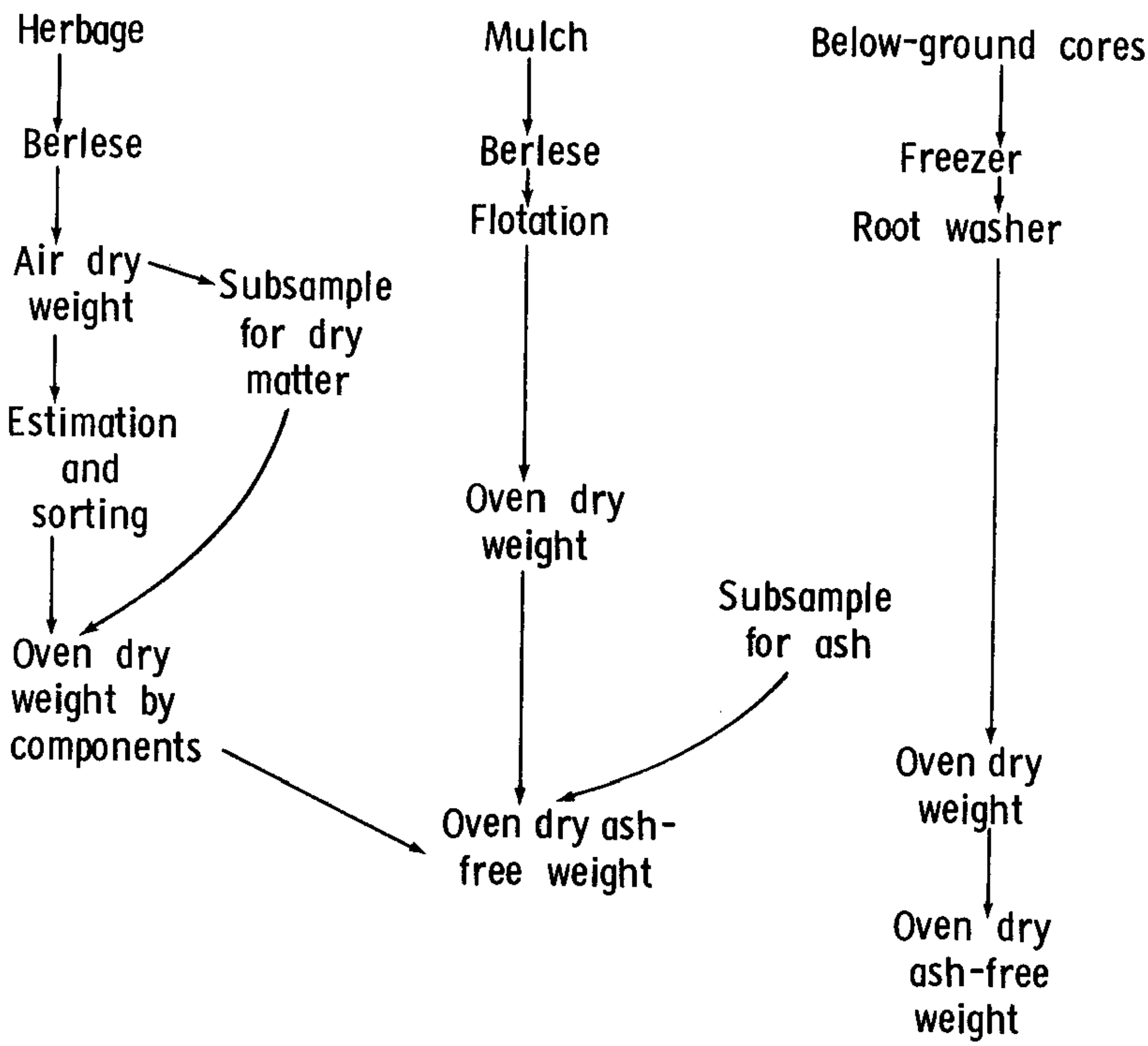

Fig. 7. Flow chart of laboratory operations in herbage dynamics. Cottonwood, 1971.

each sample and composited by replicate. Ash determinations (800 C for 1 hour) were made on two samples from the composite sample after thorough mixing. Ash-free mulch was computed by combining the mulch content estimated in the herbage samples with that weighed in the mulch samples and multiplying the sum by the organic matter proportion (1 - ash proportion).

4. Below-ground plant biomass. Soil core segments were removed from the freezer and allowed to thaw. They were partially crushed and placed into individual cylinders of a root washer designed and constructed at South Dakota State University. Each root washer has six cylinders mounted on a bar. Each cylinder has removable 32 mesh brass screen caps on each end and is large enough to hold a fragmented 4.2 x 10 cm core segment easily. An electric motor delivers power through a washing machine transmission to raise and lower the cylinders into a water bath with a stroke of about 10 cm and a cadence of about 75 strokes per minute. Plastic wastebaskets were filled with about 12 liters of warm (about 38 C) water containing commercial Calgon (sodium hexametaphosphate). One hundred g Calgon were added to the wash water of the 0-10 and 10-20 cm segments, 80 g to the 20-30 cm segment, 60 g to the 30-40 cm segment, and 40 g to the 40-50 and 50-60 cm segments. Approximately 75 to 90 minutes washing was required to remove all but the most stubborn soil peds. Sand and very resistant small peds in some cores did not pass the 32 mesh screen during this time. The lower cap on the cylinder was removed under water so that the plant material in the cylinder would float and not fall into the wash water. The cap was set aside until the cylinder was emptied. The cylinder was brought to the surface and the plant material transferred to a piece of 32 mesh brass screen on a window screen

over a sink. Peds were crushed and roots washed carefully and removed by hand. Some small roots did pass through the 32 mesh screen and were floating in the wash water. Accordingly, the wash water was carefully poured through the screen, thus collecting all of the material on one screen. The label was transferred and the washed sample was dried at 65 C for a minimum of 4 hours.

After drying, the samples were removed from the screen, placed in crucibles, weighed, ashed, and reweighed. The entire material from each increment of each core was placed into pre-weighed crucibles, oven-dried overnight, weighed to the nearest .01 g, and ashed at 800 C for 1 hour and weighed again. Weight loss of 34 samples which had been ashed at 600 C for 4 hours was negligible when ashed for an additional 1 hour at 800 C.

Above-Ground Herbage Biomass: Field, Laboratory, and Analytical Procedures

Field procedures

1. Each important component or group of components was field weight-estimated on a fresh weight basis (X_i^F) in 50-100 0.5 M^2 circular plots per replicate per sampling date per treatment (Stage 1 Sample). A field weight estimate form is shown in Appendix B1. *Agropyron smithii*, *Buchloe dactyloides*, *Bouteloua gracilis*, *Carex eleocharis* and *Bromus japonicus* were always estimated separately. For AGSM, estimates were made of live, recent dead, and old dead. For BUDA and BOGR, live and recent dead were estimated separately, but old dead was estimated only for BUDA + BOGR because of the difficulty in distinguishing between the species at this stage. Live and recent dead were estimated for CAEL; however, old

dead was so rare that it was not recorded. Only live BRJA was recorded. Other species were estimated separately if they were important at a given sample date. Otherwise, they were lumped as Miscellaneous.

2. A subsample of 10 of these plots per replicate per sampling date per treatment was clipped with electric shears (Stage 2 Sample) to obtain regression data to predict the clipped oven-dry component weight from the field estimates.

3. The clipped material was placed in berlese funnels to extract the arthropods.

4. The clipped plots and the field weight-estimated plots were organized into data sets which were thought to be sufficiently uniform that neither the field nor the laboratory weight estimates of a component would have regression coefficients or intercepts that would differ significantly from one sample date to the next (Table 5). Hopefully, this objective was accomplished by grouping plots from sampling dates in which the vegetation appeared similar into data sets within treatments within estimators. In no case were the estimates of plots from the high and low range condition treatments placed in the same data set, nor were the estimates of different observers placed in the same data set.

The number of field weight plots in a data set is represented by n, and the number of clipped plots in Stage 2 as n_2.

Laboratory procedures

1. After the herbage material was removed from the berlese funnels and grouped into data sets, the air-dry total weight of each plot was determined and at least one plot from each day of laboratory estimation was oven-dried to determine dry matter percentage.

Table 5. Description of Data Sets Into Which Herbage Samples Were Grouped For Estimation of Component Weights - Cottonwood, 1971

Data Set	Treatment	IBP Sampling Dates	Number Plots Estimated	Number Subsamples Processed	Estimator and Code
01	Permanent, high	Early and late April	20	5	Herndon 61
02	Temporary, low	Early and late April and May	100	11	Erdmann 62
03	Permanent, high	Early and late May and June	80 30[a/] 110	9	Seager 63
04	Temporary, low	Early and late June, late July, late August, and early October	100 30[a/] 130	10	Erdmann 62
05	Permanent, high	Late July and August, early October	60	6	Seager 63
06	Permanent, high	Early July, August, September, and November	80 60[a/] 140	9 2[a/] 11	Herndon 61
07	Temporary, low	Early July, August, September, and November	80 60[a/] 140	8 2[a/] 10	Erdmann 62

a/ Samples from similar vegetation but on grazing diet study plots.

2. After weighing, the clipped plot material was spread over a well-lighted, smooth surface ruled in squares and the weight of blocks of components (indicated on the attached form) were estimated in such a manner that the block totals equaled the plot weight. A running total was carried in the manner of percentage estimates rather than allocating weight differences to different blocks. Individual components were estimated in such a way that they equaled the weight of the block. Laboratory estimates of components on the entire group of clipped plots are represented as X_i^L. Field weight estimates of these components on the clipped plots are represented as X_i^f. In addition to the above-ground herbage biomass components that were weight-estimated in the field, the clipped material contained live and dead crowns and stolons, fresh mulch, humic mulch, small amounts of soil, and often contained lichens. In some cases perennial live parts of Opuntia spp. and half-shrubs may have been included.

3. After all plots in a replicate within a date within a data set were weighed and estimated, one or more were chosen at random (Stage 3 Samples) to obtain regression data to predict the separated component weights from the plot estimates. About 10 plots per data set were chosen.

4. Each of the selected plots was spread evenly over the squares to a density convenient for estimation. Size of the squares was chosen so that about 10 squares were covered by each plot. Each square was carefully delineated and the total contents weighed and sacked. Then the weight of each block of components in each square was estimated in such a way that the blocks totaled to the weight of the square. Then the components in each block were estimated in such a way as to sum to the

block total. After all of the squares were estimated, one square was chosen at random (Stage 4 Sample). The contents of this square were hand-separated to a very small residue. The residue was weighed, its components estimated to total to the residue weight and this weight added to the separated component weight to equal the actual separated weight. The laboratory weight estimate form and the data format code for the laboratory estimates are shown in Appendices B2 and B3, respectively.

Experimental and sampling design

1. The experimental design was completely randomized with subsampling. All effects were fixed.

2 treatments, T_t where t = 1,2

9 sampling dates, H_h where h = 1,2---9

2 replicates/treatments, R_r where r = 1,2

2. Sampling design. The replicates were sampled with 0.5 M^2 circular plots at each sampling date. The plots were organized into data sets with 1 field estimator, 1 laboratory estimator, and similar vegetation. Data sets were planned so that the assumption seemed reasonable that there was no significant difference between regression coefficients or intercepts between sampling dates within a data set. Within each data set 4 stage sampling with prediction was used. Sampling stages with pertinent statistics are shown below.

a. First Stage Sample

N_{drh} = total number of available 0.5 M^2 circular plot locations in the hth harvest date in the rth replicate of the dth data set, where h = 2,3,4; r = 1,2; d = 1,2---6. N_{drh} is large.

n_{1drh} = number of plots chosen at random from N_{drh} for weight estimation at the first stage.

f_{1drh} = sampling fraction for stage 1 = <.01.

X^F_{drhik} = field estimated weight of the kth component of the ith plot in the stage 1 sample of n_{1drh} plots, where k = 1,2---k herbage components, i = 1,2---10 plots.

$\bar{t}_1$ = mean time required to locate field estimate and record a plot in stage 1 $\doteq$ 3 minutes.

b. Second Stage Sample

n_{2drh} = number of plots subjectively chosen from n_{1drh} for weight estimation at the second stage = 10.

f_{2drh} = sampling fraction for stage 2 for the hth date, rth replicate and dth data set = 0.2

X^f_{drhik} = field estimated fresh weight of the kth component of the ith plot in the stage 2 sample of n_{2drh} plots. For the same plots $X^f_{drhik} = X^F_{drhik}$.

W^L_{drhi} = actual air dry weight of the ith clipped plot in the stage 2 sample of n_{2drh}.

X^L_{drhik} = laboratory estimated weight of the kth component of the ith plot in the stage 2 sample of n_{2drh} plots where k = 1,2---k herbage components and k + 1---k + μ other components. $\sum_{k=1}^{k+\mu} X^L_{drhik} = W^L_{drhi}$

$\bar{t}_2$ = time required to weigh, record, spread, estimate, record and resack the herbage from a plot $\doteq$ 45 minutes.

M_{drhp} = dry matter percentage of p plots from the second stage sample n_{2drh}, where p = 1/day of estimation.

= 1,2,3.

c. Third Stage Sample

n_{3d} = number of plots selected by restricted randomization from n_{2d} for laboratory weight estimation in squares at the third stage.

One or 2 plots were selected at random at the hth harvest date from the 4th rep so that the total number of third stage plots was 5, 7, 8, 8, 6, and 6, respectively, for data sets 1 through 6.

f_{3d} = sampling fraction for stage 3 for data set d $\simeq$.01.

W^{1}_{dij} = actual air dry weight of the jth square in the ith laboratory-estimated plot in the stage 3 sample of data set d.

X^{1}_{dik} = laboratory estimated weight of the kth component of the ith plot in the stage 3 sample of data set d, where k = 1,2---k herbage components and K = 1,2---k other components. This is the same estimate as X^{L}_{drhik}.

X^{S}_{dijk} = laboratory estimated weight of the kth component in the jth square of the ith plot in the stage 3 sample of data set d, where k designates other components as well as herbage as noted above, j = squares over which the sample is spread, 1,2---c.

C $\approx$ 10, therefore equivalent field area $\approx$0.05 M^2.

$$\sum_{k=1}^{k} X^{S}_{dijk} = W^{1}_{dij}$$

X^S_{dik} = sum of the laboratory estimated weight of the kth component over all squares, j = 1,2---c, in the ith plot in the stage 3 sample of data set d.

$\bar{t}_{3d}$ = mean time required to isolate the contents of each square, record, sack, weigh, spread, estimate, and record the component weight of all of the j squares in each of the i plots of the stage 3 sample of n_{3d} ≈ 6 hours.

d. Stage 4 Sample

n_{4d} = number of squares (field equivalent ≈0.05 M^2) selected by restricted randomization from the stage 3 sample of squares, $\bar{C}n_{3d}$. One square was chosen at random from each plot in the stage 3 sample of data set d.

f_{4d} = sampling fraction for stage 4 of data set d ≈ .01.

X^S_{dijk} = laboratory estimated oven dry weight of the kth component in the jth square chosen for separation in the stage 4 sample of data set d. This is the same estimate as X^S_{dijk} from stage 3 for data set d.

Y^S_{dijk} = laboratory separated oven dry weight of the kth component in the jth square chosen for separation in the stage 4 sample, data set d.

$\bar{t}_{4d}$ = mean time required to separate the contents of one square to a residue, weigh the residue, estimate the weight of residue components, total all components to the square weight, record, and resack ≈ 4 hours.

Analyses

Programs used to process the data are shown in Appendix B4. The analyses proceeded as follows.

1. A component which was not encountered in a given plot in the first, second, or third stage sample was considered to have a true value of zero for that plot. If the component occurred in any one of the first three stages of a plot, that component was given a missing value if it was not recorded at one of the other first 3 stages. In stage 4 a sample was given a zero value if it was not found in the hand separated square. If the component was reported in the estimated square, but not in the separated square, we assumed that an error of identification had been made and that the estimated value should have been zero. Zero values were not used in the regression statistics and were not predicted.

2. Using data from stage 4 with n_{4d} squares, the regression of the separated, Y^{s}_{dijk}, on the estimated X^{s}_{dijk} weights of each of the k components in each of the j squares in each of the i plots across all harvest dates in each of the d data sets was calculated.

The sum of the separated weights of each of the k components over j squares for the ith plot in stage 3 across all harvest dates in data set d was predicted with linear regression not forced through the origin,

$$\hat{Y}^{1}_{dik} = a'^{s}_{dk} + b^{s}_{dk}X^{s}_{dik}$$

and where $a'^{s}_{dk} = C\bar{Y}^{s}_{dk} - b^{s}_{dk}C\bar{X}^{s}_{dk}$ and $b^{s}_{dk} = \dfrac{\Sigma x^{s}_{dk}y^{s}_{dk}}{\Sigma x^{s2}_{dk}}$

This is the equation for the prediction of the third stage variate $\hat{Y}^{1}_{dik}$.

3. Using the data from stage 3 with n_{3d} plots, the regression of the predicted sum of the separated square weights, $\hat{Y}^{1}_{dik}$, of each k components in i plots in the dth data set on the laboratory estimated weights of each of k components in the ith plot across all harvest dates in the dth data set (X^{1}_{dik}) was calculated.

The separate weight of each of k components for the ith plot in stage 2 in the hth harvest date in the rth replicate of the dth data set was predicted with linear regression not forced through the origin,

$\hat{Y}^{L}_{drhik} = a'^{1}_{dk} + b^{1}_{dk}X^{L}_{drhik}$

where $a'^{1}_{dk} = \bar{\hat{Y}}^{1}_{dk} - b^{1}_{dk}\bar{X}^{1}_{dk}$ and $b^{1}_{dk} = \dfrac{\Sigma x^{1}_{dk}\hat{y}^{1}_{dk}}{\Sigma x^{12}_{dk}}$

This is the equation for the prediction of the second stage variate.

4. Using the data from stage 2 with n_{2drh} plots, the regression of the predicted separated plot weight ($\hat{Y}^{L}_{drhik}$) of each of k components on the field estimated plot weights of these components (X^{f}_{drhik}) was calculated. The nonherbage components which were included in the clipped material of stages 2, 3, and 4 were not used in this regression or in the following prediction.

The separated oven dry weight of each of k components for the ith plot in stage 1 for the hth harvest date of the rth replicate of the dth data set was predicted with linear regression not forced through the origin, $\hat{Y}^{F}_{drhik} = a'^{L}_{dk} + b^{L}_{dk}X^{F}_{drhik}$, where $a'^{L}_{dk} = \bar{\hat{Y}}^{L}_{dk} - b^{L}_{dk}\bar{X}^{f}_{dk}$ and $b^{L}_{dk} = \dfrac{\Sigma x^{L}_{dk}y^{L}_{dk}}{\Sigma x^{L2}_{dk}}$. This is the equation for the prediction of the first stage variate.

5. A test for outliers was performed at each stage using the method described by Draper and Smith (1966). If an outlier was found, the prediction was recalculated without the outlier. Regression statistics were calculated for each component. The original data, number of observations, mean of the ocular estimates, mean of the "true" values, intercept, regression coefficient, residual variance, coefficient of

determination, variance of regression coefficient, predicted value, deviations from the predicted value, and probability levels for outliers were printed out for each sampling stage. A typical printout is shown in Appendix B5. The feasibility of combining data sets was tested using the method described by Steel and Torrie (1960, p. 320). Combining data sets was not feasible in 1971.

6. The precision of the predicted values for the stage 1 variate was very low, probably due to inadequate training. Consequently, predicted stage 2 variates were used in subsequent analyses as though they were hand separated.

Problems

1. Validity of the multi-stage sampling procedure.

The multi-stage sampling procedure described above has been used because of the extreme amount of time required to hand separate live and dead components of *Buchloe dactyloides* and *Bouteloua gracilis* in this vegetation. The time required to estimate the weight of various components in a 0.5 m^2 plot in the field was about 3 minutes (stage 1); the time to estimate a plot in the laboratory was approximately 45 minutes (stage 2); the time required to estimate a plot by squares (stage 3) was about 6 hours; and the time required to hand separate a single square containing herbage from about 0.05 m^2 (stage 4) was about 4 hours. The use of laboratory estimation also permitted the use of electric shears for rapid harvesting of the herbage, thus avoiding delays caused by inclement weather and the errors inherent in attempting to separate minute vegetation components in the field in a high wind, in heat or cold, or when bothered by mosquitos or flies.

The multi-stage sampling scheme was examined by R. O. Gilbert and R. J. Olson of the Battelle Memorial Institute, Richland, Washington. Their report dated January, 1972, is included as Appendix B6. Equations are given to calculate the mean biomass and to approximate the variance of the mean. Since the variances and covariances of the various predictions are included in the variance of predicted mean, it seems reasonable that the residual mean square of the analysis of variance shown in Table 6 would also provide an estimate of the variance of the predicted mean. Thus, the equations presented by Gilbert and Olson would be of greatest value to determine the components of variation within the variance of the predicted mean in order to determine the optimum allocation among sample stages. However, the residual mean square appears to be adequate to calculate the standard errors of the mean.

Table 6. Analysis of Variance of Predicting First Stage Variates, Cottonwood, 1971

Source	d.f.	Sums of Squares	Expected Value
Total	$trhn_1-1$	$SS = \sum_1^t \sum_1^r \sum_1^h \sum_1^n \hat{Y}F^2_{trhi} - C_t$	
Treatments, T	t-1	$SST = \sum_1^t \left(\frac{\sum_1^r \sum_1^h \sum_1^n \hat{Y}^F_{trhi}}{rhn_1} \right)^2 - C_t$	$\sigma^2_{\hat{Y}^F} + n_1\sigma^2_R + rhn_1\sigma^2_T$
Sampling dates, H	h-1	$SSH = \sum_1^h \left(\frac{\sum_1^t \sum_1^r \sum_1^{n_1} \hat{Y}^F_{trhi}}{trn_1} \right)^2 - C_t$	$\sigma^2_{\hat{Y}^F} + n_1\sigma^2_R + trn_1\sigma^2_R$
TH	(t-1)(h-1)	$SSTH = \sum_1^t \sum_1^h \left(\frac{\sum_1^r \sum_1^{n_1} \hat{Y}^F_{trhi}}{rn_1} \right)^2 - C_t - SST - SSH$	$\sigma^2_{\hat{Y}^F} + n_1\sigma^2_R + rn_1\sigma^2_{TH}$
Replicates, R/TH	(r-1)th	$SSR/TH = \sum_1^t \sum_1^h \left[\sum_1^r \left(\frac{\sum_1^{n_1} \hat{Y}^F_{trhi}}{n_1} \right)^2 - C_{th} \right]$	$\sigma^2_{\hat{Y}^F} + n_1\sigma^2_R$
Among Field Estimates $\hat{Y}^F$/R/TH	$(n_1-1)trh$	$SSY^F = \sum_1^t \sum_1^r \sum_1^h \left[\left(\frac{\sum_1^{n_1} \hat{Y}^F_{trhi}}{n_1} \right)^2 - C_{trh} \right]$	$\sigma^2_{\hat{Y}^F}$

$$SSY^F = \sum_1^d \sum_1^r \sum_1^h \left[\left(\frac{\sum_1^{n_1} \hat{Y}^F_{drhi}}{n_1} \right)^2 - C_{drh} \right] = \text{Total } SS\hat{Y}^F \text{ for all data sets}$$

Results and Discussion (Jerrold L. Dodd, James K. Lewis and H. L. Hutcheson)

Above-Ground Plant Standing Crop

1. Evaluation of estimation. Various regression statistics for the frequently encountered vegetation components are presented in Appendix Table 3. Coefficients of determination are summarized by important components for each data set in Table 7. Estimator Seager was less proficient than Herndon and Erdmann, probably because of a shorter training period and less experience. In general, it was more difficult to estimate small inconspicuous components such as live *Bromus japonicus* and live *Carex eleocharis* in early spring (data set 01) or the small amount of humic mulch in mid-summer in the plots in low range condition (data set 04). Confusion of *Buchloe dactyloides* and *Bouteloua gracilis* appeared to be a problem in most data sets. Better precision could probably be obtained by combining these taxa. The errors in the sampling procedure are reflected in the standard errors of the mean and in the calculated number of plots required to sample within 20% of the mean with 80% confidence. Means, standard errors and number of plots required for the important components for the permanent exclosure in high range condition are shown in Table 8 and for the temporary exclosure in low range condition are shown in Table 9. Sampling was generally adequate to samnle within 20% of the mean with 80% confidence except when the mean standing crop for a component was low (<6 g/m^2). Exceptions were total live for April 2 and total recent dead and live *Agropyron smithii* for July 6 in low range condition. Inadequate sampling of these components was probably due to erratic distribution. In high range condition inadequate sampling was achieved for

Table 7. Coefficients of Determination (R^2) for Single Square and Total Plot Estimations, Above-Ground Plant Standing Crop, Cottonwood, 1971

Treatment	Permanent Exclosure High Range Condition							
Sampling Dates	2,16 Apr		4,21 May 8,22 Jun		6 Jul, 3 Aug, 2 Sep		20 Jul, 17 Aug, 1 Oct, 12 Nov	
Data Set	01		03		05		06	
Estimator Number	61		63		63		61	
Estimator Name	Herndon		Seager		Seager		Herndon	
No. Plots	40		80		60		80	
Component	Sq.	Plot	Sq.	Plot	Sq.	Plot	Sq.	Plot
Agropyron smithii								
Live	.99	.97	.84	.41	.98	.96	.99	.97
Recent Dead					.52	.74	.98	.99
Old Dead	.88	.99	.84	.41	.70	.59	.93	.96
Bouteloua gracilis								
Live			.76	.13	.20	.58	.99	.96
Recent Dead					.35	.86	.95	.84
Buchloe dactyloides								
Live			.96	.33	.84	.71	.96	.86
Recent Dead					.01	.95	.98	.39
Buchloe + *Bouteloua*								
Old Dead	1.00	1.00	.54	.34	.01	.99	.86	.86
Bromus japonicus								
Live	.31	1.00	.99	.91	0	.09	.93	.97
Recent Dead					.96	.97	.99	.07
Carex eleocharis								
Live	.47	.76	.65	.80	.96	.32	.94	.82
Recent Dead							.79	.46
Fresh Mulch	.98	.51	.86	.93	.67	.82	.98	.97
Humic Mulch	1.00	.95	.92	.60	0	.63	.79	.20

Table 7 Continued. Coefficients of Determination

Treatment	Temporary Exclosure Low Range Condition					
Sampling Dates	2,16 Apr 4,21 May 8,22 Jun		6 Jul, 3 Aug 2 Sep		20 Jul, 17 Aug 1 Oct, 12 Nov	
Data Set	02		04		07	
Estimator Number	62		62		62	
Estimator Name	Erdman		Erdman		Erdman	
No. Plots	140		60		80	
Component	Sq.	Plot	Sq.	Plot	Sq.	Plot
Agropyron smithii						
Live	1.00	1.00	.97	1.00	.88	.94
Recent Dead			.98	1.00	.81	.95
Old Dead	.93	.87	.42	.89		
Bouteloua gracilis						
Live	1.00	.96	.95	.85	.73	.94
Recent Dead			.61	.95	.87	.50
Buchloe dactyloides						
Live	.97	.97	.33	.82	.96	.90
Recent Dead			.49	.62	.39	.57
Buchloe + *Bouteloua*						
Old Dead	.87	.90	.75	.66	.47	.97
Bromus japonicus						
Live	.96	.96	1.00	.94	.99	.97
Recent Dead			.77	.40	.99	.97
Carex eleocharis						
Live	.98	.85	.74	.43	.98	.53
Recent Dead			1.00	.90	.95	.56
Fresh Mulch	.96	.96	.68	.29	.61	.93
Humic Mulch	.68	.93	.45	.27	.98	.86

recent dead Agropyron smithii and total recent dead on June 22 where standing crop was small and data were available for only one replicate. Sampling was inadequate also for old dead Agropyron on July 20 and August 17 and for live Buchloe on August 3. Means for all 3 of these components ranged from 11 to 13 g/m^2 out of total herbage weights ranging from 286 to 323 g/m^2.

2. Herbage. A list of plant species encountered in temporary and permanent exclosures in 1971 is presented in Appendix Table 4.

Seasonal change in the live, recent dead (this year's dead) and old dead (standing dead) components by treatment for the major plant species is summarized in Tables 8 and 9 and in Fig. 8 through 19. The major species in the high range condition exclosure in decreasing order of peak standing crop were A. smithii, B. gracilis, and B. dactyloides while only the latter two were major species in the low range condition exclosure. Carex eleocharis and Bromus japonicus were the most important minor species on both treatments. Standing crop of B. japonicus was much greater in the exclosure in high range condition, while C. eleocharis was about the same in both treatments. Collectively, these two cool-season species accounted for 5 to 25% of the current year's standing crop during the season for both treatments.

The herbage dynamics of the combined total of all species is shown in Fig. 8 and 9. Seasonal changes in A. smithii are shown in Fig. 10 while those for B. gracilis and B. dactyloides are shown in Fig. 11 and 12 and Fig. 13 and 14, respectively. Fig. 14A shows the dynamics of Buchloe + Bouteloua old dead. Seasonal changes in C. eleocharis and B. japonicus

Table 8. Mean Standing Crop With Standard Error (g/m^2 oven dry; mean of 10 plots/replicate, 2 replicates/treatment) and Plots Required to Sample Within 20% of the Mean With 80% Confidence[a/] for Major Species and Categories, Permanent Exclosure, High Range Condition, Cottonwood, 1971

Sampling Date		Agropyron smithii Live	Agropyron smithii Recent Dead	Agropyron smithii Old Dead	Bouteloua gracilis Live	Bouteloua gracilis Recent Dead	Buchloe dactyloides Live	Buchloe dactyloides Recent Dead	BOGR + BUDA Old Dead	Carex eleocharis Live	Bromus japonicus Live	Total Live	Total Recent Dead	Total Dead
2 Apr	Mean g/m^2	2.6	.0	92.0	t	.0	--	--	28.0	.4	.4	8.7	.0	120.0
	Standard error	.3	.0	9.2	t	.0	--	--	4.2	.1	t	.8	.0	8.0
	Plots required	15	0	9	529	0	--	--	20	15	7	7	0	4
16 Apr	Mean g/m^2	9.7	.0	118.4	.1	.0	t	.0	36.5	t	.6	10.2	.0	154.8
	Standard error	1.3	.0	9.4	t	.0	.0	.0	3.3	t	t	1.9	.0	9.8
	Plots required	17	0	6	88	0	0	0	7	2	7	12	0	4
4 May	Mean g/m^2	32.3	.0	56.2	5.2	.0	1.8	.0	6.6	3.3	2.8	48.7	.0	62.9
	Standard error	.7	.0	1.6	.2	.0	.1	.0	.6	.1	t	.8	.0	1.9
	Plots required	0	0	1	1	0	4	0	6	1	0	0	0	1
21 May	Mean g/m^2	53.5	.0	80.9	4.7	.0	1.8	.0	8.8	2.3	3.2	71.1	.0	89.7
	Standard error	2.1	.0	3.0	.1	.0	t	.0	.6	.1	.1	1.9	.0	3.2
	Plots required	1	0	1	0	0	1	0	4	1	1	1	0	1
8 Jun	Mean g/m^2	64.1	.0	74.9	6.2	.0	7.6	.0	10.8	2.6	5.8	96.9	.0	65.9
	Standard error	1.8	.0	2.5	.2	.0	.2	.0	.5	.1	.2	4.0	.0	2.7
	Plots required	1	0	1	1	0	1	0	2	1	1	2	0	1
22 Jun[b/]	Mean g/m^2	146.0	5.9	50.7	6.3	.0	7.4	.0	9.6	2.7	13.0	188.3	5.9	60.3
	Standard error	15.3	1.9	3.1	1.1	.0	.9	.0	1.3	.2	1.3	16.4	1.9	3.6
	Plots required	5	47	2	15	0	8	0	9	1	5	4	47	2
6 Jul[c/]	Mean g/m^2	116.5	34.7	46.1	16.1	4.9	19.2	9.2	9.0	6.4	39.0	204.6	51.5	55.4
	Standard error	7.5	3.2	4.0	2.1	.8	4.8	1.3	1.3	.4	4.7	10.1	2.5	3.7
	Plots required	4	7	6	14	23	53	16	16	5	12	2	2	4
20 Jul	Mean g/m^2	119.1	59.2	13.2	12.5	6.2	7.4	8.8	8.8	6.6	.0	149.6	114.1	22.0
	Standard error	8.5	3.6	3.6	1.5	1.2	1.1	.5	.3	.2	.0	8.5	7.8	3.4
	Plots required	4	3	64	12	18	18	3	1	1	0	3	4	21
3 Aug	Mean g/m^2	100.9	115.8	18.5	12.1	14.7	10.9	10.5	4.4	6.4	.0	133.2	116.5	23.0
	Standard error	8.9	9.4	2.2	1.6	2.0	2.9	1.6	.5	.4	.0	7.0	8.0	2.0
	Plots required	7	6	13	16	16	45	20	13	3	0	2	2	7
17 Aug	Mean g/m^2	44.7	126.8	11.8	10.6	21.0	2.4	13.3	11.4	.0	.2	59.5	208.2	23.1
	Standard error	2.8	8.0	3.4	.4	1.7	.3	.4	.3	.0	.2	3.2	11.7	3.3
	Plots required	3	4	74	1	5	16	1	1	0	823	3	3	18
2 Sep	Mean g/m^2	72.1	161.6	8.3	12.3	25.0	5.0	9.5	1.3	1.3	.0	91.8	220.0	9.7
	Standard error	6.6	13.5	.4	1.5	2.9	.8	.9	.2	.2	.0	6.8	14.4	.4
	Plots required	8	6	2	13	12	21	8	22	19	0	5	4	1
1 Oct	Mean g/m^2	31.8	136.9	.0	13.4	23.0	4.0	11.8	--	8.5	5.4	64.9	194.1	.0
	Standard error	2.8	9.6	.0	.9	2.1	.5	1.0	--	.4	.5	3.5	12.3	.0
	Plots required	7	4	0	4	7	13	6	--	2	7	2	4	0
12 Nov	Mean g/m^2	26.8	130.2	7.3	1.6	38.6	2.3	18.5	.1	1.0	13.9	46.0	207.9	7.4
	Standard error	4.4	15.6	.2	.3	5.0	.2	1.7	t	.1	.9	4.6	16.6	.2
	Plots required	22	12	0	25	14	7	7	346	6	3	8	5	0

a/ Number of plots required was calculated as $N = \frac{t^2 s^2}{d^2}$ with 18 or 19 d.f. for t using two-tailed test.

b/ Replicate 1 only.
c/ Only 9 plots in replicate 1.

Table 9. Mean Standing Crop With Standard Error (g/m² oven dry; mean of 10 plots/replicate, 2 replicates/treatment) and Plots Required to Sample Within 20% of the Mean With 80% Confidence[a] for Major Species and Categories, Temporary Exclosure, Low Range Condition, Cottonwood, 1971

Sampling Date		Agropyron smithii Live	Agropyron smithii Recent Dead	Agropyron smithii Old Dead	Bouteloua gracilis Live	Bouteloua gracilis Recent Dead	Buchloe dactyloides Live	Buchloe dactyloides Recent Dead	BOGR + BUDA Old Dead	Carex eleocharis Live	Bromus japonicus Live	Total Live	Total Recent Dead	Total Old Dead
2 Apr	Mean g/m²	t	.0	.9	.7	.0	.7	.0	18.6	.8	2.1	11.9	.0	19.5
	Standard error	.5	.0	.2	t	.0	.1	.0	2.5	.1	.4	4.5	.0	2.5
	Plots required	0	0	60	6	0	6	0	16	29	40	129	0	15
16 Apr	Mean g/m²	.1	.0	.4	1.0	.0	.8	.0	28.2	1.4	2.2	8.2	.0	28.6
	Standard error	t	.0	.2	t	.0	t	.0	1.7	.1	.6	.8	.0	1.7
	Plots required	177	0	171	2	0	2	0	3	8	63	9	0	3
4 May	Mean g/m²	.8	.0	.6	2.5	.0	2.3	.0	21.9	3.9	2.8	17.7	.0	22.6
	Standard error	.2	.0	.2	.1	.0	.1	.0	1.8	.3	.3	1.1	.0	2.0
	Plots required	55	0	141	2	0	3	0	6	4	12	4	0	7
21 May	Mean g/m²	3.8	.0	.8	6.4	.0	6.5	.0	28.5	5.9	5.8	35.1	.0	29.4
	Standard error	.8	.0	.3	.4	.0	.5	.0	2.3	.5	.8	2.1	.0	2.3
	Plots required	42	0	125	4	0	4	0	6	6	16	3	0	5
9 Jun	Mean g/m²	5.2	.4	.1	31.6	.2	34.8	1.1	15.8	7.7	19.7	114.2	1.7	15.9
	Standard error	1.1	.2	t	3.1	.2	2.4	.6	1.9	.9	2.9	9.4	.7	1.9
	Plots required	40	269	353	8	388	4	280	13	11	19	6	157	13
22 Jun	Mean g/m²	3.9	.1	t	47.9	.8	44.3	2.1	11.6	8.3	25.5	152.6	3.1	11.6
	Standard error	.5	t	.0	2.3	.3	1.8	.7	.6	.6	8.8	11.8	1.0	.6
	Plots required	14	178	0	2	100	2	95	3	4	104	5	91	142
6 Jul	Mean g/m²	12.0	.0	.0	32.9	.0	73.4	.0	14.8	10.4	.0	147.3	19.0	14.8
	Standard error	4.0	.0	.0	2.9	.0	3.9	.0	1.1	1.2	.0	9.9	10.5	1.1
	Plots required	96	0	0	7	0	2	0	5	13	0	4	267	5
21 Jul	Mean g/m²	5.2	1.3	.0	28.5	7.8	45.2	19.4	7.5	5.4	.0	98.9	44.5	7.5
	Standard error	1.3	.3	.0	1.9	.6	3.2	1.3	.4	.5	.0	6.6	6.7	.4
	Plots required	53	56	0	4	5	4	4	2	8	0	4	20	2
3 Aug	Mean g/m²	5.2	1.2	.0	14.3	10.1	30.9	20.7	12.4	8.5	.0	61.5	51.5	12.4
	Standard error	.5	.2	.0	1.4	.6	2.3	1.8	1.2	.4	.0	3.6	4.4	1.2
	Plots required	23	22	0	8	4	5	6	8	2	0	3	6	8
17 Aug	Mean g/m²	4.2	4.4	t	13.9	24.0	21.6	39.4	7.1	1.6	.0	43.3	88.2	7.1
	Standard error	1.0	1.1	.0	.5	1.9	.6	3.3	.2	.3	.0	1.1	6.4	.2
	Plots required	43	56	0	1	6	1	6	1	26	0	1	5	1
2 Sep	Mean g/m²	5.3	3.1	.0	8.4	11.2	16.7	21.9	7.2	.2	.0	33.6	58.1	7.2
	Standard error	.8	.5	.0	.3	.5	.6	1.4	.7	.2	.0	1.6	5.3	.7
	Plots required	22	21	0	1	2	1	4	8	1217	0	2	7	8
1 Oct	Mean g/m²	3.2	3.5	t	17.6	9.0	33.2	29.4	7.1	4.3	.0	66.0	53.6	7.1
	Standard error	.6	.9	.0	1.0	.7	2.0	2.1	.2	.5	.0	3.4	4.0	.2
	Plots required	27	58	0	3	5	3	4	1	10	0	2	5	1
12 Nov	Mean g/m²	1.2	4.2	.1	.8	23.1	1.6	31.7	31.7	.0	.0	3.9	77.9	31.8
	Standard error	.4	.9	.1	.6	1.5	1.1	1.9	2.1	.0	.0	1.5	4.4	2.1
	Plots required	90	36	654	429	4	423	3	4	0	0	131	3	4

[a] Number of plots required was calculated as $N = \frac{t^2 s^2}{d^2}$ with 18 or 19 d.f. for t, using two-tailed test.

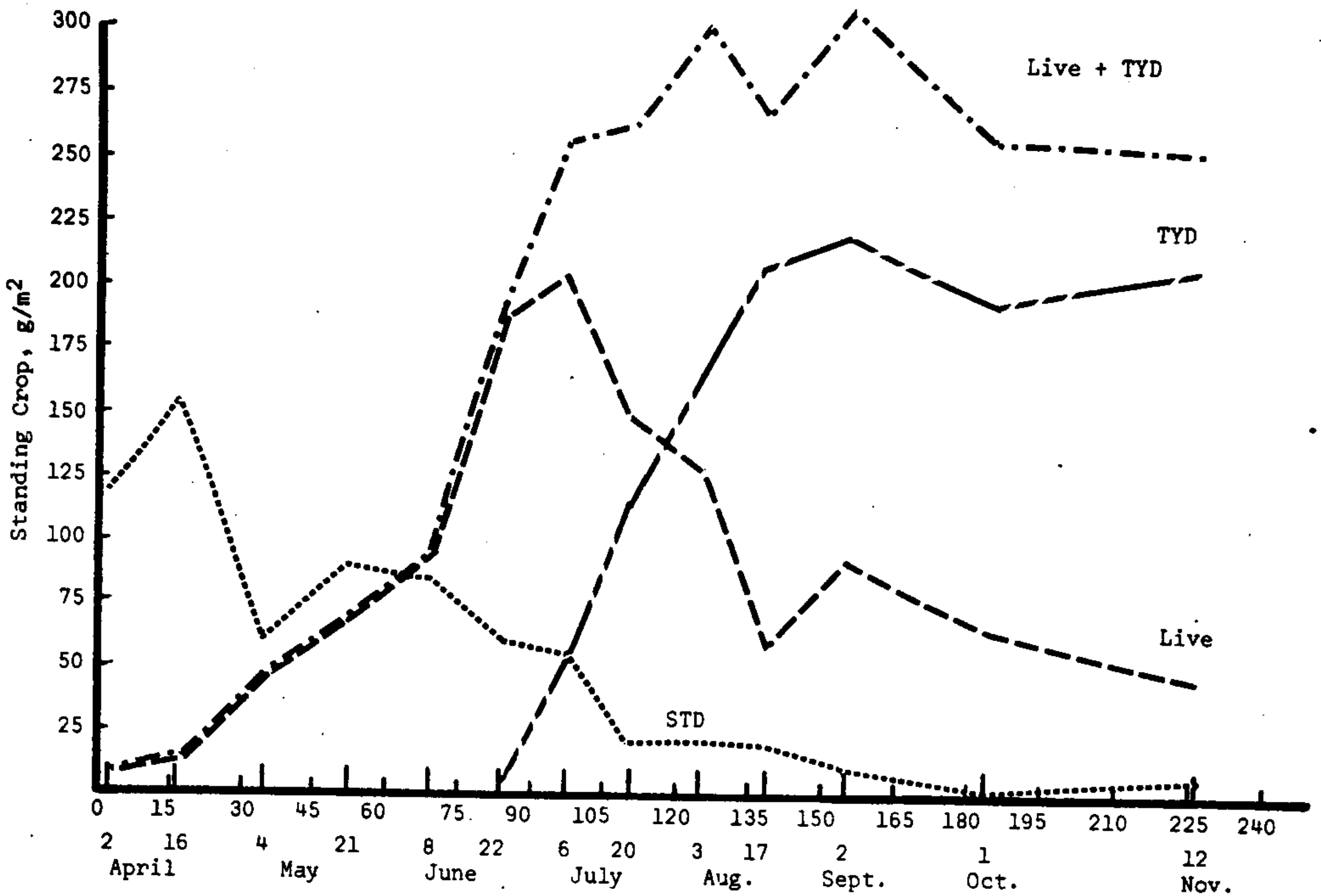

Fig. 8. Seasonal change in live, this year's dead (TYD), standing dead (STD), and live + TYD standing crop (oven dry g/m^2) for all species - permanent exclosure, high range condition. Cottonwood, 1971.

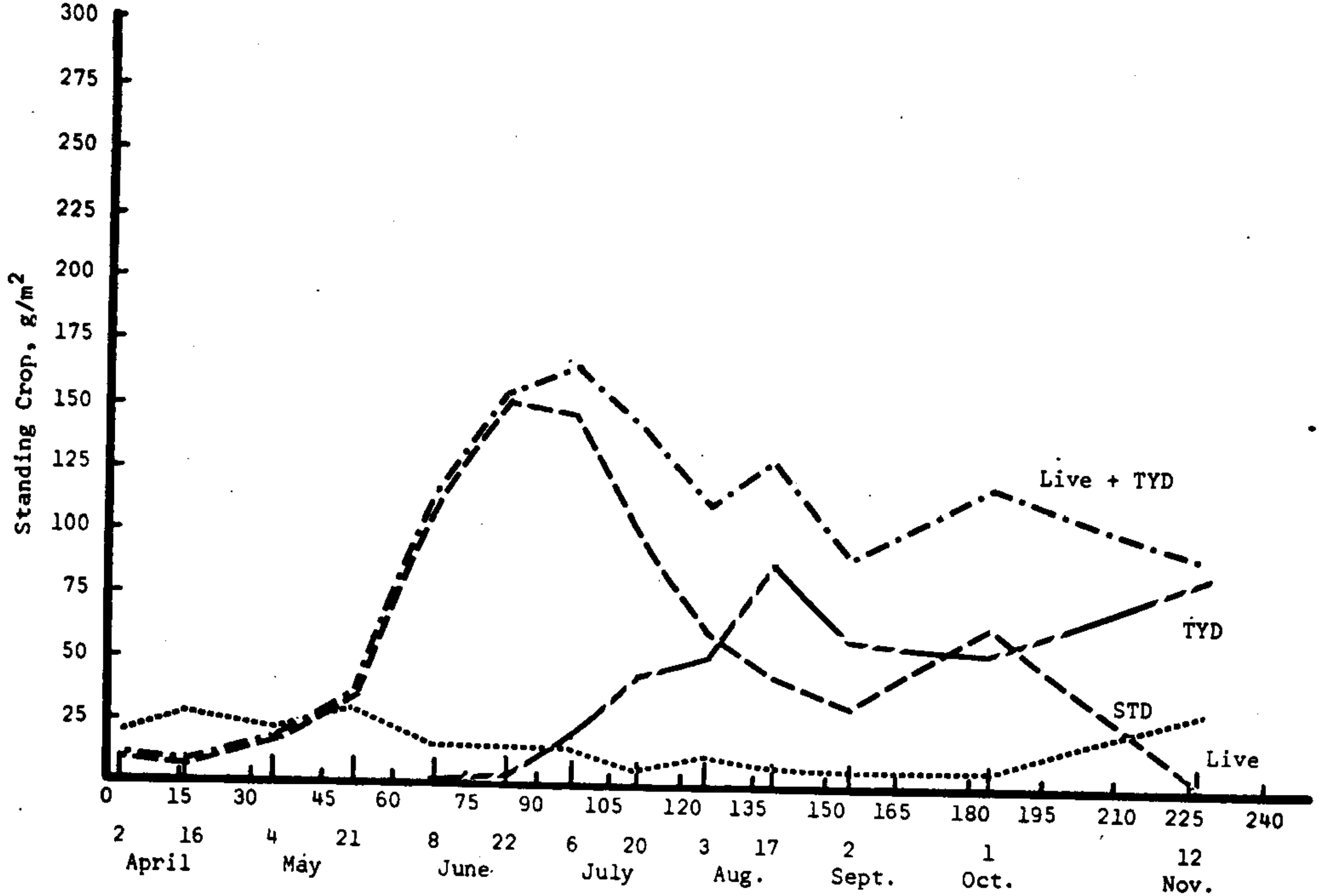

Fig. 9. Seasonal change in live, this year's dead (TYD), standing dead (STD), and live + TYD standing crop (oven dry g/m^2) for all species - temporary exclosure, low range condition. Cottonwood, 1971.

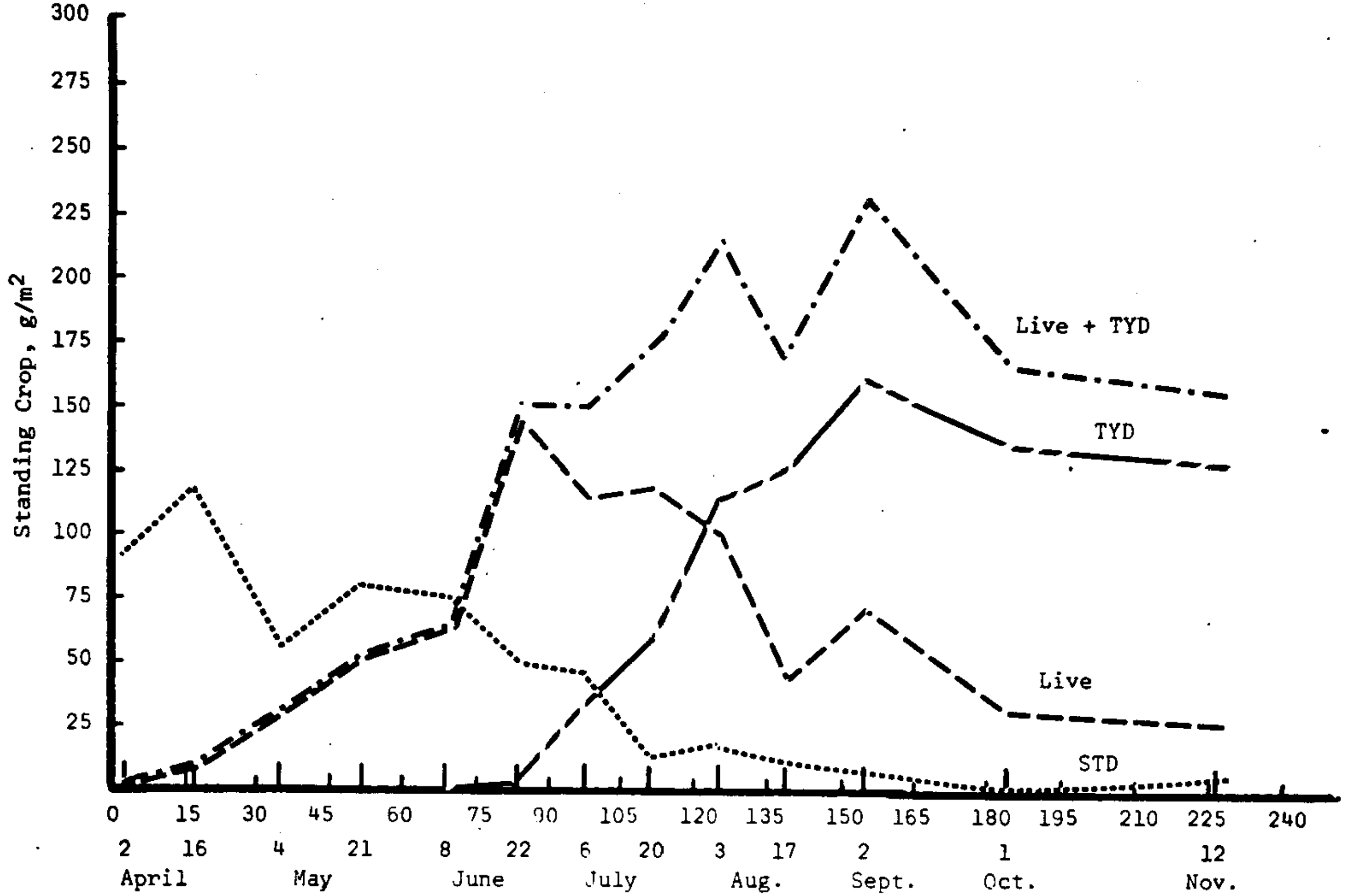

Fig. 10. Seasonal change in live, this year's dead (TYD), standing dead (STD), and live + TYD standing crop (oven dry g/m^2) for Agropyron smithii - permanent exclosure, high range conditicn. Cottonwood, 1971.

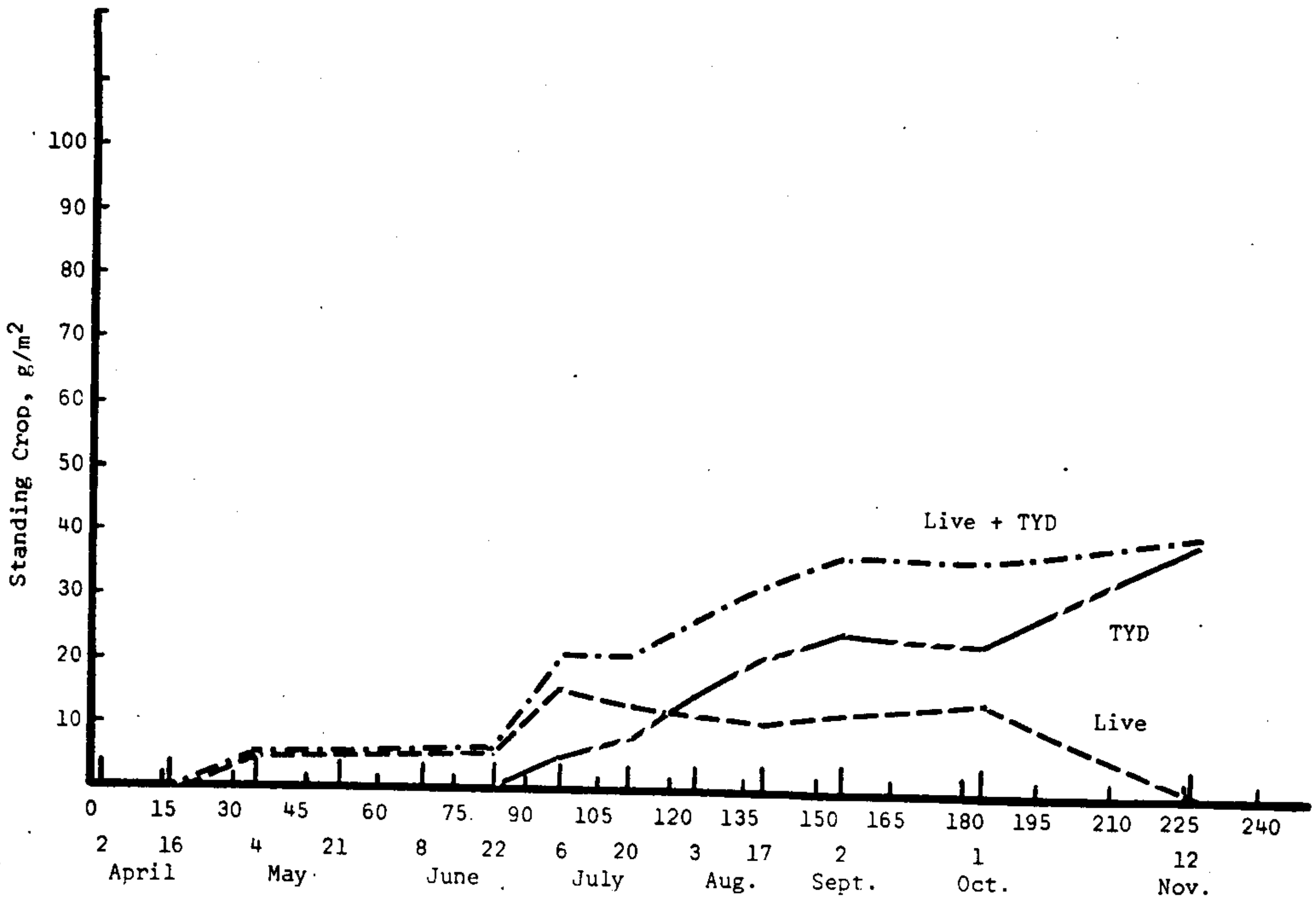

Fig. 11. Seasonal change in live, this year's dead (TYD), and live + TYD standing crop (oven dry g/m^2) for Bouteloua gracilis - permanent exclosure, high range condition. Cottonwood, 1971.

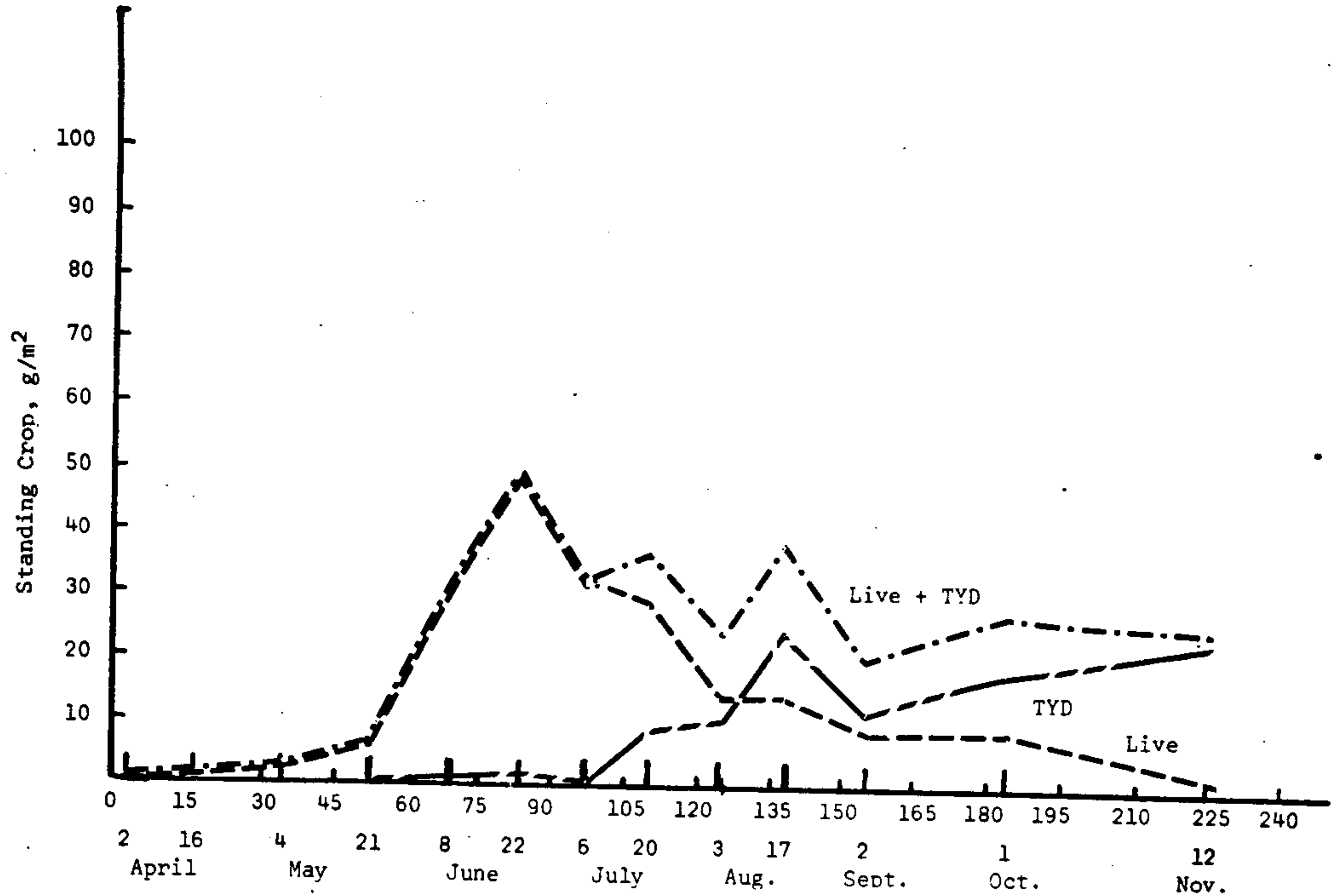

Fig. 12. Seasonal change in live, this year's dead (TYD), and live + TYD standing crop (oven dry g/m^2) for <u>Bouteloua gracilis</u> - temporary exclosure, low range condition. Cottonwood, 1971.

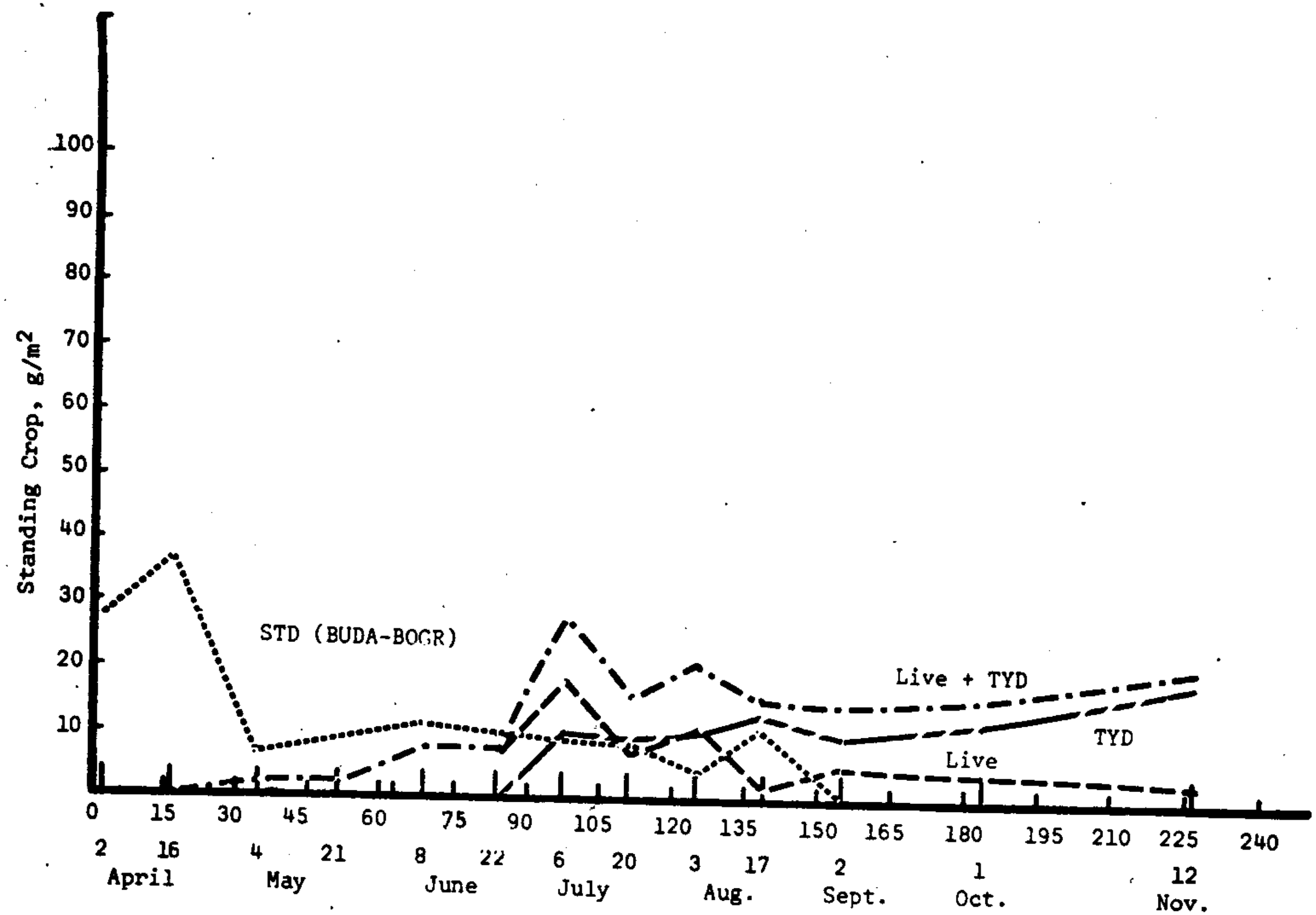

Fig. 13. Seasonal change in live, this year's dead (TYD), and live + TYD standing crop (over dry g/m^2) for Buchloe dactyloides and in standing dead (STD) for Buchloe dactyloides and Bouteloua gracilis combined - permanent exclosure, high range condition. Cottonwood, 1971.

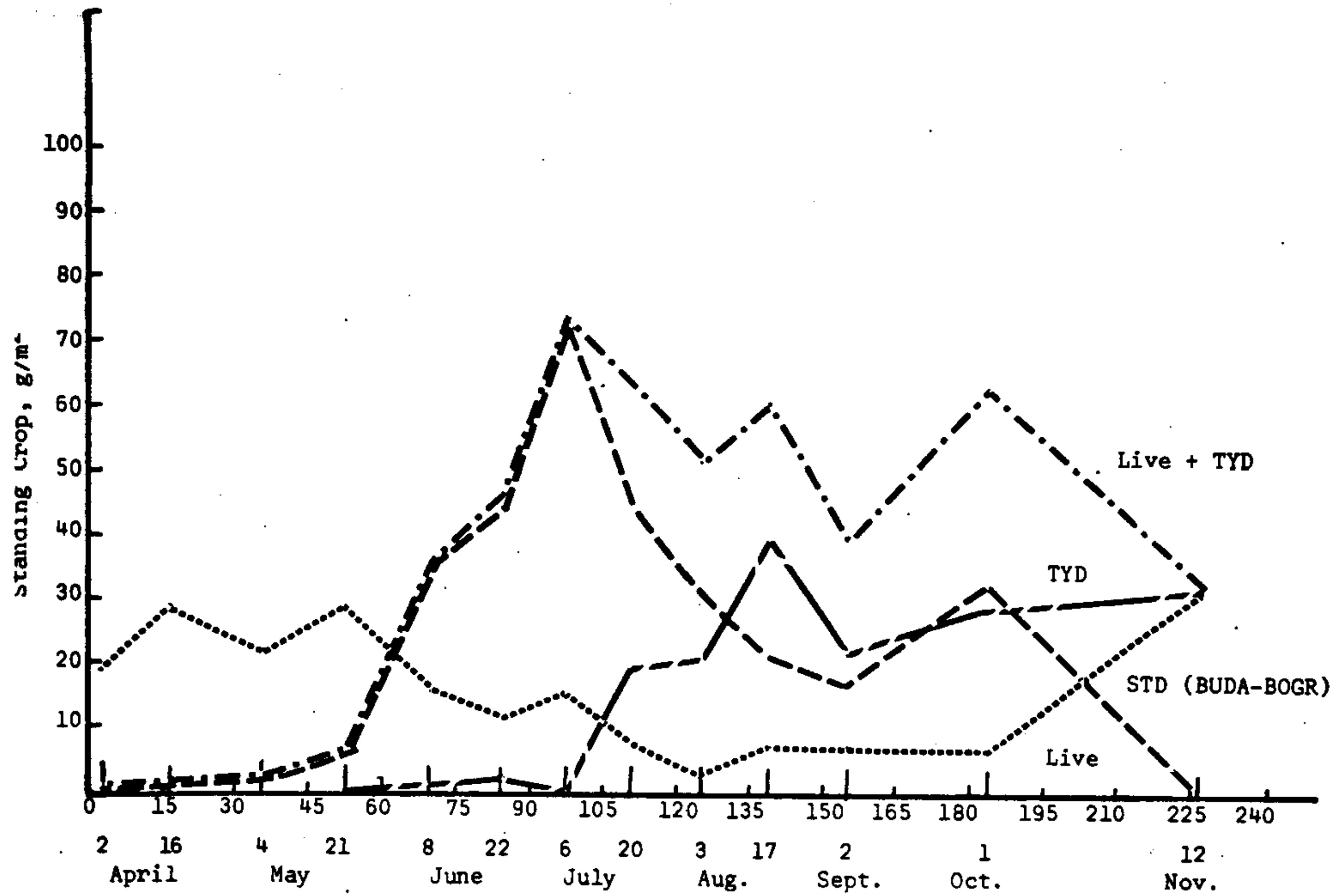

Fig. 14. Seasonal change in live, this year's dead (TYD), and live + TYD standing crop (oven dry g/m^2) for <u>Buchloe dactyloides</u> and in standing dead (STD) for <u>Buchloe dactyloides</u> and <u>Bouteloua gracilis</u> combined - temporary exclosure, low range condition. Cottonwood, 1971.

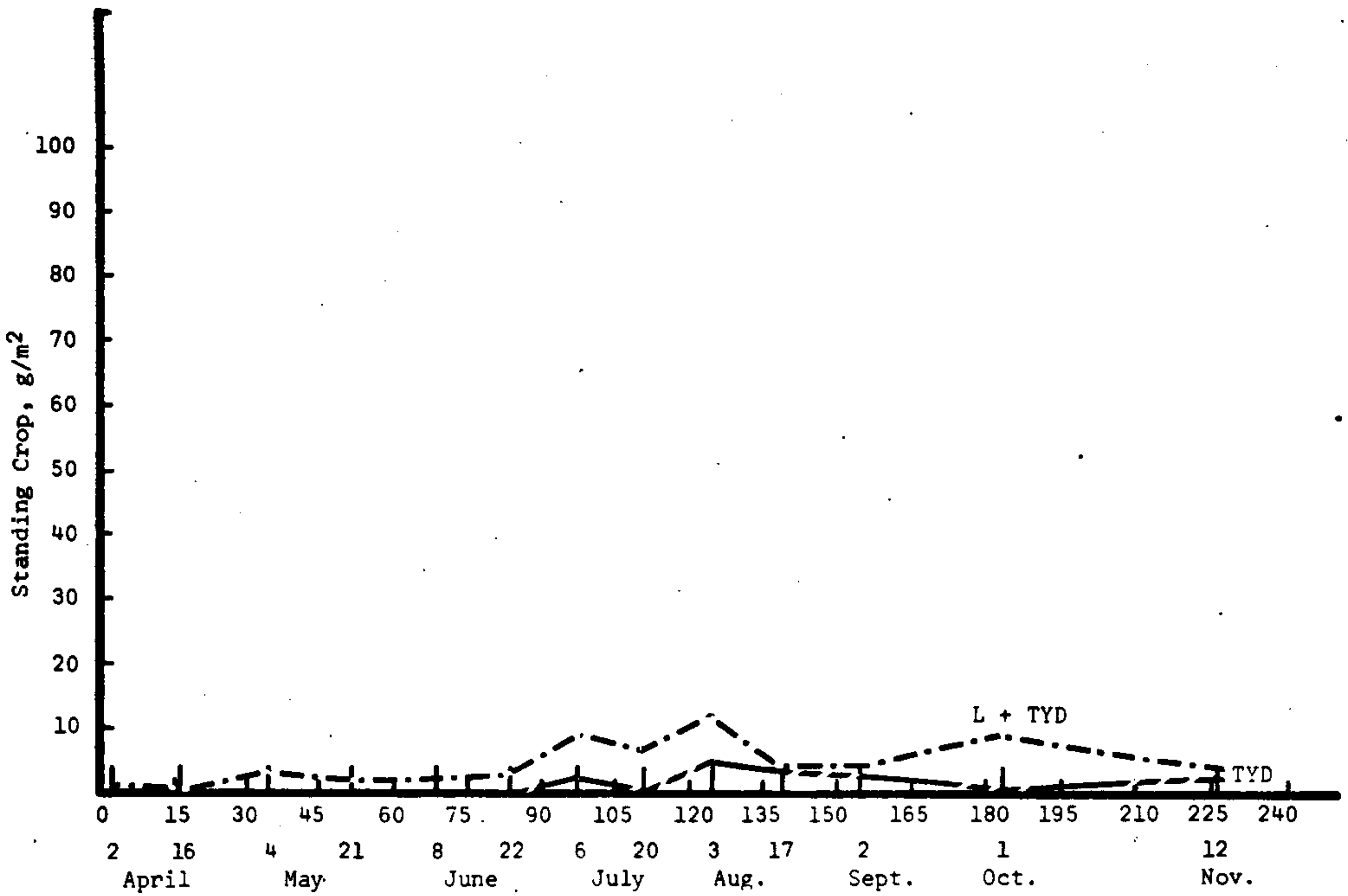

Fig. 15. Seasonal change in this year's dead (TYD) and live + TYD standing crop (oven dry g/m^2) of <u>Carex eleocharis</u> - permanent exclosure, high range condition. There was no standing dead. Cottonwood, 1971.

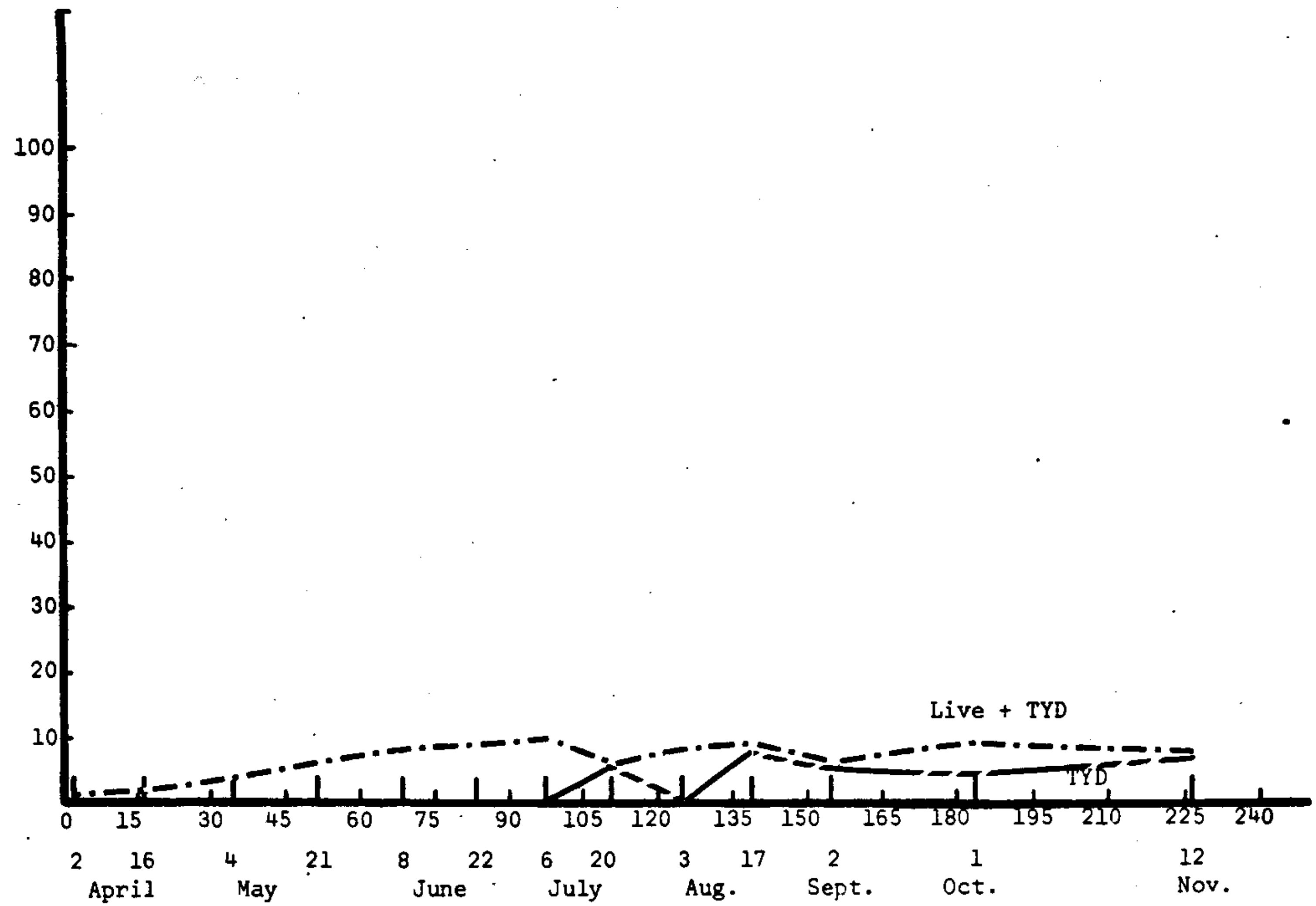

Fig. 16. Seasonal change in this year's dead (TYD) and live + TYD standing crop (oven dry g/m^2) of <u>Carex eleocharis</u> - temporary exclosure, low range condition. There was no standing dead. Cottonwood, 1971.

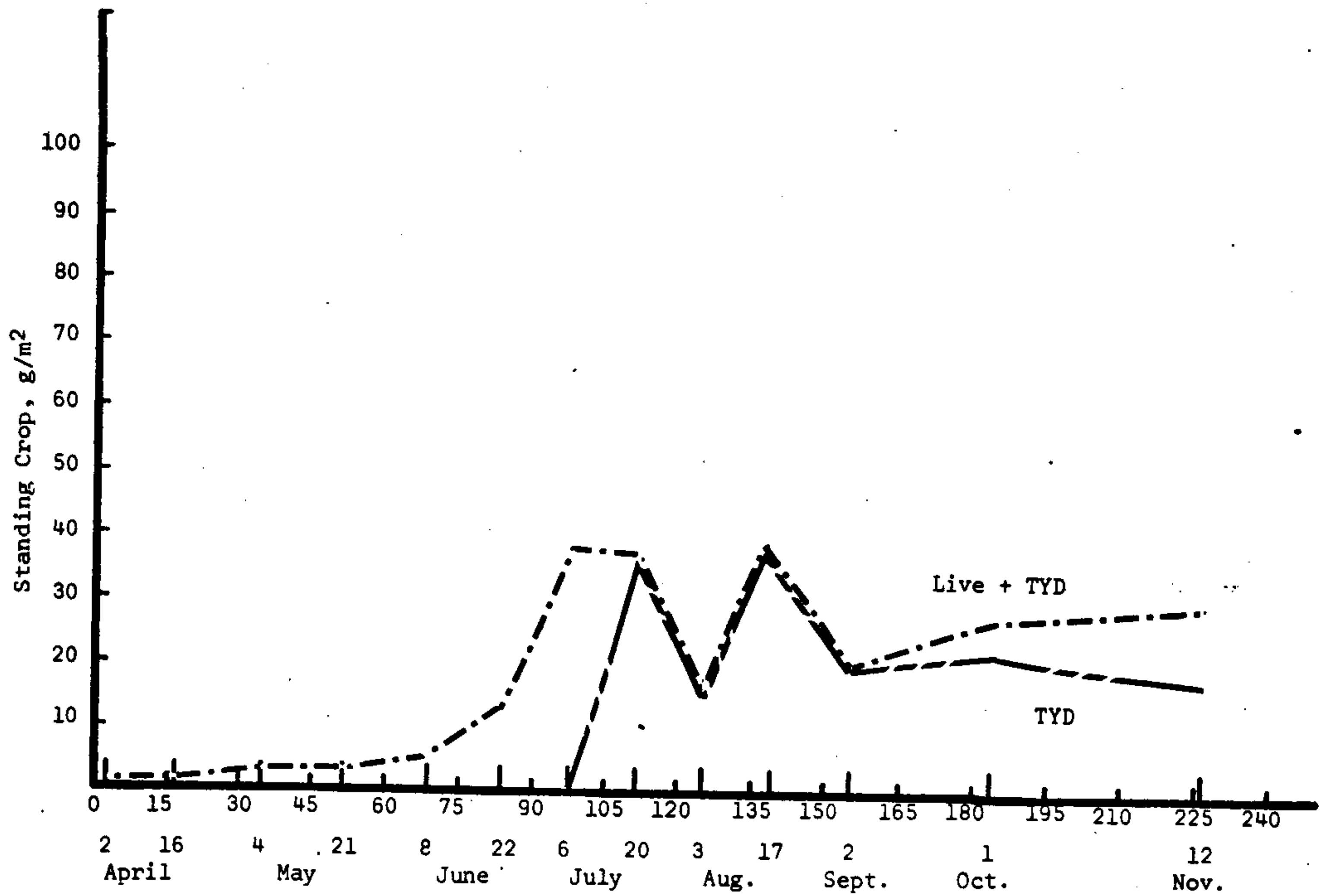

Fig. 17. Seasonal change in this year's dead (TYD) and live + TYD standing crop (oven dry g/m2) of <u>Bromus japonicus</u> - permanent exclosure, high range condition. There was no standing dead. Cottonwood, 1971.

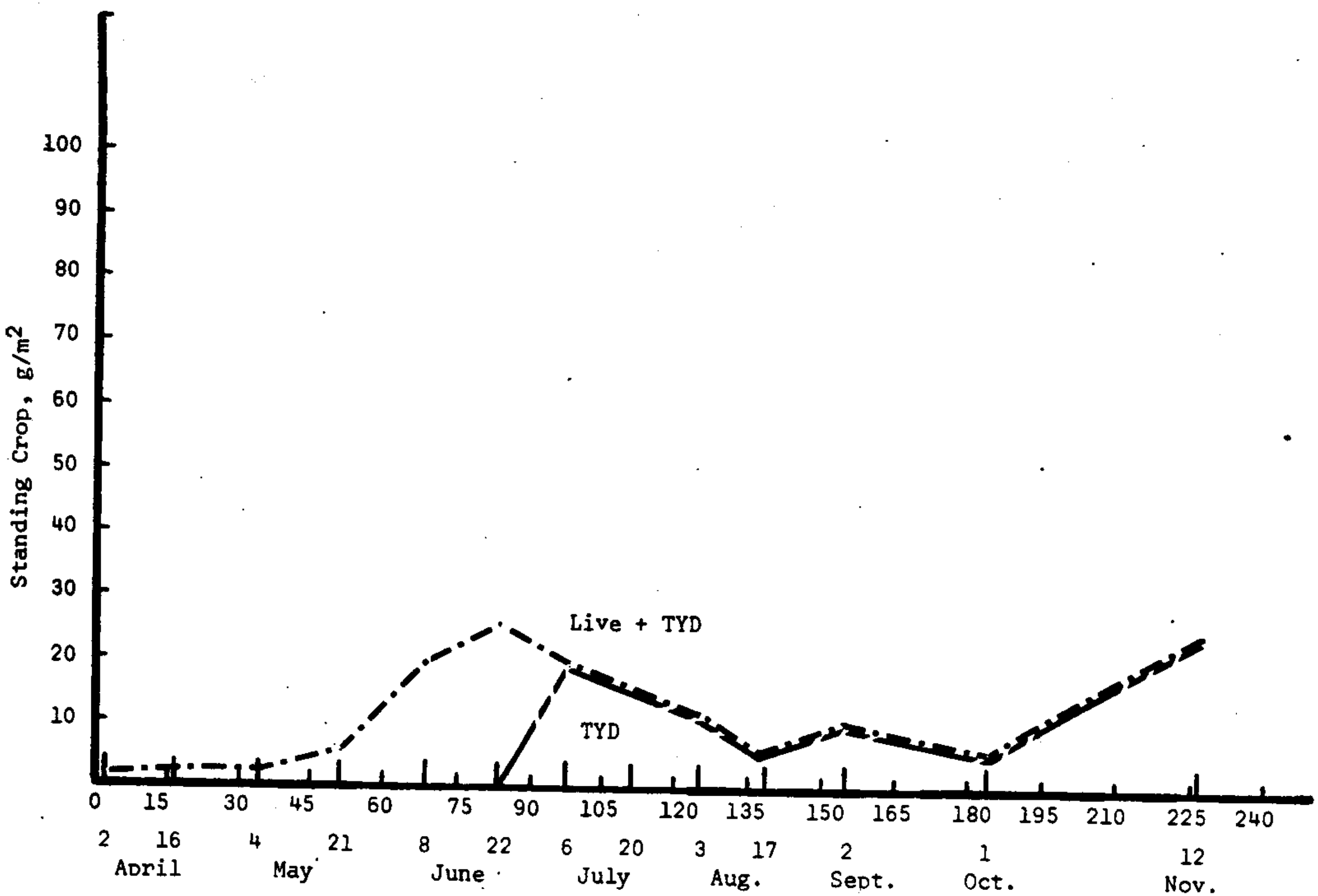

Fig. 18. Seasonal change in this year's dead (TYD) and live + TYD standing crop (oven dry g/m^2) of Bromus japonicus - temporary exclosure, low range condition. There was no standing dead. Cottonwood, 1971.

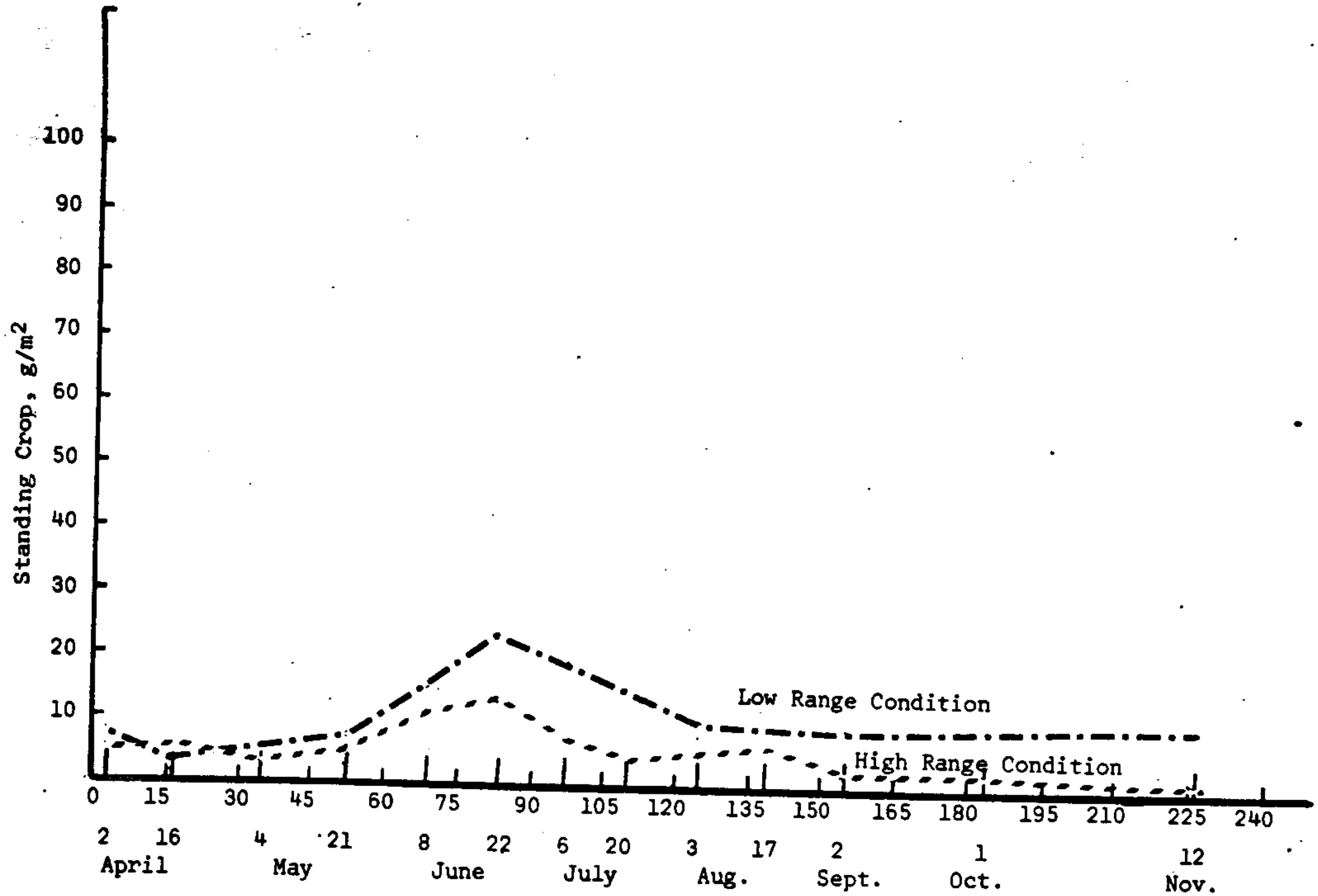

Fig. 19. Seasonal change in the sum of live plus this year's dead standing crop (oven dry g/m^2) for all secondary species in high and low condition range. Cottonwood, 1971.

(two cool-season species) are shown in Fig. 15 and 16 and 17 and 18, respectively, while seasonal changes for the sum of all other species are shown in Fig. 19.

The seasonal peak for live herbage biomass of the entire community in the high range condition exclosure occurred in early July while the biomass for live plus recent dead increased to early August and then peaked in early September following an apparent mid-August decline (Fig. 8). This behavior was also noted in 1970 (Lewis *et al.*, 1971). In the low range condition exclosure, live herbage biomass for the community peaked in late June while the live plus recent dead peaked in early July (Fig. 9). As expected, recent dead generally increased throughout the season while standing dead decreased. Old dead (standing dead) was the result of growth in previous years, thus increases in this compartment during the season reflect sampling or identification error. Some materials weather more rapidly than others. The large increase in old dead shortgrass (Fig. 14A and Fig. 9) after October 1 is doubtless due to the darker color of the older recent dead.

Within the high range condition exclosure, the seasonal high for live *A. smithii* biomass occurred in late June while the seasonal high for live plus this year's dead was reached on September 2 (Fig. 10). *A. smithii* increased in biomass in a very regular manner to a maximum in early August and then declined during the early and mid-August dry period. The large increase at the September 2 sampling date was apparently the result of rapid growth in response to late August precipitation (Table 1). Live *B. gracilis* increased until early July and then decreased However, live plus recent dead increased until September 2. Slight increases after this date were not significant. Both live and live plus recent dead B. dactyloides reached a peak in early July (Fig. 13) and generally declined throughout the remainder of the season as both shortgrasses did during the 1970 season (Lewis et al., 1971). Seasonal peaks for C. eleocharis (Fig. 15) and B. japonicus (Fig. 17) appear to have been attained by early August and early July, respectively. Collectively, the species other than the five main species reached a seasonal peak of about 13 g/m^2 in late June and declined steadily throughout the season (Fig. 19). The principal species in this group were Vicia americana and Sphaeralcea coccinea.

Seasonal changes in biomass for species and species groups in the low range condition exclosure were similar to those in the high range condition exclosure. The seasonal peaks for B. gracilis, B. japonicus, and "others" occurred in early July (Fig. 12, 18 and 19) while seasonal peaks for B. dactyloides and C. eleocharis occurred in late June (Fig. 14 and 16). Agropyron smithii was a minor component of the vegetation in low range condition (Table 8) and trends are not presented graphically.

The community peak standing crop of live plus recent dead was 312 and 166 g/m^2 for the permanent exclosure in high range condition and the temporary exclosure in low range condition, respectively (Tables 7 and 8). The sum of the peak standing crop of the individual species and species groups was 367 and 189 g/m^2, respectively, for high and low range condition or about 17 and 14%, respectively, more than the community peak standing crop.

3. Mulch. Seasonal changes in oven dry ash-free weights of mulch are shown by treatment and date in Table 10. Trends are shown graphically in Fig. 20. In the high range condition exclosure values for mulch were low in early April (337 g/m2), increased to an early June peak (424 g/m^2) and then decreased somewhat erratically throughout the growing season. The seasonal changes were of a lower magnitude for the low range condition exclosure with a generally high level from the beginning of the season through the August 17 collection date and a seasonal low in early September.

Table 10. Seasonal Change in Weight of Mulch[a/] (g/m^2 oven dry organic matter; means of 10 plots/replicate, 2 replicates/treatment), Cottonwood, 1971

Treatment	Permanent Exclosure High Range Condition			No. effective plots	Temporary Exclosure Low Range Condition			No. effective plots
Replicate	1	2	Mean		1	2	Mean	
Sampling Date								
2 Apr	349.3±14.4	324.6±15.4	337.0±10.6	18	187.1±14.1	151.9± 7.8	169.5± 8.0	15
16 Apr	362.9± 7.3	357.1±10.2	360.0± 6.3	17	213.7±11.7	181.6±10.0	197.6± 7.7	18
4 May	360.9±21.3	402.0±27.5	381.4±17.4	17	160.0±16.7	184.1±17.5	172.0±12.1	18
21 May	344.2±15.9	311.9±11.6	328.1± 9.9	17[b/]	165.4±11.3	168.1± 8.9	166.8± 6.9	c/
8 Jun	422.8±23.0	424.4±20.5	423.6±15.4	18	153.0±11.3	136.7±17.0	144.8±10.2	16
22 Jun	342.8±20.1	--	342.8±20.1	10	178.1±15.9	161.1±11.6	169.6± 9.9	17
6 Jul	289.5±21.7	297.8±14.1	293.6±12.9	16	159.9±11.0	183.0±10.0	171.5± 7.4	18
20 Jul	372.1±33.5	354.3±30.1	363.2±22.5	18	182.0± 6.2	176.2±11.1	179.1± 6.3	15
3 Aug	366.4±19.6	303.8± 9.9	335.1±11.0	14	213.0±10.4	161.6±12.9	187.3± 8.3	18
17 Aug	369.5±18.6	386.5±18.9	378.0±13.3	18	170.4±11.5	188.6±12.4	179.5± 8.5	18
2 Sep	234.8±17.0	272.7±20.3	253.8±13.6	c/	118.9± 8.4	121.6±10.6	120.2± 6.6	c/
1 Oct	410.5±16.5	334.1±19.4	372.3±12.7	18	136.6±11.0	118.7± 5.8	127.6± 6.2	14
12 Nov	314.5±20.4	303.0±15.8	308.8±12.9	17	197.5±10.1	178.7± 8.4	188.1± 6.6	18

a/ Mulch includes above-ground stolons and crowns.
b/ Replicate contains 9 plots.
c/ Not calculated.

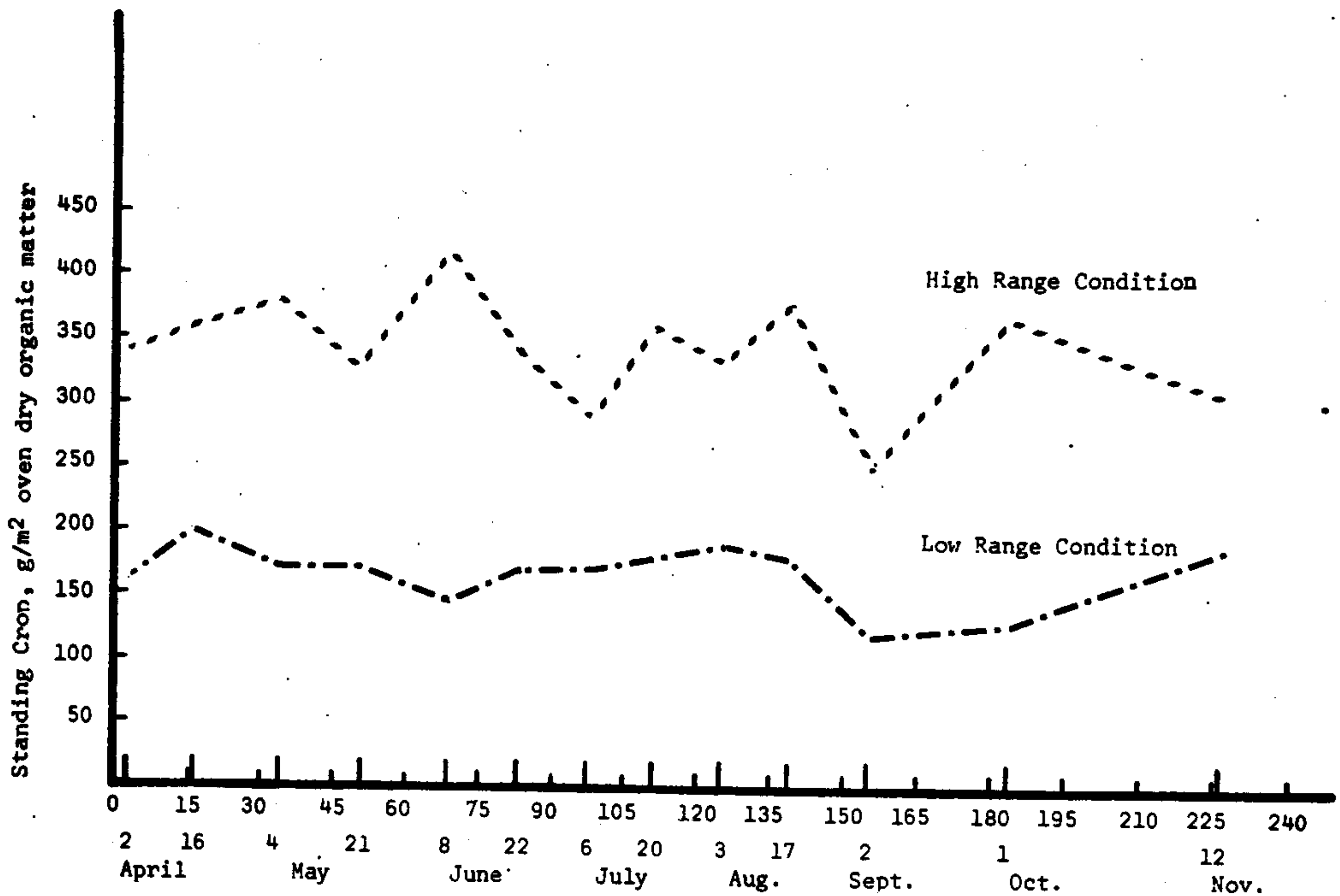

Fig. 20. Seasonal change in weight (g/m^2 oven dry organic matter) of mulch for the permanent exclosure, high range condition, and temporary exclosure, low range condition. Cottonwood, 1971.

Below-Ground Plant Standing Crop

The seasonal variation in total below-ground standing crop, including below-ground crowns, rhizomes, and roots, is presented in Appendix Tables 5 and 6, Tables 11 and 12 and in Fig. 21. A much higher root biomass is apparent in the low range condition exclosure. A peak biomass of roots and rhizomes in the upper 60 cm of soil of 2832 g/m^2 occurred on July 6 while a peak of 1675 g/m^2 occurred on the same date in the high range condition exclosure. These correspond to respective peak weights in 1970 of 2227 g/m^2 and 1366 g/m^2 for the two treatments on July 10. The treatment differences could be a direct result of the past grazing history of the treatments, or more likely, an indirect effect of the grazing history altering the species composition. The low range condition treatment was dominated by *B. dactyloides* and *B. gracilis*, while the high range condition treatment was dominated by these two species in combination with *A. smithii*.

Below-ground plant biomass in both treatments increased from April 2 to a peak on July 6. It then decreased in low range condition until August 3 when the biomass was lower than at the beginning of the sampling period in April. Biomass then increased to 1990 g/m^2 on September 2. The previous year's data and the October 1 0-30 cm sample indicate that it may have continued to increase beyond that date. The proportionate decrease following the peak was not as great in the high range condition treatment. The low point was also reached on August 3. The subsequent increase was greater than in low range condition and almost reached the equivalent of the July 6 peak. Seasonal changes in root biomass may have been affected by the seasonal distribution of soil moisture (Fig. 3)

Table 11. Seasonal Change in Below-Ground Plant Standing Crop (g/m^2 oven dry organic matter of below-ground crowns, rhizomes, and roots) by Depth, Permanent Exclosure, High Range Condition, Cottonwood, 1971

	Apr		May		Jun		Jul		Aug		Sep	Oct
	1	16	4	22	8	20	6	20	3	17	1	1
Depth, cm												
0-10	845	865	683	736	793	718	965	823	622	680	850	806
10-20	177	211	204	212	214	219	226	194	186	182	232	182
20-30	132	179	130	147	186	176	154	177	144	152	146	142
30-40	103	128			116		132		114		96	
40-50	80	108			116		112		92		76	
50-60	59	84			86		86		71		68	
Total												
0-30	1153	1255	1016	1094	1193	1113	1345	1194	953	1015	1228	1130
0-60	1395	1575			1511		1675		1230		1468	

Table 12. Seasonal Change in Below-Ground Plant Standing Crop (g/m^2 oven dry organic matter of below-ground crowns, rhizomes, and roots) by Depth, Temporary Exclosure, Low Range Condition, Cottonwood, 1971

	Apr		May		Jun		Jul		Aug		Sep	Oct
	1	16	4	22	8	20	6	20	3	17	1	1
Depth, cm												
0-10	1222	1352	1247	1291	1441	1557	1596	1500	971	1427	1199	1324
10-20	296	417	404	427	404	537	461	412	300	463	333	430
20-30	153	257	209	302	257	320	280	239	216	340	200	279
30-40	94	171			155		221		166		119	
40-50	57	120			143		154		115		90	
50-60	36	79			89		121		98		56	
Total												
0-30	1671	2026	1860	2020	2103	2414	2337	2151	1488	2231	1732	2033
0-60	1859	2396			2489		2832		1867		1998	

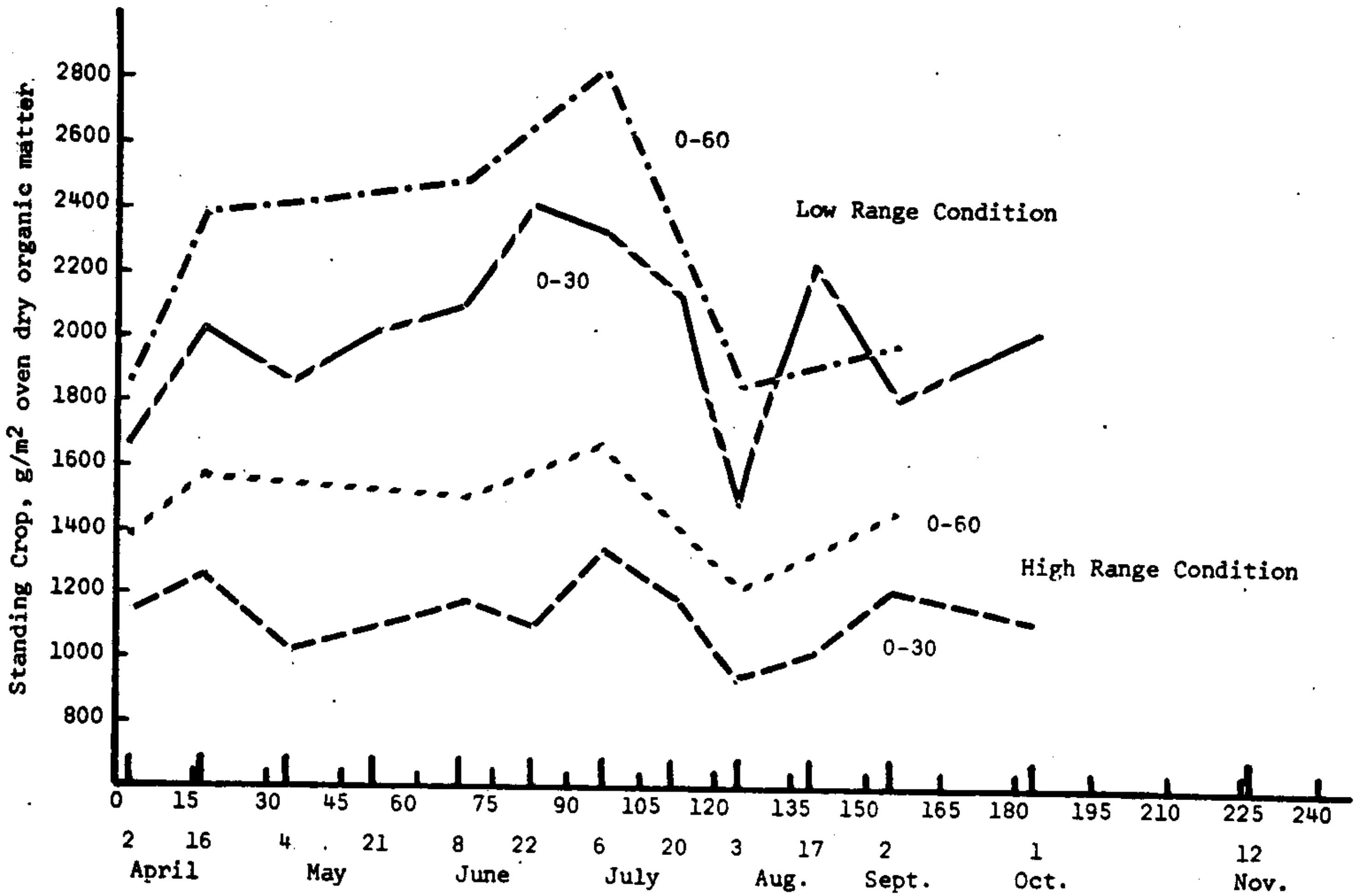

Fig. 21. Seasonal change in below-ground plant standing crop in the permanent exclosure in high range condition and in the temporary exclosure in low range condition, Cottonwood, 1971.

and accompanying changes in above-ground productivity. However, root biomass changes also reflect shifts in carbohydrate sinks during the growing season. Although the trends were evident at all depth increments, the fluctuations were much greater in the upper levels. The seasonal occurrence of the peaks and lows corresponded to those of the 1970 season. The 1970 data indicated that the below-ground biomass consisted of 85 and 87% roots, 14 and 11% root crowns and 1 and 2% rhizomes for low and high range conditions, respectively.

Fig. 22 shows the mean root biomass (April through October) by depth increment. More than half of the total biomass was in the top 10 cm (55% in the high range condition and 57% in the low range condition). The differences in biomass between the two treatments was also proportionately greater in the upper levels. The percentage biomass in the top 10 cm was greater in 1971 than in 1970 (55 vs. 46% in the high range condition and 57 vs. 44% in the low range condition).

Turnover rates were calculated for the root component using the formula of Dahlman and Kucera (1965) of

$$T = \frac{B_{max} - B_{min}}{\text{Total B}}$$

where T is the turnover, B_{max} is the maximum root biomass, B_{min} is the minimum root biomass and Total B is the total mean root biomass for the year. This method indicated a turnover rate of .434 (.177 in 1970) for the low range condition treatment and .301 (.213 for 1970) for the high range condition treatment.

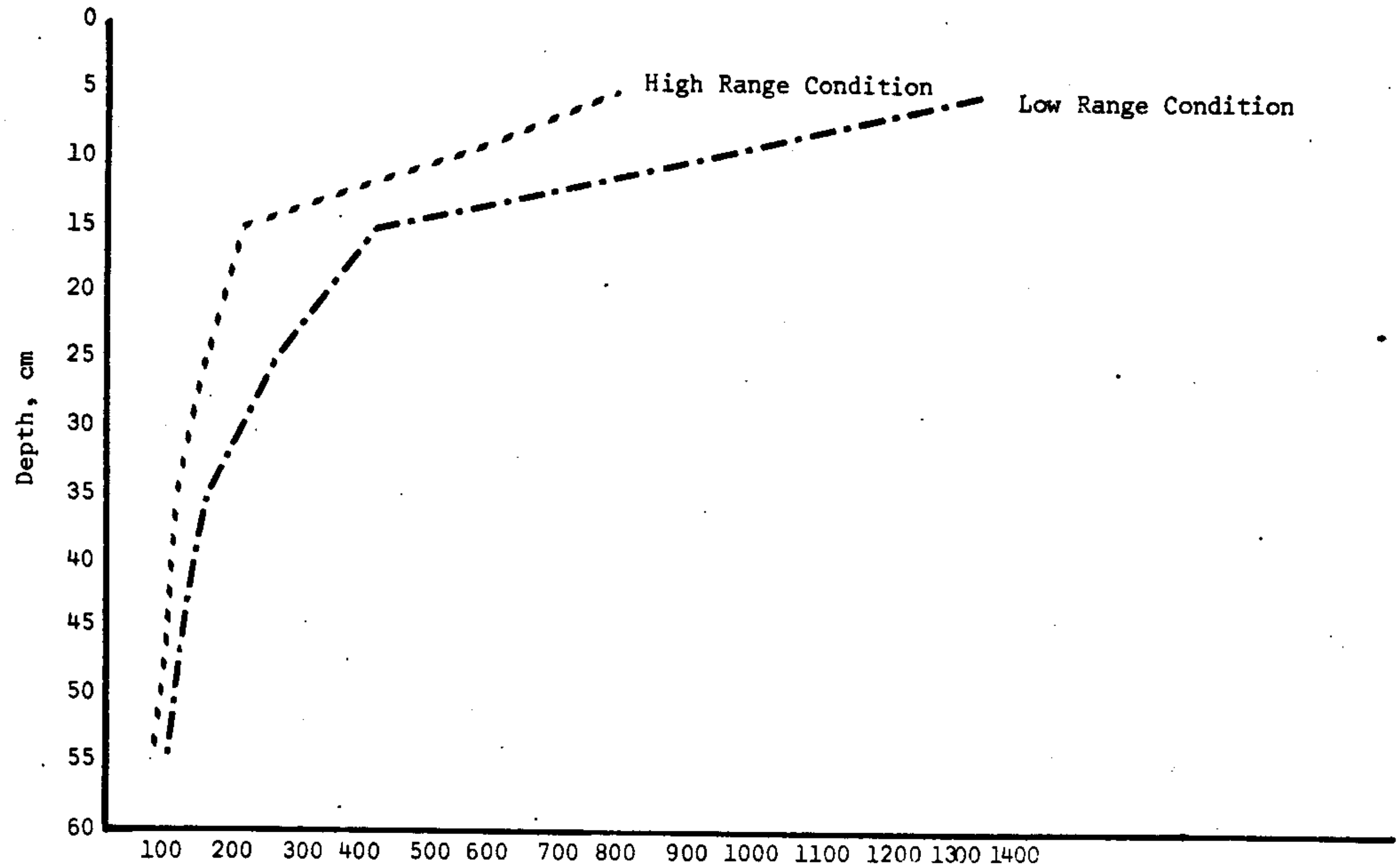

Fig. 22. Distribution of below-ground plant standing crop, g/m^2 oven dry organic matter, with depth, Cottonwood, 1971.

Plant Standing Crop by Compartments

Estimates of above- and below-ground oven dry ash-free plant biomass by components is shown for the high range condition exclosure in Fig. 23 and for the low range condition exclosure in Fig. 24, assuming ash contents of 8, 10, and 13%, respectively, for live, recent dead, and old dead above-ground herbage standing crop.

Above-ground components reached a peak of 640 g/m^2 in mid-August in high range condition; however, differences were small from early June through October. In the low range condition exclosure a peak of 337 g/m^2 was reached in early July, although differences were small through late August.

Below-ground plant components increased from a low in early April to a peak in early July in both treatments (1394 and 1676 to 1861 and 2832 g/m^2, respectively, for high and low range condition exclosures), then declined to a low in early August in both high and low range condition (954 and 1867 g/m^2, respectively) and then both increased late in the season.

Below-:above-ground standing crop ratios ranged from 3.1 to 2.7 to 1 in the exclosure in high range condition and from 6.2 to 10.4 to 1 in the temporary exclosure in low range condition.

Transfer From Herbage to Mulch

Partially delittered plots were employed to measure the transfer of plant material from the herbage to the mulch compartment for most of the 1971 growing season. Ten .0225 m^2 (15 x 15 cm) permanent plots were randomly located in each of two replicates per treatment, high

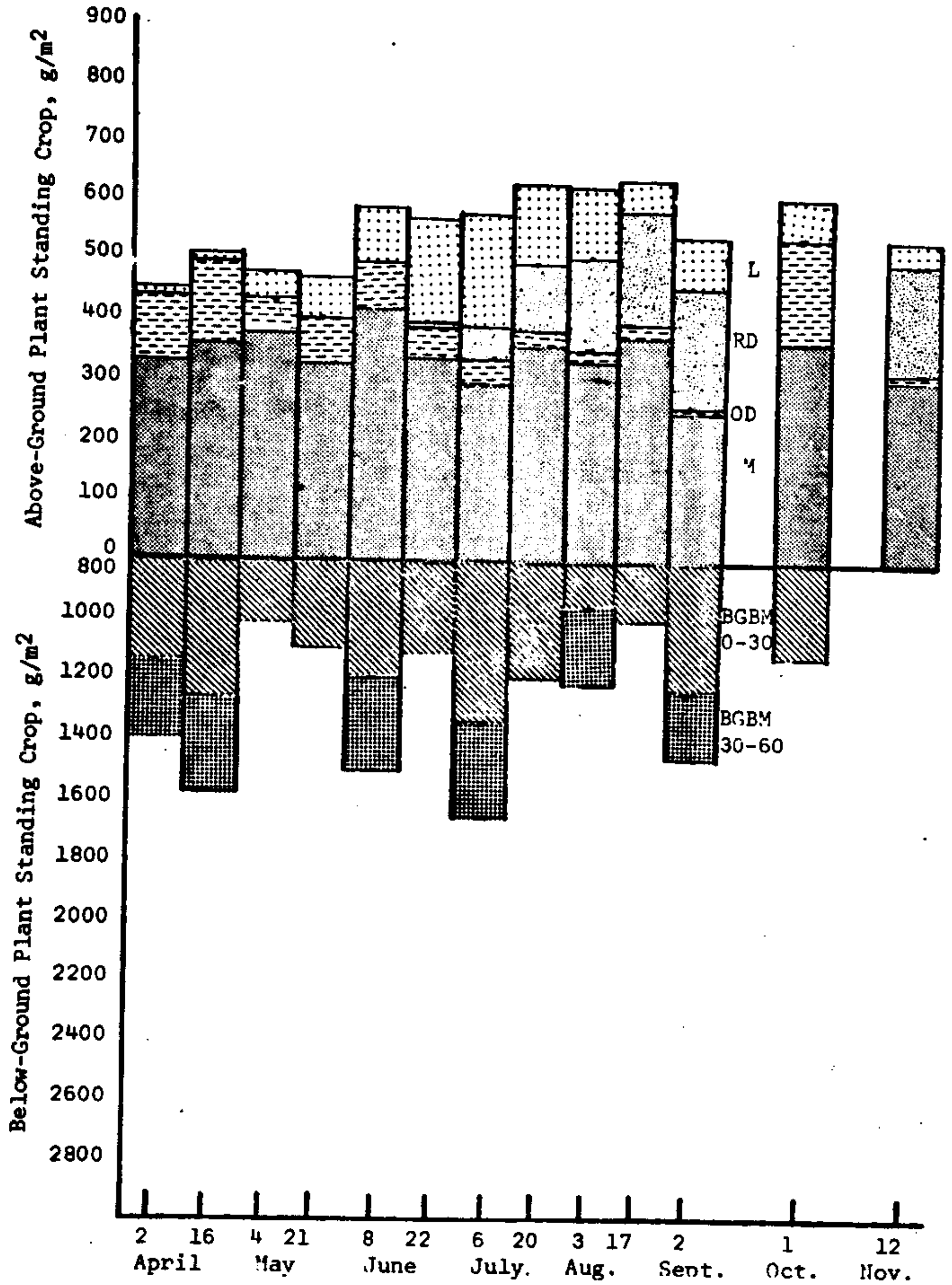

Fig. 23. Above- and below-ground oven dry ash-free plant biomass by components, permanent exclosure, high range condition, Cottonwood, 1971. (L:Live; RD:Recent Dead; OD:Old Dead; M:Mulch, Crowns and Stolons; BGBM:Below-Ground Plant Biomass, 0-30 cm depth and 0-60 cm depth)

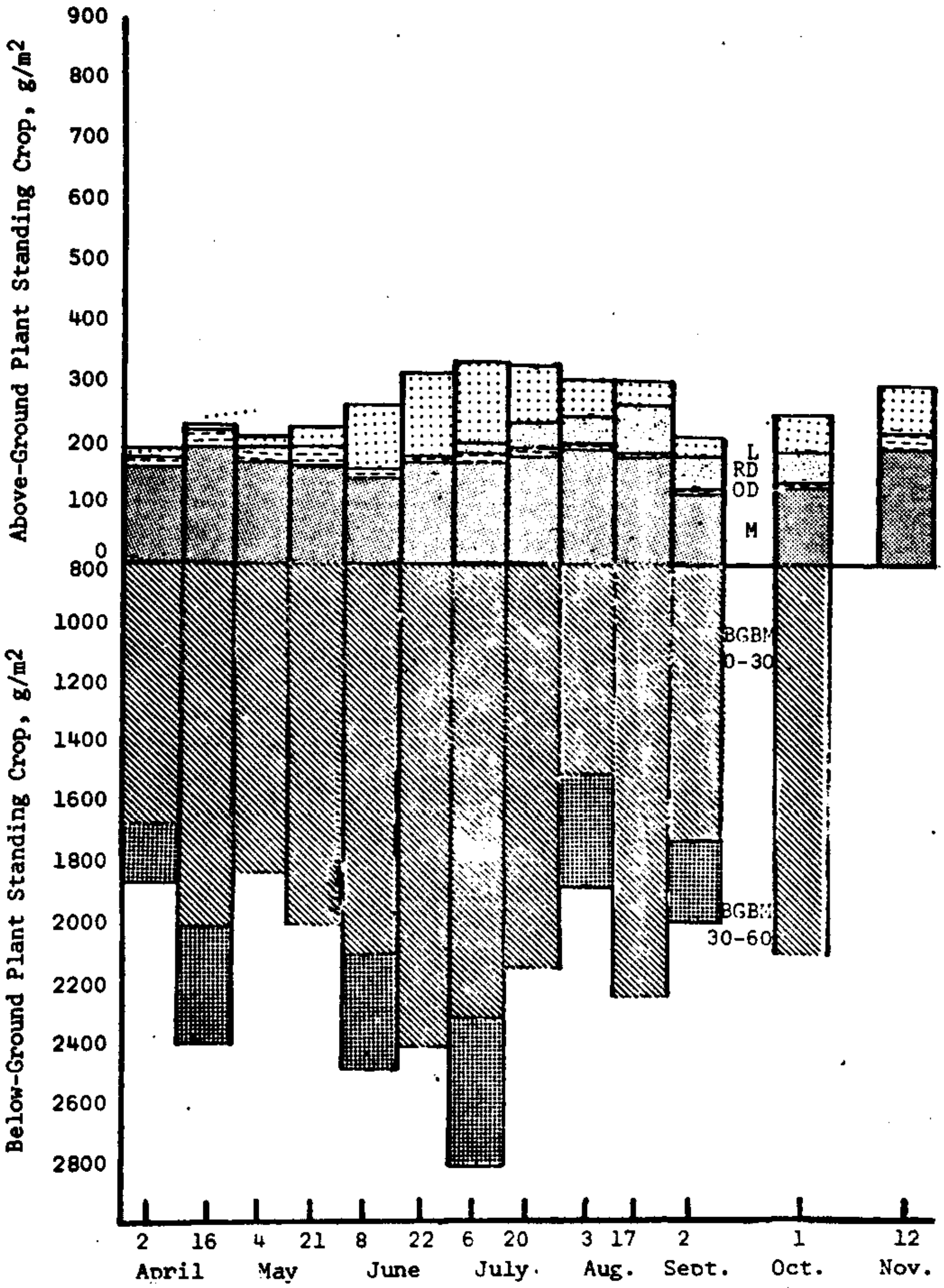

Fig. 24. Above- and below-ground oven dry ash-free plant biomass by components, temporary exclosure, low range condition, Cottonwood, 1971. (L:Live; RD:Recent Dead; OD:Old Dead; M:Mulch, Crowns and Stolons; BGBM:Below-Ground Plant Biomass, 0-30 cm depth and 0-60 cm depth)

condition range and low condition range treatments. The plots were marked with four 1/2-inch steel nails and lightweight wire. The wire was looped around each nail so that the corners of each plot were determined by the intersection of the wire and the nails were outside the plot. The wire was positioned about one-half inch above the ground surface and tightened to prevent movement between visitations.

All bright-colored material was removed from the mulch layer of the plots on June 4 and June 7 for the high and low conditiontreatments, respectively. The plots were revisited in mid-June, late June, late July, and late September and all current year's dead and live material that had fallen to the mulch layer was removed. Removal of material was accomplished with 30-cm tweezers to prevent disturbance of the attached components of the herbage layer. The removed components were oven dried, categorized, and then weighed to the nearest .01 g. Categories used were live and this year's dead for western wheatgrass, buffalograss, blue grama, Japanese brome, needleleaf sedge, and the remaining live and this year's dead included in an "others" category.

The long interval of measurement between late July and late September may have generated inaccurate low rates of transfer for August and September. The first five weeks of this interval were extremely dry and not conducive to rapid decomposition rates that would result in discoloration of freshly fallen material. However, a sizable amount of precipitation occurred in early September and, although the air temperatures were fairly cool, might possibly have given rise to conditions suitable for decompositional processes that could have discolored some of the material that had fallen during the interval.

The extent of the discoloration may have been enough to prohibit the identification of the material as freshly fallen. If so, then only an unknown portion of the material transferred during the interval was actually measured. Ideally, the plots should have been tended just prior to or immediately after the precipitation event of early September.

Table 13 presents a summary of the daily rates of transfer to mulch results, while individual plot data are presented in Appendix Tables 7 through 10. The daily rates of transfer were generally higher in the low condition treatment than in the high condition treatment and were extremely variable. The rates were higher in July than in the other intervals of measurement in both treatments.

The amount of material transferred from herbage to mulch is shown by treatment in Table 14 for each collection period interval after June 10 and prior to October 2. Appendix Tables 11 and 12 show the data on a replicate basis. Species composition (%) of the transferred material is also indicated. The composition is high in Japanese brome for both treatments. The "others" category, mostly forbs, is also high. Most of the forbs grow, die and fall to the mulch layer within the growing season. Most of the Japanese brome material transferred during the growing season is seed. Western wheatgrass (mostly leaves) made up 17% of the transferred material in the high condition treatment, while buffalograss (leaves and seeds) accounted for 30% of the total in the low condition treatment.

Table 15 shows the amount of material transferred from herbage to mulch for each major component on a cumulative basis by treatment and herbage dynamics collection periods. Appendix Tables 13 and 14 show

Table 13. Rates (g/m^2/day) of Live + This Year's Dead Transfer From Herbage to Mulch From June 4 Through September 27, 1971

Interval	AGSM	BUDA	BOGR	CAEL	BRJA	OTHR	Total
	Permanent Exclosure High Range Condition, Replicate I						
6/4-6/16	0.019	0.015	0.022	0.011	0.030	0.048	0.145
6/17-6/28	0.015	0.026	--	0.015	0.033	0.067	0.156
6/29-7/28	0.013	--	0.001	--	0.065	0.128	0.207
7/29-9/27	0.011	0.005	0.001	0.001	0.011	0.005	0.034
	Permanent Exclosure High Range Condition, Replicate II						
6/4-6/17	0.031	0.010	0.007	--	0.010	0.051	0.109
6/18-6/30	0.003	0.010	0.021	--	0.034	0.027	0.095
7/1-7/28	0.037	0.022	0.005	0.008	0.079	0.079	0.230
7/29-9/27	0.014	0.004	0.003	0.001	0.009	0.003	0.034
	Permanent Exclosure High Range Condition, Mean Both Reps						
	0.025	0.013	0.015	0.006	0.020	0.050	0.127
	0.009	0.018	0.011	0.008	0.034	0.047	0.126
	0.025	0.011	0.003	0.004	0.072	0.104	0.216
	0.013	0.005	0.002	0.001	0.010	0.004	0.036
	Temporary Exclosure Low Range Condition, Replicate I						
6/7-6/16	--	0.084	0.034	0.030	--	0.049	0.197
6/17-6/30	--	0.051	--	--	0.013	0.013	0.077
7/1-7/26	0.007	0.137	0.002	0.002	0.215	0.085	0.448
7/27-9/24	0.006	0.033	0.002	0.001	0.052	0.011	0.105
	Temporary Exclosure Low Range Condition, Replicate II						
6/7-6/16	0.010	0.054	0.005	0.054	0.005	0.099	0.227
6/17-6/30	--	0.060	--	--	0.031	0.022	0.113
7/1-7/27	--	0.066	0.007	0.007	0.174	0.040	0.294
7/28-9/24	0.007	0.024	0.001	0.002	0.043	0.012	0.089
	Temporary Exclosure Low Range Condition, Mean Both Reps						
	0.005	0.069	0.020	0.042	0.003	0.074	0.213
	--	0.056	--	--	0.022	0.018	0.094
	0.004	0.102	0.005	0.005	0.195	0.063	0.367
	0.009	0.029	0.002	0.002	0.048	0.012	0.097

Table 14. Transfer From Herbage to Mulch--Totals by Treatment and Collection Period (g/m2)

	AGSM	BUDA	BOGR	CAEL	BRJA	OTHR	Total
			High Range Condition				
6/10-6/23	0.25	0.21	0.17	0.09	0.36	0.69	1.78
6/24-7/7	0.24	0.18	0.10	0.07	0.77	1.11	2.46
7/8-7/21	0.35	0.15	0.04	0.06	1.01	1.45	3.06
7/22-8/4	0.26	0.11	0.04	0.04	0.57	0.74	1.75
8/5-8/18	0.18	0.06	0.03	0.01	0.14	0.06	0.48
8/19-9/2	0.19	0.07	0.03	0.02	0.15	0.06	0.51
9/3-10/1	0.36	0.13	0.06	0.03	0.29	0.12	0.99
Total	1.83	0.92	0.46	0.31	3.30	4.22	11.02
% Composition	17	8	4	3	30	38	
			Low Range Condition				
6/10-6/23	0.04	0.87	0.14	0.29	0.17	0.64	2.15
6/24-7/7	0.03	1.10	0.03	0.03	1.52	0.56	3.26
7/8-7/21	0.05	1.42	0.06	0.06	2.72	0.88	5.19
7/22-8/4	0.08	0.76	0.04	0.04	1.40	0.42	2.73
8/5-8/18	0.09	0.40	0.02	0.02	0.67	0.16	1.36
8/19-9/2	0.10	0.43	0.02	0.02	0.71	0.17	1.45
9/3-10/1	0.19	0.83	0.04	0.04	1.38	0.33	2.81
Total	0.56	5.81	0.35	0.51	8.57	3.16	18.96
% Composition	3	30	2	3	45	17	

Table 15. Transfer From Herbage to Mulch--Cumulative Totals by Treatments for Data Collection Periods (g/m^2)

	AGSM	BUDA	BOGR	CAEL	BRJA	OTHR	Total
			High Range Condition				
6/10-6/23	0.25	0.21	0.17	0.09	0.36	0.69	1.78
6/24-7/7	0.49	0.39	0.26	0.16	1.13	1.80	4.23
7/8-7/21	0.84	0.55	0.31	0.21	2.14	3.25	7.29
7/22-8/4	1.10	0.65	0.34	0.25	2.72	3.99	9.04
8/5-8/18	1.28	0.72	0.37	0.26	2.86	4.04	9.52
8/19-9/2	1.46	0.78	0.40	0.28	3.01	4.10	10.03
9/3-10/1	1.83	0.92	0.46	0.31	3.30	4.22	11.02
			Low Range Condition				
6/10-6/23	0.04	0.87	0.14	0.29	0.17	0.64	2.15
6/24-7/7	0.06	1.10	0.17	0.33	1.69	1.20	5.41
7/8-7/21	0.11	3.39	0.23	0.39	4.41	2.08	10.61
7/22-8/4	0.19	4.16	0.27	0.43	5.81	2.49	13.34
8/5-8/18	0.28	4.56	0.29	0.45	6.48	2.65	14.69
8/19-9/2	0.37	4.98	0.31	0.47	7.19	2.82	16.15
9/3-10/1	0.56	5.81	0.35	0.51	8.57	3.16	18.96

similar data on a replicate basis. The cumulative totals should be used in the compilation of net primary production estimates. Species peaks of live plus this year's dead herbage should be supplemented with the corresponding cumulative total of herbage transferred to the mulch by the date of the species peak on a replicate basis.

About 19 g/m^2 of current year's production was transferred to the mulch layer on the low range condition treatment and about 11 g/m^2 in the high range condition exclosure during the 1971 growing season. Most of this transferred material is not included in the frequent harvest estimates of net primary production of above-ground plant parts. It, therefore, seems mandatory that this transfer be determined and subsequently accounted for in net primary production estimates of the grassland ecosystem at Cottonwood.

It should be emphasized that at Cottonwood knowledge of the rates of transfer of plant biomass from the herbage to the mulch compartment is considered more critical in estimating net primary production (NPP) than it is in simply characterizing the decomposition process. This creates a problem in measuring the transfer when using a frequent harvest method for estimating NPP.

If the only objective was to describe this mechanical phase of the decompositional process, the plots could be cleared of freshly fallen material as often as time and labor would permit, possibly weekly or more frequent. The manner in which the transfer of herbage to mulch influences NPP estimates is that a portion of the herbage that is transferred to the mulch in the interval between two frequent harvest dates is discolored and not identified as current year's production by the second harvest date. However, some of the transferred material is not discolored and is properly identified as current year's production and is so classified. During intervals that are microclimatically unfavorable for decomposition, and therefore discoloration, material that was transferred will still look like herbage and be classified as herbage. If the standing crop for the date at the end of the interval includes this material and is also supplemented with estimates of transferred material based on separate plots, then the transferred but nondiscolored material is accounted for twice in the NPP estimate.

Since decomposition rates are closely associated with moisture and temperature, the transfer plots should be tended very often in moist warm periods and only rarely in dry or cold periods. The problem is in determining the interval length. Weekly intervals may be too long during warm or hot periods when the mulch layer is moist. During periods when this layer is dry, the intervals should be extended until the layer is moistened by precipitation or heavy dew.

Estimate of Net Primary Production

Net primary production (NPP) was calculated from the above-ground plant standing crop data by adding to the peak live standing crop later significant increases in live plus contributions calculated from the recent dead, old dead, and mulch data. Contributions calculated from the recent dead data were the amount of recent dead at the time of peak live standing crop plus the sum of the significant increases in recent dead which exceeded the corresponding decrease in live. The contribution to NPP calculated from the old dead data was the sum of the significant increases in old dead which were greater than could be accounted for by the corresponding changes in live and recent dead. The contribution to NPP calculated from the mulch data was the sum of the significant increases in mulch which were greater than could be accounted for by the corresponding changes in live, recent dead, and old dead. Creditability of the values calculated from the mulch dynamics can be checked against values extrapolated from the mulch transfer plots. The estimates of herbage transferred to the mulch layer are certainly below the actual. The probability level chosen for significance was .05. Live, recent dead, and old dead contributions were calculated on an organic matter basis by multiplying the oven dry contribution by 0.91, 0.86, and 0.85, respectively.

Net primary production was calculated from the below-ground plant standing crop data by summing the significant increases in standing crop. Standard errors were not available for sums of depth increments but were assumed to be about 8% of the mean. Calculations were made separately from the 0-30 cm plus 30-60 cm depths and from the 0-60 cm depth.

Estimated net primary production not including losses to herbivory are shown in Tables 16 and 17 for the exclosures in high and low range condition, respectively. NPP estimated from the above-ground components was 550 and 252 g/m^2/year oven dry organic matter, respectively, for high and low range condition. NPP estimated from frequent sampling of below-ground standing crop at 0-30 cm and less frequent sampling at 30-60 cm was 682 and 1969 g/m^2, respectively, for high and low range condition.

Table 16. Calculation of Net Primary Production (g/m^2/year oven dry organic matter), Permanent Exclosure, High Range Condition, Cottonwood, 1971

Date	Above-Ground Standing Crop: Live x̄	Live S.E.	Recent Dead x̄	Recent Dead S.E.	Old Dead x̄	Old Dead S.E.	Mulch x̄	Mulch S.E.	Mulch Transfer Total	Below-Ground Standing Crop, Depth, cm: 0-30	30-60	0-60
2 Apr	9	1	0	0	120	8	337	11		1153	242	1395
16 Apr	16	2	0	0	155	10	360	6	2	1255	320b/	1575b/
4 May	49	1	0	0	63	2	381	17	2	1016		
21 May	71	2	0	0	90d/	3	328	10	2	1094		
8 Jun	97	4	0	0	86	3	424e/	15	2	1193	318	1511
22 Jun	188	16	6	2	60	4	343	20	2	1113		
6 Jul	205a/	10	52	3	55	4	294	13	2	1345f/	330	1675h/
20 Jul	150	9	114c/	8	22	3	363e/	22	3	1194		
3 Aug	133	7	167c/	8	23	2	335	11	3	953	277	1230
17 Aug	60	3	208	12	23	3	378	13	1	1015		
2 Sep	92b/	7	220c/	14	10	t	254	14	1	1228g/	240	1468i/
1 Oct	65	3	144	12	0	0	372e/	13	1	1130		
12 Nov	46	5	208	17	7	t	309	13	2			
NPP, dry	237		107		27							
NPP, o.m.	216		92		23		219			604	78	582

Total NPP (g/m^2/year oven dry organic matter = 1232 using 0-30 and 30-60 cm below-ground plant standing crop data or 1132 using only the 0-60 cm data.

a/ Peak live standing crop.
b/ Significant increase since previous date.
c/ Significant increase since previous date greater than accounted for by corresponding changes in live.
d/ Significant increase since previous date greater than accounted for by corresponding changes in live and recent dead.
e/ Significant increase since previous date greater than accounted for by corresponding changes in live, recent dead, and old dead.
f/ Significant increase since May 4.
g/ Significant increase since August 3.
h/ Significant increase since June 8.
i/ Significant increase since August 3.

Table 17. Calculation of Net Primary Production (g/m^2/year oven dry organic matter), Temporary Exclosure, Low Range Condition, Cottonwood, 1971

Date	Above-Ground Standing Crop: Live $\bar{x}$	Live S.E.	Recent Dead $\bar{x}$	Recent Dead S.E.	Old Dead $\bar{x}$	Old Dead S.E.	Mulch $\bar{x}$	Mulch S.E.	Mulch Transfer Total	Below-Ground Standing Crop, Depth, cm: 0-30	30-60	0-60
2 Apr	12	5	0	0	20	3	170	8	1	1671	187	1859
16 Apr	8	1	0	0	29	2	198	8	1	2026f/	370f/	2396
4 May	18	1	0	0	23	2	172	12	2	1860		
21 May	35	2	0	0	29	2	167	7	4	2019		
8 Jun	114	9	2	1	16	2	145	10	4	2103	386	2489f/
22 Jun	153a/	12	3	1	12	1	170	10	2	2414g/		
6 Jul	149	10	19	10	15	1	172	7	3	2337	496i/	2833
20 Jul	99	7	45	7	8	t	179	6	5	2151		
3 Aug	62	4	51	4	12	1	187	8	4	1488	380	1867
17 Aug	43	1	88c/	6	7	t	180	8	1	2231h/		
2 Sep	34	2	58	5	7	1	120	7	2	1732	266	1998h/
1 Oct	66b/	3	54	4	7	t	128	6	3	2033		
12 Nov	4	2	78	4	32d/	2	188e/	7	4			
NPP, dry	186		18		25		47					
NPP, o.m.	169		15		21		47			1876	293	1105

Total NPP (g/m^2/year oven dry organic matter = 2421 using 0-30 and 30-60 cm below-ground plant standing crop data or 1357 using only the 0-60 cm data.

a/ Peak live standing crop.
b/ Significant increase since previous date.
c/ Significant increase since previous date greater than accounted for by corresponding changes in live.
d/ Significant increase since previous date greater than accounted for by corresponding changes in live and recent dead.
e/ Significant increase since previous date greater than accounted for by corresponding changes in live, recent dead, and old dead.
f/ Significant increase since April 2.
g/ Significant increase since May 4.
h/ Significant increase since August 3.
i/ Significant increase since June 8.

When 0-60 cm depths were used, NPP was estimated to be 582 and 1105 for high and low range condition, respectively. Total NPP was thus estimated at 1232 or 1132 and 2421 or 1357 g/m^2 for high and low range condition, respectively, depending on whether two depths or one were used to study the dynamics of the below-ground plant parts.

LITERATURE CITED

Dahlman, R. C. and C. L. Kucera. 1965. Root productivity and turnover in native prairie. Ecology 48:84-89.

Draper, N. R. and H. Smith. 1966. Applied Regression Analysis. John Wiley and Sons, Inc., New York. 407 p.

Lewis, J. K. 1970a. Comprehensive network site description: Cottonwood. U.S. IBP Grassland Biome Tech. Rep. No. 39. 28 p.

Lewis, J. K. 1970b. Primary producers in grassland ecosystems, p. 241: 1-87. In: R. L. Dix and R. G. Beidleman (ed.) The grassland ecosystem: A preliminary synthesis. A Supplement. Range Sci. Dep. Sci. Ser. No. 2 Supplement. Colo. State Univ., Fort Collins. 437 p.

Lewis, J. K., J. L. Dodd, H. L. Hutcheson and C. L. Hanson. 1971. Abiotic and herbage dynamics studies on the Cottonwood site, 1970. U.S. IBP Grassland Biome Tech. Rep. No. 111. 146 p.

Spuhler, W., W. L. Lytle and D. Moe. 1969. Climatological Summary, Cottonwood, South Dakota. Climatography of the U. S. No. 20-39. No. 14. Envir. Sci. Serv. Admin. 6 p.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc., New York. 481 p.

APPENDIX A

APPENDIX TABLES

Appendix Table 1. Daily, Weekly and Monthly Abiotic Data, Cottonwood, South Dakota - 1971.

Explanation of Data

All data are from 0800-0800 MST. The air temperature, relative humidity, radiation and 1 and 2 meter wind values are common for Pastures 1 and 3. The instrumentation for these data is located in Pasture 2. The information in the columns in the table is as follows:

Column

1 Month

2 Day

3 Maximum daily air temperature (°F).

4 Minimum daily air temperature (°F).

5 Average daily air temperature based on maximum and minimum temperatures.

6 Average daily air temperature based on two hourly temperature readings starting at 0800 (°F).

7 Average daily relative humidity based on two hourly relative humidity ratings starting at 0800.

8 11:00 a.m. (MST) relative humidity.

9 Daily evaporation in inches.

10 Maximum daily evaporation pan temperature (°F).

11 Minimum daily evaporation pan temperature (°F).

12 Average daily evaporation pan temperature (°F).

13 Evaporation pan temperature at about 0800 (°F).

14 Daily radiation in Langleys.

15 Total 24-hour pan wind movement in miles. (Data from Pastures 1 and 3).

16 Average daily pan wind in miles per hour. (Data from Pastures 1 and 3).

17 Total 24-hour wind movement at 1 meter in miles.

Column

18 Average daily wind velocity at 1 meter in miles per hour.

19 Total daily wind movement at 2 meters in miles.

20 Average daily wind velocity at 2 meters in miles per hour.

21 The first digit of each day is the prevailing wind direction from 0800-2000; the second digit is the prevailing wind direction from 2000-0800 (Code: 0-N; 1-NE; 2-E; 3-SE; 4-S; 5-SW; 6-W; 7-NW; 8-Variable).

22 Daily precipitation in inches at the evapotranspiration plots in Pastures 1 and 3.

23 Daily runoff in inches from the evapotranspiration plots in Pastures 1 and 3.

24 Daily soil temperatures at 10 cm on the evapotranspiration plots in Pastures 1 and 3 (°F).

25 Daily soil temperature at 20 cm on the evapotranspiration plots in Pastures 1 and 3 (°F).

26 Average daily soil temperatures for the 5, 10, 20, and 50 cm depths in Pastures 1 and 3 (°F).

27 Average daily soil temperatures of the 5, 10, 20, 50, 100, and 150 cm depths for Pastures 1 and 3 (°F).

28 Cloud cover at about 0800 (Code: 0-Clear; 1-25% cloud cover; 2-50% cloud cover; 3-75% cloud cover; 4-Overcast).

29 Code to indicate if precipitation is falling at about 0800 (Code: 0-No; 1-Yes).

The date given for the average values is the beginning of the week or month. The monthly averages are for 28 days.

DAILY E. T. DATA PASTURE 1 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	AV	RH AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	60	49	54	51	79.50	111.90	4.66	128.60	5.36	199.01	8.29	22	2.04	0.67	47	46	46	43	4	0
4	21	61	46	53	51	79	68	0.11	59	46	52	46	185.51	107.40	4.47	120.30	5.01	155.49	6.48	33	0.06	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.05	58	46	52	46	278.26	196.00	8.17	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.05	49	39	44	45	172.26	74.60	3.11	75.20	3.13	107.29	4.47	28	0.00	0.00	42	45	43	42	2	0
4	24	65	42	53	51	72	47	0.14	71	44	57	54	596.28	58.10	2.42	76.00	3.17	94.28	3.93	43	0.00	0.00	44	43	42	41	4	0
4	25	61	36	48	48	67	51	0.16	64	39	51	39	371.02	184.60	7.69	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	38	88	85	0.18	44	37	40	39	145.76	85.60	3.57	100.20	4.17	129.26	5.39	01	0.63	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	44	32	38	37	212.01	141.20	5.88	146.60	6.11	195.96	8.17	17	0.00	0.00	37	40	39	40	4	0
4	28	45	30	37	37	83	82	0.08	47	37	42	42	344.52	118.10	4.92	113.40	4.72	202.06	8.42	78	0.00	0.00	32	39	37	38	3	0
4	29	55	35	45	44	69	55	0.12	61	40	50	44	490.28	54.30	2.26	71.00	2.96	92.45	3.85	73	0.00	0.00	42	43	42	42	1	0
4	30	66	40	53	51	74	61	0.17	70	44	57	50	569.78	95.60	3.98	89.90	3.75	123.36	5.14	46	0.00	0.00	46	46	45	44	1	0
5	1	63	39	51	51	69	53	0.20	72	44	58	47	583.03	83.20	3.47	96.50	4.02	126.61	5.28	03	0.00	0.00	47	47	46	45	2	0
5	2	63	34	48	48	68	63	0.26	69	39	54	44	636.03	119.60	4.98	152.70	6.36	190.47	7.94	03	0.00	0.00	45	47	45	44	1	0
5	3	67	41	54	52	65	51	0.25	69	44	56	50	662.53	112.70	4.70	131.80	5.49	192.71	8.03	33	0.00	0.00	49	49	48	46	0	0
5	4	79	48	63	62	69	46	0.27	81	50	65	62	569.78	94.10	3.92	110.10	4.59	112.38	4.68	28	0.15	0.00	53	52	51	48	1	0
5	5	70	47	58	58	49	40	0.33	75	46	50	49	622.79	132.60	5.53	155.10	6.46	207.35	8.64	21	0.00	0.00	52	54	52	49	3	0
5	6	66	37	51	52	54	37	0.34	61	47	54	48	437.27	155.70	6.49	182.10	7.59	224.43	9.35	11	0.00	0.00	48	50	48	47	0	0
5	7	65	34	49	51	58	30	0.23	71	46	58	48	509.04	64.90	2.70	75.90	3.16	100.58	4.19	18	0.00	0.00	50	53	50	49	0	0
5	8	60	37	48	48	79	59	0.18	66	43	54	50	503.53	92.90	3.87	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	49	48	0	0
5	9	76	54	65	63	50	35	0.39	74	53	63	60	649.28	163.60	6.82	191.40	7.97	231.75	9.66	34	0.00	0.00	56	56	54	51	1	0
5	10	73	50	61	60	73	48	0.12	76	54	65	54	490.28	73.50	3.06	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.21	57	40	48	56	159.01	168.70	7.03	197.30	8.22	223.21	9.30	00	0.60	0.00	51	52	51	49	0	0
5	12	59	38	48	48	65	43	0.23	68	41	54	51	562.53	76.90	3.20	90.00	3.75	128.44	5.35	04	0.00	0.00	51	53	51	49	1	0
5	13	72	44	58	58	52	34	0.31	76	48	62	54	662.53	56.30	2.35	61.70	2.57	86.35	3.60	55	0.00	0.00	52	54	52	49	0	0
5	14	78	50	64	64	54	33	0.37	78	50	64	55	689.04	118.30	4.93	135.70	5.65	177.05	7.38	37	0.00	0.00	56	56	54	51	1	0
5	15	67	46	56	56	70	74	0.23	69	49	59	53	490.28	106.60	4.44	123.00	5.13	158.54	6.61	70	0.00	0.00	58	58	57	53	0	0
5	16	71	44	57	58	51	30	0.29	76	48	62	62	675.79	104.80	4.37	130.80	5.45	163.02	6.79	03	0.00	0.00	59	59	58	54	0	0
5	17	84	47	65	63	68	44	0.33	77	54	65	50	503.53	160.00	6.67	167.40	6.97	240.09	10.00	47	0.13	0.00	56	58	56	53	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN	1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	48	47	83	71	0.74	0.11	50	1828.60	261.23	116.89	4.87	129.97	5.42	168.04	7.00	44	44	44	42	2.82	0.670
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	103.53	4.31	114.56	4.77	160.52	6.69	42	44	43	43	0.00	0.000
5	4	56	56	62	43	1.86	0.27	60	3961.96	565.99	111.04	4.63	129.89	5.41	163.54	6.81	51	52	51	48	0.15	0.000
5	11	56	57	65	49	1.97	0.28	59	3842.70	548.96	113.09	4.71	129.41	5.39	168.10	7.00	54	55	54	51	0.73	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN	1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	52	51	71	57	5.66	0.21	55	13131.44	468.98	111.14	4.63	125.96	5.25	165.05	6.88	48	50	48	47	3.70	0.670

DAILY E. T. DATA PASTURE 1 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS			RH			EVAPORATION					RADIA	WIND (MILES / DAY) (MPH)							PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
5	18	66	41	53	54	60	43	0.28	73	42	57	42	593.03	119.00	4.96	121.30	5.05	204.30	8.51	77	0.00	0.00	56	58	55	53	4	0
5	19	48	39	43	43	82	77	0.12	50	38	44	44	278.26	177.00	7.37	192.70	8.03	260.83	10.87	77	0.00	0.00	51	53	52	50	2	0
5	20	59	34	46	47	59	38	0.19	61	39	50	42	609.53	75.70	3.15	73.40	3.06	133.12	5.55	78	0.00	0.00	51	54	52	50	1	0
5	21	70	46	58	59	59	38	0.34	70	41	55	56	649.28	137.30	5.72	152.00	6.33	206.94	8.62	22	0.00	0.00	57	54	54	52	0	0
5	22	75	56	65	64	66	54	0.42	75	54	64	56	609.53	196.10	8.17	234.10	9.75	304.56	12.69	23	0.00	0.00	50	60	59	56	4	0
5	23	63	45	54	55	92	78	0.08	62	45	53	46	145.76	156.20	6.51	186.90	7.79	251.48	10.48	30	0.45	0.00	0	0	0	0	4	1
5	24	53	39	46	43	94	97	0.31	47	39	43	43	198.76	128.60	5.36	143.40	5.97	196.57	8.19	00	1.09	0.25	49	51	50	50	3	0
5	25	66	41	53	53	71	48	0.31	67	41	54	51	636.03	139.70	5.82	163.90	6.83	214.67	8.94	05	0.00	0.00	52	53	52	51	0	0
5	26	65	43	54	54	66	53	0.21	73	48	60	53	675.79	79.50	3.31	97.90	4.08	126.00	5.25	23	0.00	0.00	55	56	55	53	2	0
5	27	66	45	55	56	63	57	0.31	68	45	56	51	569.78	154.60	6.44	188.00	7.83	268.76	11.20	33	0.00	0.00	53	55	53	52	1	0
5	28	73	49	61	60	64	48	0.36	75	48	61	53	715.54	150.50	6.27	185.80	7.74	242.12	10.09	33	0.00	0.00	56	58	56	54	1	0
5	29	79	57	68	66	71	56	0.37	79	54	66	59	622.78	173.60	7.23	196.90	8.20	250.87	10.45	44	0.00	0.00	61	60	59	56	4	0
5	30	66	58	62	60	91	83	0.02	63	56	59	59	278.26	135.60	5.65	158.50	6.60	204.70	8.53	12	0.81	0.00	0	0	0	0	4	1
5	31	67	52	59	57	94	77	0.33	67	53	60	56	212.01	94.10	3.92	104.60	4.36	174.40	7.27	28	0.54	0.00	58	58	57	55	1	0
6	1	53	51	57	56	91	80	0.11	63	51	57	52	291.52	91.30	3.80	112.40	4.68	153.46	6.39	07	0.00	0.00	56	56	56	54	4	0
6	2	66	52	59	57	86	83	0.15	71	51	61	56	371.02	57.00	2.38	65.90	2.75	101.80	4.24	14	0.00	0.00	59	59	58	56	3	0
6	3	77	54	65	66	75	51	0.23	84	57	70	62	636.03	78.40	3.27	85.90	3.58	124.78	5.20	23	0.00	0.00	52	62	60	57	1	0
6	4	81	64	72	70	80	66	0.27	83	60	71	67	569.78	115.70	4.82	144.30	6.01	192.91	8.04	34	0.00	0.00	57	65	64	60	3	0
6	5	78	54	66	64	73	68	0.31	84	53	68	62	569.78	134.40	5.60	129.70	5.40	166.68	6.94	66	0.00	0.00	53	65	62	59	1	0
6	6	80	52	66	66	61	50	0.34	85	51	68	65	702.29	107.10	4.46	110.00	4.58	142.48	5.94	55	0.00	0.00	0	0	0	0	1	0
6	7	77	54	65	63	78	59	0.29	84	53	68	60	543.28	78.50	3.27	81.60	3.40	121.12	5.05	07	0.14	0.00	54	64	63	59	1	0
6	8	68	54	61	60	81	64	0.20	74	56	65	59	477.03	106.20	4.42	102.90	4.29	158.13	6.59	66	0.00	0.00	53	63	62	58	1	0
6	9	76	62	69	67	76	69	0.17	83	60	71	62	569.78	102.70	4.28	128.70	5.36	174.00	7.25	33	0.00	0.00	53	59	61	58	4	0
6	10	80	54	67	67	74	70	0.37	79	58	68	62	490.28	106.90	4.45	122.10	5.09	163.63	6.82	34	0.07	0.00	64	64	63	60	4	0
6	11	85	61	73	71	67	56	0.30	88	60	74	65	622.78	85.00	3.54	91.80	3.82	122.34	5.10	44	0.12	0.00	57	67	65	61	0	0
6	12	86	58	72	69	72	58	0.41	91	60	75	69	675.79	74.90	3.12	34.00	1.42	109.33	4.56	47	0.33	0.00	57	67	66	61	1	0
6	13	82	58	70	70	78	54	0.20	91	65	78	74	589.04	35.00	1.46	72.90	3.04	60.72	2.53	03	0.00	0.00	71	70	69	64	1	0
6	14	79	54	66	65	85	60	0.20	81	56	68	68	437.27	65.30	2.72	79.60	3.32	108.72	4.53	33	0.03	0.00	68	68	67	62	0	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
5	18	52	52	73	60	1.74	0.25	52	3074.16	439.17	141.41	5.89	157.69	6.57	222.54	9.27	54	55	54	52	1.54	0.250
5	25	59	58	74	60	1.91	0.27	59	3710.20	530.03	132.51	5.52	156.51	6.52	211.65	8.82	55	56	55	53	1.35	0.000
6	1	64	63	78	65	1.70	0.24	66	3683.69	526.24	94.63	3.94	104.26	4.34	143.32	5.97	61	61	61	57	0.14	0.000
6	8	68	67	76	61	1.85	0.27	71	3951.96	565.99	82.29	3.43	90.29	3.76	128.12	5.34	66	65	64	61	0.55	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
5	18	61	60	75	61	7.20	0.26	62	14430.01	515.36	112.71	4.70	127.19	5.30	176.41	7.35	59	59	59	56	3.58	0.250

DAILY E. T. DATA PASTURE 1 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS				RH		EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)							PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
6	15	84	58	71	71	69	48	0.29	85	60	72	66	675.79	81.40	3.39	96.90	4.04	138.41	5.77	33	0.00	0.00	67	68	66	62	0	0
6	16	83	58	70	71	81	69	0.23	90	64	77	65	596.28	60.60	2.53	66.20	2.76	100.79	4.20	78	0.00	0.00	70	70	68	64	4	0
6	17	84	61	72	71	78	69	0.33	90	63	76	68	509.53	64.30	2.68	73.80	3.07	102.21	4.26	88	0.19	0.00	70	70	68	64	0	0
6	18	80	60	70	71	79	65	0.26	89	65	77	72	562.53	66.40	2.77	77.90	3.25	118.07	4.92	02	0.00	0.00	72	72	70	65	1	0
6	19	90	62	76	75	71	59	0.30	89	65	77	68	675.79	85.50	3.56	99.10	4.13	137.39	5.72	35	0.00	0.00	72	72	70	65	1	0
6	20	83	58	70	71	70	51	0.36	96	63	79	69	729.79	88.90	3.70	104.30	4.35	155.08	6.46	08	0.00	0.00	72	70	70	65	3	0
6	21	81	60	70	70	72	51	0.23	81	62	71	65	490.28	53.00	2.21	62.00	2.58	99.36	4.14	35	0.00	0.00	70	71	69	65	3	0
6	22	88	55	71	71	74	58	0.25	88	61	74	67	569.78	45.30	1.89	53.10	2.21	81.87	3.41	86	0.00	0.00	70	71	69	65	1	0
6	23	85	57	71	71	67	44	0.35	89	64	76	73	609.53	67.50	2.81	79.40	3.31	101.60	4.23	44	0.00	0.00	71	72	70	66	0	0
6	24	92	66	79	78	63	49	0.37	90	67	78	72	609.53	101.70	4.24	119.10	4.96	167.49	6.98	42	0.00	0.00	74	74	72	67	1	0
6	25	85	61	73	74	68	54	0.45	89	60	74	69	728.79	115.40	4.81	134.20	5.59	180.10	7.50	13	0.38	0.00	73	75	72	67	1	0
6	26	94	68	81	79	65	54	0.40	91	68	79	72	549.28	106.30	4.43	123.00	5.13	168.30	7.01	33	0.00	0.00	73	73	72	67	1	0
6	27	88	67	77	77	77	56	0.35	85	62	73	69	596.28	87.60	3.65	104.60	4.36	145.93	6.08	00	0.11	0.00	76	76	74	69	4	0
6	28	84	54	69	67	78	67	0.35	86	55	70	59	583.03	128.40	5.35	146.50	6.10	217.72	9.07	00	0.02	0.00	72	74	72	68	1	0
6	29	73	54	63	67	81	57	0.18	72	58	65	66	397.52	102.80	4.28	117.90	4.91	166.88	6.95	20	0.09	0.00	70	71	70	66	4	0
6	30	75	51	63	64	83	90	0.17	76	55	65	58	357.77	73.20	3.05	66.80	2.78	122.95	5.12	77	0.04	0.00	59	69	68	65	0	0
7	1	82	49	65	67	58	35	0.26	85	57	71	61	589.04	56.50	2.35	58.90	2.45	85.94	3.58	08	0.00	0.00	68	69	67	65	0	0
7	2	89	62	75	75	51	40	0.36	91	61	76	69	715.54	56.60	2.36	77.90	3.25	109.73	4.57	33	0.00	0.00	73	73	71	68	1	0
7	3	92	59	75	76	54	42	0.47	85	63	74	68	636.03	170.50	7.10	181.10	7.55	240.70	10.03	45	0.00	0.00	70	73	71	67	1	0
7	4	87	56	71	72	64	49	0.29	85	60	72	68	742.04	95.70	3.99	109.50	4.56	160.37	6.68	07	0.05	0.00	73	73	72	68	2	0
7	5	85	52	68	65	68	35	0.43	86	54	70	59	556.53	61.00	2.54	67.30	2.80	102.01	4.25	04	0.17	0.00	0	0	0	0	1	0
7	6	89	61	75	74	57	45	0.33	88	59	73	68	562.53	75.30	3.14	93.00	3.88	133.32	5.56	44	0.06	0.00	0	0	0	0	1	0
7	7	96	62	79	80	56	57	0.47	90	57	73	58	596.28	201.60	8.40	236.10	9.84	335.67	13.99	47	0.00	0.00	0	0	0	0	3	0
7	8	78	50	64	64	48	32	0.32	75	56	65	58	543.28	91.70	3.82	100.50	4.19	135.15	5.63	08	0.00	0.00	70	72	70	67	3	0
7	9	81	60	70	69	53	44	0.33	79	56	67	62	543.28	111.40	4.64	141.70	5.90	189.45	7.89	33	0.00	0.00	71	71	70	67	1	0
7	10	97	54	75	73	61	42	0.32	93	60	76	70	596.28	71.20	2.97	83.90	3.50	102.62	4.28	43	0.00	0.00	73	73	72	69	1	0
7	11	94	64	79	79	59	33	0.49	88	65	76	66	649.28	199.10	8.30	239.70	9.99	328.15	13.67	33	0.00	0.00	73	74	72	69	4	0
7	12	96	66	81	79	64	55	0.30	92	65	78	66	649.28	129.90	5.41	158.40	6.60	238.06	9.92	37	0.00	0.00	74	74	73	69	2	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
6	15	71	71	74	58	2.00	0.29	75	4438.98	634.14	71.44	2.98	82.89	3.45	121.62	5.07	70	70	69	64	0.19	0.000
6	22	74	74	70	54	2.52	0.36	75	4346.23	620.89	93.17	3.88	108.56	4.52	151.86	6.33	72	73	71	67	0.51	0.000
6	29	69	69	66	49	2.16	0.31	70	4094.47	584.92	88.04	3.67	97.06	4.04	141.23	5.88	70	71	70	66	0.35	0.000
7	6	74	74	57	44	2.56	0.37	73	4240.22	605.75	125.74	5.24	150.47	6.27	208.92	8.70	72	72	71	68	0.06	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
6	15	72	72	67	51	9.24	0.33	73	17119.90	611.43	94.60	3.94	109.74	4.57	155.90	6.50	71	72	70	66	1.11	0.000

DAILY E. T. DATA PASTURE 1 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	AV	RH AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) PAN	1 M	(MPH) 1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
7	13	88	56	72	71	46	36	0.49	87	59	73	60	575.79	84.00	3.50	90.80	3.78	131.29	5.47	70	0.00	0.00	74	75	73	69	3	0
7	14	83	60	71	71	46	34	0.29	85	60	72	64	609.53	63.20	2.63	74.10	3.09	113.80	4.74	34	0.00	0.00	74	74	73	69	2	0
7	15	88	51	69	72	47	24	0.50	83	57	70	63	702.29	77.50	3.23	97.20	4.05	123.16	5.13	08	0.00	0.00	74	75	73	70	0	0
7	16	94	54	74	76	41	29	0.41	88	60	74	63	702.29	58.20	2.43	58.60	2.44	90.82	3.78	78	0.00	0.00	74	75	73	70	0	0
7	17	100	59	79	81	38	23	0.45	91	57	74	65	649.28	58.80	2.45	77.50	3.23	103.63	4.32	03	0.00	0.00	75	75	74	70	3	0
7	18	93	60	76	77	64	57	0.25	81	62	71	65	331.27	100.50	4.19	112.70	4.70	144.71	6.03	47	0.03	0.00	72	73	72	69	1	1
7	19	82	50	66	68	62	37	0.45	78	55	66	58	562.53	122.50	5.10	126.90	5.29	207.55	8.65	77	0.00	0.00	72	73	71	69	1	0
7	20	87	52	69	71	51	40	0.31	84	57	70	63	596.28	54.40	2.27	60.30	2.51	84.72	3.53	78	0.00	0.00	72	75	72	69	1	0
7	21	94	56	75	77	35	26	0.41	89	61	75	63	649.28	42.50	1.77	52.80	2.20	80.04	3.34	68	0.00	0.00	75	75	74	70	3	0
7	22	99	62	80	78	52	28	0.38	83	64	73	69	728.79	89.90	3.75	106.80	4.45	153.66	6.40	78	0.00	0.00	75	75	74	70	1	0
7	23	94	56	76	76	56	34	0.46	86	61	73	67	549.28	85.00	3.54	94.00	3.92	131.09	5.46	08	0.00	0.00	77	77	75	71	1	0
7	24	91	66	78	77	49	37	0.42	90	65	77	71	636.03	88.80	3.70	121.60	5.07	140.44	5.85	04	0.00	0.00	76	76	75	71	0	0
7	25	99	56	77	77	47	26	0.42	86	58	72	60	397.52	128.30	5.35	141.90	5.91	199.01	8.29	60	0.28	0.00	73	76	73	70	2	0
7	26	72	44	58	58	63	53	0.21	69	50	59	50	437.27	70.60	2.94	66.60	2.78	123.97	5.17	76	0.00	0.00	66	70	68	66	1	0
7	27	80	49	64	65	49	33	0.27	79	50	64	53	509.53	52.70	2.20	49.30	2.05	86.55	3.61	77	0.00	0.00	68	71	69	67	3	0
7	28	81	42	61	64	50	26	0.35	67	48	57	53	384.27	147.70	6.15	147.30	6.14	204.70	8.53	77	0.00	0.00	64	68	66	65	1	0
7	29	68	43	55	54	68	34	0.15	67	45	56	47	344.52	92.20	3.84	82.30	3.43	129.87	5.41	76	0.00	0.00	62	66	64	64	2	0
7	30	73	39	56	58	49	33	0.29	70	46	58	51	583.03	90.70	3.78	104.00	4.33	136.58	5.69	08	0.00	0.00	63	67	65	65	0	0
7	31	85	44	64	66	40	25	0.28	82	52	67	58	689.04	47.30	1.97	52.00	2.17	72.11	3.00	66	0.00	0.00	66	69	67	66	1	0
8	1	93	54	73	75	46	18	0.42	80	56	68	63	583.03	77.20	3.22	86.50	3.60	126.41	5.27	77	0.00	0.00	71	72	71	68	0	0
8	2	88	49	68	70	48	34	0.37	84	53	68	56	536.03	71.20	2.97	96.80	4.03	125.80	5.24	02	0.00	0.00	71	73	68	67	1	0
8	3	83	52	67	68	48	38	0.38	81	53	67	55	596.28	93.40	3.89	102.50	4.27	159.96	6.67	22	0.00	0.00	71	73	71	68	3	0
8	4	87	61	74	74	60	52	0.42	80	55	67	65	596.28	164.30	6.85	194.40	8.10	262.66	10.94	33	0.00	0.00	72	73	71	68	1	0
8	5	95	60	77	78	56	40	0.48	83	62	72	66	636.03	118.70	4.95	142.60	5.94	209.99	8.75	33	0.00	0.00	73	73	71	68	1	0
8	6	95	60	77	78	48	30	0.47	85	60	72	64	609.53	99.10	4.13	117.40	4.89	166.68	6.94	33	0.00	0.00	74	75	73	70	0	0
8	7	95	62	78	79	42	28	0.47	86	59	72	67	675.79	103.40	4.31	125.20	5.22	157.73	6.57	33	0.00	0.00	0	0	0	0	0	0
8	8	95	65	80	79	42	29	0.52	85	59	72	62	662.53	98.60	4.11	126.60	5.28	180.10	7.50	34	0.00	0.00	76	77	75	71	1	0
8	9	101	64	82	82	40	32	0.48	89	61	74	65	649.28	85.10	3.55	104.30	4.35	130.68	5.45	44	0.00	0.00	75	76	75	71	0	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
7	13	72	74	49	34	2.84	0.41	71	4332.98	619.00	80.67	3.36	91.11	3.80	130.71	5.45	73	74	73	59	0.03	0.000
7	20	73	73	50	34	2.61	0.37	71	4094.47	584.92	79.93	3.33	92.00	3.83	130.42	5.43	73	74	73	70	0.28	0.000
7	27	63	64	50	29	2.14	0.31	62	3829.45	547.06	82.71	3.45	88.31	3.68	126.00	5.25	66	69	67	56	0.00	0.000
8	3	76	77	48	35	3.22	0.46	71	4425.73	632.25	108.94	4.54	130.43	5.43	181.11	7.55	73	74	72	69	0.00	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
7	13	71	72	49	33	10.81	0.39	69	16682.53	595.81	88.06	3.67	100.46	4.19	142.06	5.92	71	73	71	69	0.31	0.000

DAILY E. T. DATA PASTURE 1 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS			RH			EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
8	10	104	59	81	82	40	22	0.52	89	59	74	61	583.03	103.60	4.32	112.70	4.70	154.47	6.44	00	0.00	0.00	75	76	74	71	0	0
8	11	87	53	70	71	46	36	0.41	80	56	68	61	636.03	72.50	3.02	85.00	3.54	118.89	4.95	02	0.00	0.00	74	75	73	70	1	0
8	12	94	58	76	77	45	29	0.31	85	60	72	67	556.53	44.00	1.83	51.50	2.15	72.93	3.04	12	0.00	0.00	76	77	75	72	1	0
8	13	102	67	84	83	36	24	0.49	89	62	75	66	596.28	76.40	3.18	90.70	3.78	117.26	4.89	33	0.00	0.00	0	0	0	0	4	0
8	14	95	57	76	79	45	28	0.26	76	62	69	65	291.52	85.90	3.58	103.80	4.33	143.49	5.98	23	0.00	0.00	0	0	0	0	0	0
8	15	93	60	76	78	51	35	0.55	84	60	72	66	649.28	125.60	5.23	165.90	6.91	211.21	8.80	33	0.00	0.00	0	0	0	0	0	0
8	16	97	68	82	83	46	33	0.49	84	62	73	69	636.03	146.80	6.12	199.40	8.31	253.11	10.55	44	0.00	0.00	77	77	76	72	0	0
8	17	96	67	81	83	52	40	0.55	87	66	76	68	583.03	128.20	5.34	151.00	6.29	216.50	9.02	44	0.00	0.00	78	79	77	73	0	0
8	18	102	65	83	81	50	29	0.45	88	63	75	65	450.52	103.30	4.30	122.40	5.10	161.39	6.72	44	0.00	0.00	78	79	77	73	2	0
8	19	80	56	69	68	81	80	0.21	77	62	69	69	331.27	68.10	2.84	74.20	3.09	107.50	4.48	77	0.15	0.00	71	73	72	69	0	0
8	20	92	57	74	76	48	33	0.40	85	59	72	63	556.53	79.00	3.29	99.80	4.16	131.29	5.47	03	0.00	0.00	73	75	73	71	1	0
8	21	97	57	77	76	46	32	0.41	83	59	71	61	463.77	89.00	3.71	103.40	4.31	141.87	5.91	44	0.00	0.00	72	74	72	70	0	0
8	22	102	59	80	80	46	31	0.47	88	60	74	66	569.78	75.40	3.14	84.90	3.54	119.50	4.98	88	0.19	0.00	73	76	74	71	1	0
8	23	103	66	84	83	42	31	0.41	88	60	74	65	583.03	54.40	2.27	62.50	2.60	84.11	3.50	47	0.00	0.00	72	74	72	69	1	0
8	24	100	46	74	72	43	27	0.51	82	50	66	54	543.28	140.50	5.85	147.30	6.14	247.00	10.29	77	0.00	0.00	70	73	71	69	0	0
8	25	87	52	69	69	42	31	0.32	80	54	67	62	556.53	46.70	1.95	42.80	1.78	71.30	2.97	82	0.00	0.00	71	73	72	70	0	0
8	26	93	56	74	74	41	31	0.36	83	56	69	59	530.03	64.40	2.68	83.50	3.48	104.65	4.36	83	0.00	0.00	72	74	73	71	1	0
8	27	90	58	74	75	49	36	0.42	79	58	58	64	490.28	111.10	4.63	127.30	5.30	205.11	8.55	33	0.00	0.00	72	74	72	70	1	0
8	28	94	61	77	76	53	38	0.43	85	62	73	66	543.28	86.20	3.59	92.00	3.83	130.88	5.45	43	0.00	0.00	73	73	72	70	0	0
8	29	95	70	82	82	45	43	0.42	84	64	74	67	543.28	111.70	4.65	138.00	5.75	190.06	7.92	44	0.00	0.00	76	77	75	72	1	0
8	30	100	67	83	81	61	40	0.54	86	66	76	66	437.27	117.90	4.91	136.00	5.67	187.22	7.80	41	1.65	0.21	74	77	74	71	4	0
8	31	71	61	66	65	89	93	0.08	71	63	67	65	198.76	80.10	3.34	86.50	3.60	123.97	5.17	11	0.00	0.00	72	73	72	70	4	0
9	1	81	64	72	69	82	82	0.12	74	64	69	69	291.52	94.00	3.92	106.50	4.44	149.39	6.22	34	0.00	0.00	71	71	71	69	2	0
9	2	96	64	80	79	55	32	0.14	88	65	76	68	543.28	77.20	3.22	88.50	3.69	124.99	5.21	04	0.00	0.00	71	73	72	70	1	0
9	3	104	64	84	84	39	26	0.51	88	60	74	61	543.28	141.60	5.90	154.20	6.42	213.45	8.89	57	0.00	0.00	71	72	71	69	2	0
9	4	82	54	68	68	61	46	0.33	72	54	63	55	304.77	212.10	8.84	209.40	8.73	298.05	12.42	77	0.68	0.00	0	0	0	0	4	1
9	5	57	52	54	55	93	93	0.00	56	51	53	56	106.01	288.90	12.04	295.30	12.30	378.38	15.77	66	1.80	0.19	0	0	0	0	4	1
9	6	70	50	60	56	85	93	0.10	59	48	53	59	225.26	137.90	5.75	132.50	5.52	222.60	9.28	76	0.05	0.00	61	61	63	64	0	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)					SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN	1 METER		2 METER		10	20	50	150	(INS)	(INS)
8	10	78	79	44	29	3.03	0.43	72	3948.71	564.10	93.54	3.90	115.57	4.82	153.05	6.38	75	76	75	71	0.00	0.000
8	17	78	78	52	39	2.90	0.42	73	3537.94	505.42	85.34	3.56	99.74	4.16	137.45	5.73	73	75	74	71	0.34	0.000
8	24	76	76	48	35	3.00	0.43	70	3643.94	520.56	96.93	4.04	109.56	4.56	162.32	6.76	72	74	72	70	1.65	0.210
8	31	69	68	72	66	1.63	0.23	65	2212.87	316.12	147.40	6.14	153.27	6.39	215.83	8.99	69	70	70	69	2.53	0.190

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
8	10	75	75	54	42	10.56	0.38	70	13343.45	476.55	105.80	4.41	119.54	4.98	167.16	6.97	72	74	73	70	4.52	0.400

DAILY E. T. DATA PASTURE 1 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS				RH		EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
9	7	89	56	72	71	58	42	0.27	78	56	67	58	516.78	61.70	2.57	71.30	2.97	110.34	4.60	43	0.00	0.00	62	65	64	64	0	0
9	8	79	55	67	64	76	53	0.32	72	54	63	54	424.02	164.30	6.85	168.10	7.00	261.24	10.88	76	0.32	0.00	63	65	64	65	0	0
9	9	68	46	57	56	69	40	0.12	65	49	57	54	291.52	51.90	2.16	62.40	2.60	82.89	3.45	43	0.00	0.00	60	62	61	63	4	0
9	10	79	50	64	62	68	54	0.15	77	53	65	58	543.28	41.30	1.72	38.60	1.61	65.60	2.73	08	0.00	0.00	52	64	63	64	0	0
9	11	82	53	67	66	60	39	0.24	78	54	66	57	503.53	74.10	3.09	102.00	4.25	137.39	5.72	14	0.00	0.00	53	65	64	64	1	0
9	12	91	54	72	73	45	36	0.45	78	51	64	51	556.53	151.70	6.32	185.30	7.72	273.85	11.41	47	0.00	0.00	53	65	63	64	0	0
9	13	79	50	64	63	52	34	0.25	75	46	60	59	530.03	69.00	2.88	80.20	3.34	99.97	4.17	74	0.00	0.00	62	64	63	63	1	0
9	14	95	43	69	68	51	32	0.42	82	48	65	48	450.52	95.10	3.96	90.60	3.77	131.90	5.50	67	0.00	0.00	51	63	62	62	0	0
9	15	67	36	51	50	60	37	0.23	61	38	49	42	397.52	122.60	5.11	106.90	4.45	166.27	6.93	76	0.00	0.00	52	66	63	63	3	0
9	16	64	34	49	48	66	36	0.14	57	37	47	42	344.52	92.00	3.83	82.50	3.44	124.58	5.19	77	0.00	0.00	55	59	58	60	1	0
9	17	58	35	46	45	71	44	0.20	59	39	49	39	371.02	131.90	5.50	117.70	4.90	192.91	8.04	77	0.00	0.00	55	58	57	59	1	0
9	18	54	38	46	45	69	50	0.06	53	39	46	41	251.76	51.90	2.16	60.00	2.50	88.18	3.67	08	0.06	0.00	56	60	58	60	1	0
9	19	58	36	47	45	69	46	0.16	59	36	47	44	450.52	104.50	4.35	103.70	4.32	125.19	5.22	44	0.00	0.00	56	59	58	60	4	0
9	20	68	38	53	51	56	33	0.14	64	40	52	43	424.02	59.60	2.48	56.30	2.35	92.45	3.85	55	0.00	0.00	55	57	56	59	1	0
9	21	70	40	55	50	73	39	0.16	63	41	52	42	304.77	133.00	5.54	171.40	7.14	205.52	8.56	00	0.07	0.00	54	56	55	58	3	0
9	22	51	40	45	43	61	38	0.11	56	40	48	43	331.27	51.30	2.14	58.30	2.43	73.54	3.06	05	0.00	0.00	54	56	55	58	3	0
9	23	62	37	49	47	61	39	0.13	63	38	50	44	450.52	56.90	2.37	62.30	2.60	85.94	3.58	64	0.00	0.00	53	56	55	58	3	0
9	24	71	40	55	55	53	31	0.22	68	42	55	46	477.03	64.30	2.68	85.50	3.56	117.06	4.88	34	0.00	0.00	55	57	56	58	1	0
9	25	77	48	62	62	63	37	0.29	70	45	57	55	490.28	162.70	6.78	188.70	7.86	242.73	10.11	44	0.00	0.00	56	58	57	58	1	0
9	26	84	53	68	66	47	33	0.21	74	52	63	56	437.27	70.10	2.92	81.60	3.40	112.99	4.71	44	0.00	0.00	58	59	58	59	0	0
9	27	81	49	65	64	52	35	0.22	74	52	63	53	437.27	49.90	2.08	60.60	2.53	101.19	4.22	00	0.00	0.00	59	60	59	59	1	0
9	28	73	47	60	59	65	46	0.27	69	45	57	50	450.52	140.70	5.86	178.50	7.44	218.94	9.12	05	0.17	0.00	58	59	58	59	3	0
9	29	63	44	53	53	63	59	0.18	62	45	53	47	410.77	122.80	5.12	138.50	5.77	193.72	8.07	73	0.00	0.00	55	57	56	58	1	0
9	30	77	52	64	61	69	47	0.16	69	46	57	54	397.52	95.10	3.96	126.60	5.28	166.47	6.94	43	0.00	0.00	57	58	57	58	3	0
10	1	70	48	59	58	74	58	0.12	66	52	59	53	265.01	110.30	4.60	121.90	5.08	159.96	6.67	71	0.00	0.00	58	58	57	58	4	0
10	2	58	44	51	51	81	91	0.10	56	41	48	43	66.25	263.60	10.98	274.80	11.45	339.94	14.16	15	0.35	0.00	53	57	55	57	4	0
10	3	52	40	46	43	71	83	0.03	43	38	40	41	132.51	308.40	12.85	451.10	18.80	462.98	19.29	67	0.10	0.00	51	54	53	56	4	1
10	4	63	40	51	49	65	41	0.21	60	41	50	44	450.52	177.10	7.38	40.40	1.68	223.82	9.33	76	0.00	0.00	49	53	51	54	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
9	7	66	65	61	42	1.80	0.26	63	3365.58	480.81	87.71	3.65	101.13	4.21	147.33	6.14	62	64	63	64	0.32	0.000
9	14	51	50	63	39	1.35	0.19	50	2689.89	384.27	93.94	3.91	88.26	3.68	131.64	5.48	57	60	59	61	0.06	0.000
9	21	57	55	58	36	1.34	0.19	55	2928.40	418.34	84.03	3.50	101.20	4.22	134.14	5.59	55	57	55	58	0.07	0.000
9	28	55	53	70	59	1.07	0.15	52	2173.11	310.44	174.00	7.25	190.26	7.93	252.26	10.51	54	56	55	57	0.62	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
9	7	57	56	63	44	5.56	0.20	55	11157.09	398.47	109.92	4.58	120.21	5.01	166.34	6.93	57	59	58	60	1.07	0.000

DAILY E. T. DATA PASTURE 1 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS				RH		EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
10	5	74	44	59	56	71	41	0.16	62	41	51	48	318.02	118.50	4.94	104.50	4.35	143.49	5.98	66	0.00	0.00	51	53	52	55	1	0
10	6	73	46	59	57	66	37	0.16	67	46	56	50	424.02	76.70	3.20	70.00	2.92	107.29	4.47	76	0.00	0.00	54	53	54	56	1	0
10	7	78	45	61	60	68	42	0.14	72	47	59	49	384.27	38.90	1.62	45.70	1.90	69.47	2.89	64	0.00	0.00	53	55	54	56	1	0
10	8	70	35	52	50	60	40	0.19	62	38	50	43	291.52	165.80	6.91	149.90	6.25	218.53	9.11	77	0.00	0.00	49	53	51	54	1	0
10	9	56	30	43	42	64	38	0.28	53	35	44	38	490.28	172.90	7.20	160.40	6.68	260.63	10.86	77	0.00	0.00	49	50	51	54	1	0
10	10	66	46	56	53	49	30	0.17	58	38	48	48	437.27	89.30	3.72	82.00	3.42	114.00	4.75	76	0.00	0.00	0	0	0	0	1	0
10	11	81	37	59	56	68	40	0.22	68	42	55	46	437.27	66.50	2.77	70.80	2.95	122.14	5.09	78	0.00	0.00	0	0	0	0	1	0
10	12	73	51	62	59	49	36	0.20	63	44	53	50	344.52	136.90	5.70	272.30	11.35	225.24	9.39	37	0.00	0.00	55	56	55	57	1	0
10	13	62	29	45	47	63	45	0.37	57	38	47	38	397.52	216.10	9.00	101.60	4.23	328.96	13.71	74	0.00	0.00	50	54	53	55	2	0
10	14	74	45	59	56	49	26	0.19	60	37	48	46	357.77	158.90	6.62	148.70	6.20	216.50	9.02	47	0.00	0.00	53	54	53	55	1	0
10	15	57	43	50	49	63	50	0.18	60	41	50	41	357.77	121.20	5.05	138.40	5.77	186.81	7.78	01	0.00	0.00	52	55	53	55	4	0

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 — APPENDIX TABLE 1

DATE		AIR TEMPS				RH		EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.25	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.25	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	38	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.40	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	66	40	53	51	74	61	0.13	70	43	56	50	569.79	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	63	34	48	48	68	63	0.24	68	38	53	44	536.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.80	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	49	40	0.32	75	45	60	49	522.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.24	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	76	54	65	63	50	35	0.39	74	50	62	60	569.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.28	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	38	48	48	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	662.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.54	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.28	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	575.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	68	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2M	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	49	47	63	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	168.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2M	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS				RH		EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.25	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.25	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	38	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.60	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	66	40	53	51	74	61	0.13	70	43	56	50	569.78	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	43	34	48	48	69	63	0.24	68	38	53	44	636.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.80	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	49	40	0.32	75	45	60	49	622.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.24	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	76	54	65	63	50	35	0.39	74	50	62	60	569.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.29	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	38	48	49	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	662.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.56	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.29	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	575.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	68	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2M	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	49	47	43	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	168.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2M	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	AV	RH AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.25	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.26	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	38	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.40	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	66	40	53	51	74	61	0.13	70	43	56	50	569.79	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	63	34	48	48	68	63	0.24	68	38	53	44	536.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.80	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	44	40	0.32	75	45	60	49	522.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.24	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	76	54	65	63	59	35	0.38	74	50	62	60	549.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.28	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	38	48	48	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	562.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.54	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.28	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	675.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	68	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2M	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	48	47	43	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	166.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2M	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971   APPENDIX TABLE 1

DATE 1	2	AIR TEMPS MA 3	MI 4	AV 5	AV 6	RH AV 7	11 8	EVAPORATION INS 9	MA 10	MI 11	AV 12	PRE 13	RADIA LYS 14	PAN 15	WIND (MILES / DAY) (MPH) PAN 16	1 M 17	1 M 18	2 M 19	2 M 20	DIR 21	PREC INS 22	RO INS 23	SOIL TEMPS 10 24	20 25	50 26	150 27	WX COND CLD 28	RN 29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.26	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.26	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	39	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.40	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	66	40	53	51	74	61	0.13	70	43	56	50	569.79	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	63	34	48	49	69	63	0.24	68	38	53	44	636.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.90	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	49	40	0.32	75	45	60	49	622.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.24	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	76	54	65	63	50	35	0.39	74	50	62	60	569.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.29	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	38	48	49	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	662.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.54	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.28	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	575.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	68	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	49	47	63	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	166.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	AV	RH AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.25	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.26	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	38	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.40	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	46	40	53	51	74	61	0.13	70	43	56	50	569.79	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	43	34	48	48	68	63	0.24	68	38	53	44	636.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.90	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	49	40	0.32	75	45	60	49	522.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.24	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	75	54	65	63	50	35	0.39	74	50	62	60	549.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.28	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	34	48	48	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	662.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.54	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.28	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	575.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	68	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN	1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	48	47	53	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	166.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN	1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS			RH			EVAPORATION				RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.25	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.25	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	39	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.40	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	66	40	53	51	74	61	0.13	70	43	56	50	569.78	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	63	34	48	49	68	63	0.24	68	38	53	44	636.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.80	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	49	40	0.32	75	45	60	49	522.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.24	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	76	54	65	63	50	35	0.39	74	50	62	60	549.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.28	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	38	48	48	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	562.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.54	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.28	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	575.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	69	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION			WINDS (AV DAILY MILES) (AV MPH)					SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV		PAN	1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	49	47	53	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	166.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION			WINDS (AV DAILY MILES) (AV MPH)					SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV		PAN	1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	RH AV	AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.25	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.25	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	38	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.40	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	46	40	53	51	74	61	0.13	70	43	56	50	569.78	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	43	34	48	49	68	63	0.24	68	38	53	44	536.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.80	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	49	40	0.32	75	45	60	49	522.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.24	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	76	54	65	63	50	35	0.39	74	50	62	60	549.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.28	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	38	48	48	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	662.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.54	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.28	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	575.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	68	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	49	47	43	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	166.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS				RH		EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
4	20	58	48	53	53	96	95	0.05	54	51	52	52	79.50	101.10	4.21	128.60	5.36	199.01	8.29	22	2.12	0.01	49	49	48	45	4	0
4	21	61	46	53	51	79	68	0.12	59	46	52	47	185.51	88.60	3.69	120.30	5.01	155.49	6.48	33	0.07	0.00	0	0	0	0	4	1
4	22	57	46	51	48	90	63	0.07	59	45	52	46	278.25	164.30	6.85	208.80	8.70	258.39	10.77	22	0.09	0.00	0	0	0	0	4	1
4	23	50	35	42	43	92	94	0.01	50	37	43	45	172.25	56.10	2.34	75.20	3.13	107.29	4.47	28	0.00	0.00	42	44	43	42	2	0
4	24	65	42	53	51	72	47	0.17	71	43	57	53	596.28	65.50	2.73	76.00	3.17	94.28	3.93	43	0.00	0.00	47	48	46	45	4	0
4	25	61	36	48	48	67	51	0.16	65	39	52	39	371.02	149.00	6.21	200.70	8.36	232.57	9.69	21	0.00	0.00	0	0	0	0	4	1
4	26	43	33	38	38	88	85	0.19	44	37	40	41	145.76	85.90	3.58	100.20	4.17	129.26	5.39	01	0.68	0.00	0	0	0	0	4	1
4	27	39	32	35	35	96	94	0.01	45	32	38	37	212.01	138.00	5.75	146.60	6.11	195.96	8.17	17	0.00	0.00	42	44	43	43	4	0
4	28	45	30	37	37	83	82	0.10	47	36	41	40	344.52	117.50	4.90	113.40	4.72	202.06	8.42	78	0.00	0.00	41	42	41	42	3	0
4	29	55	35	45	44	69	55	0.12	61	39	50	43	490.28	61.00	2.54	71.00	2.96	92.45	3.85	73	0.00	0.00	43	44	43	43	1	0
4	30	46	40	53	51	74	61	0.13	70	43	56	50	569.79	76.10	3.17	89.90	3.75	123.36	5.14	46	0.00	0.00	45	45	44	43	1	0
5	1	63	39	51	51	69	53	0.23	71	44	57	48	583.03	85.10	3.55	96.50	4.02	126.61	5.28	03	0.00	0.00	49	49	48	46	2	0
5	2	43	34	48	43	69	63	0.24	68	38	53	44	636.03	122.10	5.09	152.70	6.36	190.47	7.94	03	0.00	0.00	48	50	48	46	1	0
5	3	67	41	54	52	65	51	0.26	69	43	56	49	662.53	117.30	4.89	131.90	5.49	192.71	8.03	33	0.00	0.00	49	49	48	47	0	0
5	4	79	48	63	62	69	46	0.27	80	48	64	62	569.78	87.30	3.64	110.10	4.59	112.38	4.68	28	0.17	0.00	53	52	51	49	1	0
5	5	70	47	58	58	49	40	0.32	75	45	60	49	622.78	112.10	4.67	155.10	6.46	207.35	8.64	21	0.00	0.00	52	53	51	49	3	0
5	6	66	37	51	52	54	37	0.30	61	47	54	48	437.27	142.80	5.95	182.10	7.59	224.43	9.35	11	0.00	0.00	50	51	50	48	0	0
5	7	65	34	49	51	58	38	0.26	70	44	57	48	689.04	63.60	2.65	75.90	3.16	100.58	4.19	18	0.00	0.00	49	51	49	48	0	0
5	8	60	37	48	48	79	59	0.16	65	42	53	50	503.53	82.10	3.42	108.60	4.53	134.95	5.62	03	0.00	0.00	49	51	50	48	0	0
5	9	76	54	65	63	50	35	0.39	74	50	62	60	569.28	149.90	6.25	191.40	7.97	231.75	9.66	34	0.00	0.00	53	53	52	50	1	0
5	10	73	50	61	60	73	48	0.11	77	54	65	54	490.29	68.20	2.84	86.00	3.58	133.32	5.56	48	0.00	0.00	0	0	0	0	4	1
5	11	55	40	47	49	94	90	0.18	56	41	48	55	159.01	138.40	5.77	197.30	8.22	223.21	9.30	00	0.68	0.00	51	51	51	49	0	0
5	12	59	38	48	48	65	43	0.19	67	42	54	48	662.53	71.90	3.00	90.00	3.75	128.44	5.35	04	0.00	0.00	50	52	50	49	1	0
5	13	72	44	58	58	52	34	0.25	77	48	62	56	562.53	55.60	2.32	61.70	2.57	86.35	3.60	55	0.00	0.00	52	53	52	50	0	0
5	14	78	50	64	64	54	33	0.42	80	51	65	57	689.04	108.90	4.54	135.70	5.65	177.05	7.38	37	0.00	0.00	54	55	53	51	1	0
5	15	67	46	56	56	70	74	0.18	69	50	59	54	490.29	109.80	4.58	123.00	5.13	158.54	6.61	70	0.00	0.00	55	54	54	51	0	0
5	16	71	44	57	58	51	30	0.31	76	49	62	65	575.79	103.60	4.32	130.80	5.45	163.02	6.79	03	0.00	0.00	56	56	55	53	0	0
5	17	84	47	65	63	68	44	0.32	78	49	63	56	503.53	142.70	5.95	167.40	6.97	240.09	10.00	47	0.16	0.00	54	54	53	51	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	48	47	43	71	0.77	0.11	50	1828.60	261.23	101.50	4.23	129.97	5.42	168.04	7.00	46	47	46	44	2.96	0.010
4	27	46	45	75	65	1.09	0.16	50	3498.18	499.74	102.44	4.27	114.56	4.77	160.52	6.69	45	46	45	44	0.00	0.000
5	4	56	56	62	43	1.78	0.26	59	3961.96	565.99	100.86	4.20	129.89	5.41	163.54	6.81	51	51	50	49	0.17	0.000
5	11	56	57	65	49	1.85	0.27	59	3842.70	548.96	104.41	4.35	129.41	5.39	166.10	7.00	53	53	53	51	0.84	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP		RH		EVAPORATION			RADIATION		WINDS (AV DAILY MILES) (AV MPH)						SOIL TEMPS				PREC	RO
		AV	AV2H	AV	11	TOTAL	MEAN	TEMP	TOTAL	AV	PAN		1 METER		2 METER		10	20	50	150	(INS)	(INS)
4	20	52	51	71	57	5.49	0.20	54	13131.44	468.98	102.30	4.26	125.96	5.25	165.05	6.88	49	50	49	47	3.97	0.010

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	RH AV	AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
5	18	66	41	53	54	60	43	0.27	74	42	58	43	583.03	121.80	5.08	121.30	5.05	204.30	8.51	77	0.00	0.00	55	57	55	53	4	0
5	19	48	39	43	43	82	77	0.13	50	38	44	47	278.26	172.20	7.17	192.70	8.03	260.83	10.87	77	0.00	0.00	50	52	51	50	2	0
5	20	59	34	46	47	59	38	0.22	62	40	51	45	509.53	71.00	2.96	73.40	3.06	133.12	5.55	78	0.00	0.00	52	53	52	51	1	0
5	21	70	46	58	59	59	35	0.32	71	44	57	58	549.28	125.70	5.24	152.00	6.33	206.94	8.62	22	0.00	0.00	56	55	55	53	0	0
5	22	75	56	65	64	66	54	0.36	77	54	65	57	609.53	173.90	7.25	234.10	9.75	304.56	12.69	23	0.00	0.00	57	57	56	54	4	0
5	23	63	45	54	55	92	78	0.10	63	45	54	45	145.76	141.70	5.90	186.90	7.79	251.48	10.48	30	0.45	0.00	0	0	0	0	4	1
5	24	53	39	46	43	94	97	0.31	47	39	43	45	198.76	91.40	3.81	143.40	5.97	196.57	8.19	00	1.30	0.00	52	54	53	52	3	0
5	25	66	41	53	53	71	48	0.30	67	43	55	52	636.03	125.60	5.23	163.90	6.83	214.67	8.94	05	0.00	0.00	52	52	52	52	0	0
5	26	65	43	54	54	66	53	0.23	75	48	61	54	675.79	81.70	3.40	97.90	4.08	126.00	5.25	23	0.00	0.00	55	55	54	53	2	0
5	27	66	45	55	56	63	57	0.28	69	45	57	52	569.78	151.10	6.30	188.00	7.83	268.76	11.20	33	0.00	0.00	56	57	56	54	1	0
5	28	73	49	61	60	64	43	0.30	76	49	62	54	715.54	149.40	6.22	185.80	7.74	242.12	10.09	33	0.00	0.00	55	56	55	53	1	0
5	29	79	57	68	66	71	56	0.30	80	55	67	60	622.78	161.10	6.71	196.90	8.20	250.87	10.45	44	0.00	0.00	50	59	58	55	4	0
5	30	66	58	62	60	91	83	0.03	62	57	59	59	278.26	99.40	4.14	158.50	6.60	204.70	8.53	12	0.81	0.00	0	0	0	0	4	1
5	31	67	52	59	57	94	77	0.33	68	53	60	57	212.01	122.10	5.09	104.60	4.36	174.40	7.27	28	0.43	0.00	58	58	57	55	1	0
6	1	63	51	57	56	91	80	0.14	62	51	56	52	291.52	88.40	3.68	112.40	4.68	153.46	6.39	07	0.00	0.00	57	57	57	55	4	0
6	2	66	52	59	57	86	83	0.10	71	52	61	56	371.02	56.70	2.36	65.90	2.75	101.80	4.24	14	0.00	0.00	59	59	58	56	3	0
6	3	77	54	65	66	75	51	0.25	85	57	71	62	536.03	67.90	2.83	85.90	3.58	124.78	5.20	23	0.00	0.00	62	62	60	57	1	0
6	4	81	64	72	70	80	66	0.23	83	62	72	67	569.78	108.00	4.50	144.30	6.01	192.91	8.04	34	0.00	0.00	56	63	63	59	3	0
6	5	78	54	66	64	73	68	0.30	84	53	68	61	569.78	112.90	4.70	129.70	5.40	166.68	6.94	66	0.00	0.00	52	62	61	58	1	0
6	6	80	52	66	66	61	50	0.38	85	53	69	65	702.29	88.70	3.70	110.00	4.58	142.46	5.94	55	0.00	0.00	0	0	0	0	1	0
6	7	77	54	65	63	78	59	0.27	85	53	69	60	543.28	70.50	2.94	81.60	3.40	121.12	5.05	07	0.14	0.00	63	63	62	59	1	0
6	8	68	54	61	60	81	64	0.23	73	56	64	60	477.03	94.40	3.93	102.90	4.29	158.13	6.59	66	0.00	0.00	52	61	62	59	4	0
6	9	76	62	69	67	76	69	0.17	83	60	71	63	569.78	95.00	3.96	128.70	5.36	174.00	7.25	33	0.00	0.00	54	64	63	60	4	0
6	10	80	54	67	67	74	70	0.36	79	58	68	63	490.28	88.40	3.68	122.10	5.09	163.63	6.82	34	0.07	0.00	55	65	64	61	0	0
6	11	85	61	73	71	67	56	0.29	89	61	75	66	622.78	69.10	2.88	91.40	3.82	122.34	5.10	44	0.13	0.00	66	66	65	61	1	0
6	12	86	58	72	69	72	58	0.36	91	60	75	69	575.79	60.80	2.53	34.00	1.42	109.33	4.56	47	0.28	0.00	55	66	64	60	1	0
6	13	82	58	70	70	78	54	0.17	91	65	78	75	589.04	22.90	0.95	72.90	3.04	60.72	2.53	03	0.00	0.00	68	67	66	62	1	0
6	14	79	54	66	65	85	60	0.20	81	58	69	71	437.27	56.20	2.34	79.60	3.32	108.72	4.53	33	0.04	0.00	67	66	66	62	0	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
5	18	52	52	73	60	1.71	0.25	53	3074.16	439.17	128.24	5.34	157.69	6.57	222.54	9.27	53	54	53	52	1.75	0.000
5	25	59	58	74	60	1.77	0.25	60	3710.20	530.03	127.20	5.30	156.51	6.52	211.65	8.82	56	56	55	54	1.24	0.000
6	1	64	63	78	65	1.67	0.24	66	3683.69	526.24	84.73	3.53	104.26	4.34	143.32	5.97	61	61	60	57	0.14	0.000
6	8	68	67	76	61	1.78	0.26	71	3961.96	565.99	69.54	2.90	90.29	3.76	128.12	5.34	65	65	64	60	0.52	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
5	18	61	60	75	61	6.93	0.25	63	14430.01	515.36	102.43	4.27	127.19	5.30	176.41	7.35	59	59	58	56	3.65	0.000

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	AV	RH AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
6	15	84	58	71	71	69	48	0.24	85	58	71	67	675.79	68.20	2.84	96.90	4.04	138.41	5.77	33	0.00	0.00	68	68	66	62	0	0
6	16	83	58	70	71	81	69	0.25	90	64	77	65	596.28	53.80	2.24	66.20	2.76	100.79	4.20	78	0.00	0.00	57	67	65	62	4	0
6	17	84	61	72	71	78	69	0.31	91	64	77	69	609.53	48.40	2.02	73.80	3.07	102.21	4.26	88	0.15	0.00	57	67	66	62	0	0
6	18	80	60	70	71	79	65	0.25	90	65	77	71	662.53	54.10	2.25	77.90	3.25	118.07	4.92	02	0.00	0.00	70	70	69	64	1	0
6	19	90	62	76	75	71	59	0.32	93	66	79	69	675.79	72.80	3.03	99.10	4.13	137.39	5.72	35	0.00	0.00	70	70	69	64	1	0
6	20	83	58	70	71	70	51	0.35	95	64	79	70	728.79	82.40	3.43	104.30	4.35	155.08	6.46	08	0.00	0.00	69	69	68	64	3	0
6	21	81	60	70	70	72	51	0.19	83	63	73	65	490.28	41.20	1.72	62.00	2.58	99.36	4.14	35	0.00	0.00	68	68	67	63	3	0
6	22	88	55	71	71	74	58	0.24	89	63	76	68	569.78	36.50	1.52	53.10	2.21	81.87	3.41	86	0.00	0.00	68	69	68	64	1	0
6	23	85	57	71	71	67	44	0.33	90	64	77	73	609.53	52.90	2.20	79.40	3.31	101.60	4.23	44	0.00	0.00	71	71	70	66	0	0
6	24	92	66	79	78	63	49	0.32	93	67	80	72	609.53	86.00	3.58	119.10	4.96	167.49	6.98	42	0.00	0.00	72	72	71	67	1	0
6	25	85	61	73	74	68	54	0.42	90	63	76	73	728.79	92.80	3.87	134.20	5.59	180.10	7.50	13	0.31	0.00	70	70	69	66	1	0
6	26	94	68	81	79	65	54	0.37	93	69	81	73	649.28	94.20	3.92	123.00	5.13	168.30	7.01	33	0.00	0.00	75	73	72	68	1	0
6	27	88	67	77	77	77	56	0.33	89	66	77	70	596.28	77.60	3.23	104.60	4.36	145.93	6.08	00	0.10	0.00	74	74	73	69	4	0
6	28	84	54	69	67	78	67	0.34	87	56	71	60	583.03	110.20	4.59	146.50	6.10	217.72	9.07	00	0.01	0.00	70	72	70	66	1	0
6	29	73	54	63	67	81	57	0.18	74	59	66	66	397.52	81.90	3.41	117.90	4.91	166.88	6.95	20	0.11	0.00	71	71	70	67	4	0
6	30	75	51	63	64	83	90	0.16	76	57	66	60	357.77	55.00	2.29	66.90	2.78	122.95	5.12	77	0.04	0.00	59	69	68	66	0	0
7	1	82	49	65	67	58	35	0.30	87	58	72	61	689.04	47.40	1.97	58.90	2.45	85.94	3.58	08	0.00	0.00	57	69	68	65	0	0
7	2	89	62	75	75	51	40	0.39	92	63	77	68	715.54	55.60	2.32	77.90	3.25	109.73	4.57	33	0.00	0.00	71	71	70	67	1	0
7	3	92	59	75	76	54	42	0.53	85	62	73	68	536.03	138.90	5.79	181.10	7.55	240.70	10.03	45	0.00	0.00	70	70	69	66	1	0
7	4	87	56	71	72	64	49	0.26	85	62	73	69	742.04	77.00	3.21	109.50	4.56	160.37	6.68	07	0.03	0.00	72	72	71	67	2	0
7	5	85	52	68	65	68	35	0.40	87	55	71	61	556.53	48.10	2.00	67.30	2.80	102.01	4.25	04	0.14	0.00	0	0	0	0	1	0
7	6	89	61	75	74	57	45	0.30	89	60	74	68	662.53	69.50	2.90	93.00	3.88	133.32	5.56	44	0.05	0.00	0	0	0	0	1	0
7	7	96	62	79	80	56	57	0.46	90	57	73	58	596.28	184.40	7.68	236.10	9.84	335.67	13.99	47	0.00	0.00	0	0	0	0	3	0
7	8	78	50	64	64	48	32	0.32	74	55	64	59	543.28	69.00	2.88	100.50	4.19	135.15	5.63	08	0.00	0.00	70	72	70	67	3	0
7	9	81	60	70	69	53	44	0.28	80	58	69	63	543.28	95.20	3.97	141.70	5.90	189.45	7.89	33	0.00	0.00	71	71	70	67	1	0
7	10	97	54	75	73	61	42	0.30	93	61	77	72	596.28	59.50	2.48	83.90	3.50	102.62	4.28	43	0.00	0.00	72	71	71	68	1	0
7	11	94	64	79	79	59	33	0.40	89	65	77	67	649.28	161.90	6.75	239.70	9.99	328.15	13.67	33	0.00	0.00	74	74	73	69	4	0
7	12	96	66	81	79	64	55	0.34	93	65	79	69	649.28	116.10	4.84	158.40	6.60	238.06	9.92	37	0.00	0.00	75	75	73	69	2	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
6	15	71	71	74	58	1.91	0.27	76	4438.98	634.14	60.13	2.51	82.89	3.45	121.62	5.07	68	68	67	63	0.15	0.000
6	22	74	74	70	54	2.36	0.34	77	4346.23	620.89	78.60	3.28	108.56	4.52	151.86	6.33	71	71	70	67	0.42	0.000
6	29	69	69	66	49	2.22	0.32	71	4094.47	584.92	71.99	3.00	97.06	4.04	141.23	5.88	70	70	69	66	0.32	0.000
7	6	74	74	57	44	2.40	0.34	73	4240.22	605.75	107.94	4.50	150.47	6.27	208.92	8.70	72	72	71	68	0.05	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
6	15	72	72	67	51	8.38	0.32	74	17119.90	611.43	79.66	3.32	109.74	4.57	155.90	6.50	70	70	69	66	0.94	0.000

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	RH AV	AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLO	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
7	13	88	56	72	71	46	36	0.44	87	60	73	61	675.79	64.80	2.70	90.80	3.78	131.29	5.47	70	0.00	0.00	74	74	73	69	3	0
7	14	83	60	71	71	46	34	0.28	86	60	73	63	609.53	55.20	2.30	74.10	3.09	113.80	4.74	34	0.00	0.00	73	73	72	68	2	0
7	15	88	51	69	72	47	24	0.47	84	58	71	66	702.29	68.60	2.86	97.20	4.05	123.16	5.13	08	0.00	0.00	72	73	72	69	0	0
7	16	94	54	74	76	41	29	0.44	88	61	74	67	702.29	46.80	1.95	58.60	2.44	90.82	3.78	78	0.00	0.00	72	72	71	68	0	0
7	17	100	59	79	81	38	23	0.46	92	64	78	67	649.28	53.50	2.44	77.50	3.23	103.63	4.32	03	0.00	0.00	74	72	72	69	3	0
7	18	93	60	76	77	64	57	0.25	81	62	71	71	331.27	87.40	3.64	112.70	4.70	144.71	6.03	47	0.06	0.00	71	72	71	68	1	1
7	19	82	50	66	68	62	37	0.39	79	56	67	59	662.53	98.90	4.12	126.90	5.29	207.55	8.65	77	0.00	0.00	69	71	69	67	1	0
7	20	87	52	69	71	51	40	0.32	84	58	71	67	596.28	46.80	1.95	60.30	2.51	84.72	3.53	78	0.00	0.00	71	71	70	68	1	0
7	21	94	56	75	77	35	26	0.35	89	62	75	65	549.28	41.10	1.71	52.80	2.20	80.04	3.34	68	0.00	0.00	74	75	73	70	3	0
7	22	99	62	80	78	52	28	0.38	83	64	73	70	728.79	79.90	3.33	106.80	4.45	153.66	6.40	78	0.00	0.00	75	75	74	70	1	0
7	23	94	58	76	76	56	34	0.45	87	62	74	65	649.28	70.30	2.93	94.00	3.92	131.09	5.46	08	0.00	0.00	74	74	73	70	1	0
7	24	91	66	78	77	49	37	0.44	90	66	78	75	536.03	88.20	3.67	121.60	5.07	140.44	5.85	04	0.00	0.00	77	77	76	72	0	0
7	25	99	56	77	77	47	26	0.41	86	57	71	60	397.52	104.20	4.34	141.90	5.91	199.01	8.29	60	0.27	0.00	72	74	72	69	2	0
7	26	72	44	58	58	63	53	0.22	69	50	59	52	437.27	54.20	2.26	66.60	2.78	123.97	5.17	76	0.00	0.00	68	70	68	66	1	0
7	27	80	49	64	65	49	33	0.22	80	52	66	55	609.53	43.40	1.81	49.30	2.05	86.55	3.61	77	0.00	0.00	68	71	68	67	3	0
7	28	81	42	61	64	50	26	0.31	67	49	58	55	384.27	128.00	5.33	147.30	6.14	204.70	8.53	77	0.00	0.00	63	67	65	64	1	0
7	29	68	43	55	54	68	34	0.17	63	46	57	47	344.52	70.80	2.95	82.30	3.43	129.87	5.41	76	0.00	0.00	63	66	64	64	2	0
7	30	73	39	56	58	49	33	0.26	70	47	58	53	583.03	78.70	3.28	104.00	4.33	136.56	5.69	08	0.00	0.00	62	65	64	64	0	0
7	31	85	44	64	66	40	25	0.28	82	52	67	59	689.04	42.60	1.77	52.00	2.17	72.11	3.00	66	0.00	0.00	66	67	66	65	1	0
8	1	93	54	73	75	46	18	0.39	80	58	69	65	583.03	72.20	3.01	86.50	3.60	126.41	5.27	77	0.00	0.00	70	70	69	67	0	0
8	2	88	49	68	70	48	34	0.38	85	54	69	64	536.03	73.00	3.04	96.80	4.03	125.80	5.24	02	0.00	0.00	69	69	69	67	1	0
8	3	83	52	67	68	48	38	0.37	81	55	68	56	596.28	79.40	3.31	102.50	4.27	159.96	6.67	22	0.00	0.00	69	70	69	67	3	0
8	4	87	61	74	74	60	52	0.38	83	56	69	65	596.28	143.00	5.96	194.40	8.10	262.66	10.94	33	0.00	0.00	72	72	71	68	1	0
8	5	95	60	77	78	56	40	0.44	86	62	74	68	636.03	113.40	4.73	142.60	5.94	209.99	8.75	33	0.00	0.00	73	73	72	68	1	0
8	6	95	60	77	78	48	30	0.45	88	61	74	66	609.53	90.50	3.77	117.40	4.89	166.68	6.94	33	0.00	0.00	73	74	72	69	0	0
8	7	95	62	78	79	42	28	0.53	88	61	74	70	575.79	95.60	3.98	125.20	5.22	157.73	6.57	33	0.00	0.00	0	0	0	0	0	0
8	8	95	65	80	79	42	29	0.42	87	60	73	63	662.53	94.70	3.95	126.60	5.28	180.10	7.50	34	0.00	0.00	74	75	73	70	1	0
8	9	101	64	82	82	40	32	0.46	90	61	75	69	649.28	75.10	3.13	104.30	4.35	130.68	5.45	44	0.00	0.00	75	75	74	70	0	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
7	13	72	74	49	34	2.73	0.39	72	4332.98	619.00	68.60	2.86	91.11	3.80	130.71	5.45	72	72	71	68	0.06	0.000
7	20	73	73	50	34	2.58	0.37	71	4094.47	584.92	69.24	2.89	92.00	3.83	130.42	5.43	73	73	72	69	0.27	0.000
7	27	63	64	50	29	2.01	0.29	63	3829.45	547.06	72.67	3.03	88.31	3.68	176.00	5.25	65	67	66	55	0.00	0.000
8	3	76	77	48	35	3.05	0.44	72	4425.73	632.25	98.81	4.12	130.43	5.43	181.11	7.55	72	73	72	69	0.00	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
7	13	71	72	49	33	10.37	0.36	70	16682.63	595.81	77.33	3.22	100.46	4.19	142.06	5.92	70	71	70	68	0.33	0.000

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	MI	AV	RH AV	AV	11	EVAPORATION INS	MA	MI	AV	PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
8	10	104	59	81	82	49	22	0.51	91	60	75	61	583.03	84.90	3.54	112.70	4.70	154.47	6.44	00	0.00	0.00	75	76	74	70	0	0
8	11	87	53	70	71	46	36	0.40	82	57	69	61	636.03	63.90	2.66	85.00	3.54	118.89	4.95	02	0.00	0.00	73	74	72	69	1	0
8	12	94	59	76	77	45	29	0.30	86	62	74	71	556.53	39.10	1.63	51.50	2.15	72.93	3.04	12	0.00	0.00	74	74	73	70	1	0
8	13	102	67	84	83	36	24	0.49	93	64	78	66	596.28	64.90	2.70	90.70	3.78	117.26	4.89	33	0.00	0.00	0	0	0	0	4	0
8	14	95	57	76	79	45	28	0.26	76	58	67	67	291.52	79.80	3.32	103.80	4.33	143.49	5.98	23	0.00	0.00	0	0	0	0	0	0
8	15	93	60	76	78	51	35	0.54	85	60	73	67	649.28	114.10	4.75	165.90	6.91	211.21	8.80	33	0.00	0.00	0	0	0	0	0	0
8	16	97	68	82	83	46	33	0.55	86	63	74	78	636.03	147.00	6.12	199.40	8.31	253.11	10.55	44	0.00	0.00	78	77	76	72	0	0
8	17	96	67	81	83	52	40	0.54	89	66	77	69	583.03	115.10	4.80	151.00	6.29	216.50	9.02	44	0.00	0.00	76	76	75	71	0	0
8	18	102	65	83	81	50	29	0.45	89	64	76	67	450.52	94.60	3.94	122.40	5.10	161.39	6.72	44	0.00	0.00	77	77	76	72	2	0
8	19	80	58	69	68	81	80	0.22	77	63	70	68	331.27	63.40	2.64	74.20	3.09	107.50	4.48	77	0.15	0.00	71	73	71	69	0	0
8	20	92	57	74	76	48	33	0.37	85	60	72	67	556.53	75.40	3.14	99.80	4.16	131.29	5.47	03	0.00	0.00	72	72	71	69	1	0
8	21	97	57	77	76	46	32	0.40	86	58	72	62	463.77	76.50	3.19	103.40	4.31	141.87	5.91	44	0.00	0.00	70	72	70	69	0	0
8	22	102	59	80	80	44	31	0.47	90	61	75	68	569.78	62.70	2.61	84.90	3.54	119.50	4.98	88	0.19	0.00	71	73	71	69	1	0
8	23	103	66	84	83	42	31	0.38	90	65	77	67	583.03	46.20	1.92	62.50	2.60	84.11	3.50	47	0.00	0.00	72	73	72	70	1	0
8	24	100	49	74	72	43	27	0.55	83	52	67	58	543.28	125.30	5.22	147.30	6.14	247.00	10.29	77	0.00	0.00	59	71	70	68	0	0
8	25	87	52	69	69	42	31	0.31	81	57	59	65	556.53	38.60	1.61	42.80	1.78	71.30	2.97	82	0.00	0.00	70	72	71	69	0	0
8	26	93	56	74	74	41	31	0.38	85	57	71	59	530.03	60.40	2.52	83.50	3.48	104.65	4.36	83	0.00	0.00	71	72	71	69	1	0
8	27	90	58	74	75	49	35	0.41	80	59	69	65	490.28	109.20	4.55	127.30	5.30	205.11	8.55	33	0.00	0.00	71	72	71	69	1	0
8	28	94	61	77	76	53	38	0.38	87	63	75	67	543.28	77.90	3.25	92.00	3.83	130.88	5.45	43	0.00	0.00	72	73	72	70	0	0
8	29	95	70	82	82	45	43	0.43	87	65	76	68	543.28	108.20	4.51	138.00	5.75	190.06	7.92	44	0.00	0.00	73	74	72	70	1	0
8	30	100	67	83	81	61	40	0.56	88	66	77	66	437.27	106.30	4.43	136.00	5.67	187.22	7.80	41	1.52	0.05	74	74	73	70	4	0
8	31	71	61	66	65	89	93	0.07	72	63	57	63	198.76	74.80	3.12	86.50	3.60	123.97	5.17	11	0.00	0.00	70	71	70	69	4	0
9	1	81	64	72	69	82	82	0.13	74	64	69	69	291.52	85.00	3.54	106.50	4.44	149.39	6.22	34	0.00	0.00	59	70	70	69	2	0
9	2	96	64	80	79	55	32	0.33	88	65	76	68	543.28	71.20	2.97	88.50	3.69	124.99	5.21	04	0.00	0.00	71	73	71	69	1	0
9	3	104	64	84	84	39	26	0.57	87	60	73	61	543.28	130.10	5.42	154.20	6.42	213.45	8.89	57	0.00	0.00	59	70	69	68	2	0
9	4	82	54	68	68	61	46	0.40	74	53	63	55	304.77	192.10	8.00	209.40	8.73	298.05	12.42	77	0.68	0.00	0	0	0	0	4	1
9	5	57	52	54	55	93	93	0.90	56	51	53	56	106.01	259.60	10.82	295.30	12.30	378.38	15.77	66	1.82	0.00	0	0	0	0	4	1
9	6	70	50	60	56	85	93	0.13	61	48	54	61	225.26	112.50	4.69	132.50	5.52	222.60	9.28	76	0.04	0.00	51	63	63	64	0	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
8	10	78	79	44	29	3.05	0.44	73	3948.71	564.10	84.81	3.53	115.57	4.82	153.05	6.38	75	75	74	70	0.00	0.000
8	17	78	78	52	39	2.83	0.41	74	3537.94	505.42	76.27	3.18	99.74	4.16	137.45	5.73	72	73	72	70	0.34	0.000
8	24	76	76	48	35	3.02	0.43	72	3643.94	520.56	89.41	3.73	109.56	4.56	162.32	6.76	71	72	71	69	1.52	0.050
8	31	69	68	72	66	1.63	0.23	65	2212.87	316.12	132.19	5.51	153.27	6.39	215.83	8.99	68	69	68	68	2.54	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AV2H	RH AV	11	EVAPORATION TOTAL	MEAN	TEMP	RADIATION TOTAL	AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
8	10	75	75	54	42	10.53	0.38	71	13343.45	476.55	95.67	3.99	119.54	4.98	167.16	6.97	71	72	71	69	4.40	0.050

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS MA	AIR TEMPS MI	AIR TEMPS AV	AIR TEMPS AV	RH AV	RH 11	EVAPORATION INS	EVAPORATION MA	EVAPORATION MI	EVAPORATION AV	EVAPORATION PRE	RADIA LYS	PAN	WIND (MILES / DAY) (MPH) PAN	1 M	1 M	2 M	2 M	DIR	PREC INS	RO INS	SOIL TEMPS 10	20	50	150	WX COND CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
9	7	89	56	72	71	58	42	0.28	79	56	67	59	516.78	53.30	2.22	71.30	2.97	110.34	4.60	43	0.00	0.00	64	65	64	65	0	0
9	8	79	55	67	64	76	53	0.33	73	54	63	55	424.02	149.20	6.22	168.10	7.00	261.24	10.88	76	0.32	0.00	61	63	62	63	4	0
9	9	68	46	57	56	69	40	0.13	65	49	57	54	291.52	46.40	1.93	62.40	2.60	82.89	3.45	43	0.00	0.00	60	62	61	62	0	0
9	10	79	50	64	62	68	54	0.14	78	54	66	57	543.28	31.10	1.30	38.60	1.61	65.60	2.73	08	0.00	0.00	62	65	63	64	1	0
9	11	82	53	67	66	60	39	0.22	79	54	66	59	503.53	72.80	3.03	102.00	4.25	137.39	5.72	14	0.00	0.00	62	64	63	64	0	0
9	12	91	54	72	73	45	36	0.36	80	51	65	52	556.53	149.60	6.23	185.30	7.72	273.85	11.41	47	0.00	0.00	63	65	63	64	1	0
9	13	79	50	64	63	52	34	0.20	75	49	52	61	530.03	59.20	2.47	80.20	3.34	99.97	4.17	74	0.00	0.00	64	65	64	65	0	0
9	14	95	43	69	68	51	32	0.44	82	48	65	48	450.52	62.50	2.60	90.60	3.77	131.90	5.50	67	0.00	0.00	60	63	62	63	3	0
9	15	67	36	51	50	60	37	0.22	61	38	49	43	397.52	103.10	4.30	106.90	4.45	166.27	6.93	76	0.00	0.00	57	61	60	61	1	0
9	16	64	34	49	48	66	36	0.12	57	39	48	43	344.52	68.80	2.87	82.60	3.44	124.58	5.19	77	0.00	0.00	55	59	58	60	1	0
9	17	58	35	46	45	71	44	0.19	59	38	48	41	371.02	112.30	4.68	117.70	4.90	192.91	8.04	77	0.00	0.00	55	58	57	60	1	0
9	18	54	38	46	45	69	50	0.06	52	39	45	41	251.76	47.30	1.97	60.00	2.50	88.18	3.67	08	0.06	0.00	57	59	58	60	4	0
9	19	58	36	47	45	69	46	0.14	59	38	48	44	450.52	79.00	3.29	103.70	4.32	125.19	5.22	44	0.00	0.00	54	57	56	58	1	0
9	20	68	38	53	51	56	33	0.14	65	41	53	44	424.02	43.60	1.82	56.30	2.35	92.45	3.85	55	0.00	0.00	53	55	54	57	3	0
9	21	70	40	55	50	73	39	0.15	63	41	52	43	304.77	111.60	4.65	171.40	7.14	205.52	8.56	00	0.07	0.00	54	56	55	58	3	0
9	22	51	40	45	43	61	38	0.10	57	41	49	43	331.27	41.00	1.71	58.30	2.43	73.54	3.06	05	0.00	0.00	54	56	55	57	3	0
9	23	62	37	49	47	61	39	0.13	63	39	51	45	450.52	42.40	1.77	62.30	2.60	85.94	3.58	64	0.00	0.00	53	55	55	57	1	0
9	24	71	40	55	55	53	31	0.22	68	43	55	53	477.03	66.50	2.77	85.50	3.56	117.06	4.88	34	0.00	0.00	55	57	56	58	1	0
9	25	77	46	62	62	63	37	0.26	71	50	50	56	490.28	143.90	6.00	188.70	7.86	242.73	10.11	44	0.00	0.00	55	57	56	58	0	0
9	26	84	53	68	66	47	33	0.22	75	54	64	58	437.27	56.70	2.36	81.60	3.40	112.99	4.71	44	0.00	0.00	58	59	59	60	1	0
9	27	81	49	65	64	52	35	0.21	74	53	63	53	437.27	50.70	2.11	60.60	2.53	101.19	4.22	00	0.00	0.00	58	59	58	59	3	0
9	28	73	47	60	59	65	46	0.26	70	48	59	50	450.52	137.20	5.72	178.50	7.44	218.94	9.12	05	0.17	0.00	56	57	57	58	1	0
9	29	63	44	53	53	63	59	0.17	63	47	55	48	410.77	106.20	4.51	138.50	5.77	193.72	8.07	73	0.00	0.00	55	56	56	57	3	0
9	30	77	52	64	61	69	40	0.15	78	48	63	54	397.52	75.00	3.13	126.60	5.28	166.47	6.94	43	0.00	0.00	57	58	57	58	4	0
10	1	70	46	59	58	74	58	0.08	66	53	59	53	265.01	83.80	3.49	121.90	5.08	159.96	6.67	71	0.00	0.00	0	0	0	0	4	1
10	2	58	44	51	51	81	91	0.17	56	42	49	43	66.25	238.80	9.95	274.80	11.45	339.94	14.16	15	0.37	0.00	0	0	0	0	4	0
10	3	52	40	46	43	71	83	0.08	43	38	40	42	132.51	296.30	12.35	451.10	18.80	462.98	19.29	67	0.10	0.00	52	54	53	56	1	0
10	4	63	40	51	49	65	41	0.19	60	41	50	45	450.52	143.50	5.98	40.40	1.68	223.82	9.33	76	0.00	0.00	49	52	51	54	1	0

WEEKLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AIR TEMP AV2H	RH AV	RH 11	EVAPORATION TOTAL	EVAPORATION MEAN	EVAPORATION TEMP	RADIATION TOTAL	RADIATION AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
9	7	66	65	61	42	1.66	0.24	64	3365.68	480.81	80.23	3.34	101.13	4.21	147.33	6.14	62	64	63	64	0.32	0.000
9	14	51	50	63	39	1.31	0.19	51	2689.89	384.27	73.80	3.07	88.26	3.68	131.64	5.48	55	58	58	60	0.06	0.000
9	21	57	55	58	36	1.29	0.19	56	2928.40	418.34	73.26	3.05	101.20	4.22	134.14	5.59	55	57	55	58	0.07	0.000
9	28	55	53	70	59	1.10	0.16	53	2173.11	310.44	154.69	6.45	190.26	7.93	252.26	10.51	53	55	55	57	0.64	0.000

MONTHLY E. T. DATA COTTONWOOD, S. D. 1971

DATE		AIR TEMP AV	AIR TEMP AV2H	RH AV	RH 11	EVAPORATION TOTAL	EVAPORATION MEAN	EVAPORATION TEMP	RADIATION TOTAL	RADIATION AV	WINDS (AV DAILY MILES) (AV MPH) PAN		1 METER		2 METER		SOIL TEMPS 10	20	50	150	PREC (INS)	RO (INS)
9	7	57	56	63	44	5.36	0.20	56	11157.09	398.47	95.49	3.98	120.21	5.01	166.34	6.93	57	59	58	60	1.09	0.000

DAILY E. T. DATA PASTURE 3 COTTONWOOD, S. D. 1971 APPENDIX TABLE 1

DATE		AIR TEMPS				RH		EVAPORATION					RADIA		WIND (MILES / DAY) (MPH)						PREC	RO	SOIL TEMPS				WX COND	
		MA	MI	AV	AV	AV	11	INS	MA	MI	AV	PRE	LYS	PAN	PAN	1 M	1 M	2 M	2 M	DIR	INS	INS	10	20	50	150	CLD	RN
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
10	5	74	44	59	56	71	41	0.14	63	44	53	48	318.02	90.30	3.76	104.50	4.35	143.49	5.98	66	0.00	0.00	52	54	53	55	1	0
10	6	73	46	59	57	66	37	0.18	67	46	56	51	424.02	62.30	2.60	70.00	2.92	107.29	4.47	76	0.00	0.00	52	55	54	56	1	0
10	7	78	45	61	60	68	42	0.10	72	48	60	50	384.27	34.30	1.43	45.70	1.90	69.47	2.89	64	0.00	0.00	54	56	55	57	1	0
10	8	70	35	52	50	60	40	0.19	63	37	50	42	291.52	146.10	6.09	149.90	6.25	218.53	9.11	77	0.00	0.00	51	54	53	55	1	0
10	9	56	30	43	42	64	36	0.25	53	36	44	40	490.28	155.70	6.49	160.40	6.68	260.63	10.86	77	0.00	0.00	50	52	51	54	1	0
10	10	66	46	56	53	49	30	0.16	58	40	49	53	437.27	79.80	3.32	82.00	3.42	114.00	4.75	76	0.00	0.00	0	0	0	0	1	0
10	11	81	37	59	56	68	40	0.22	69	43	56	47	437.27	58.80	2.45	70.80	2.95	122.14	5.09	78	0.00	0.00	0	0	0	0	1	0
10	12	73	51	62	59	49	36	0.18	63	47	55	51	344.52	139.60	5.82	272.30	11.35	225.24	9.39	37	0.00	0.00	54	55	55	56	1	0
10	13	62	29	45	47	63	45	0.31	59	37	48	39	397.52	195.40	8.14	101.60	4.23	328.96	13.71	74	0.00	0.00	53	55	54	56	2	0
10	14	74	45	59	56	49	28	0.15	60	38	49	47	357.77	116.80	4.87	148.70	6.20	216.50	9.02	47	0.00	0.00	52	53	53	55	1	0
10	15	57	43	50	49	63	50	0.18	60	41	50	41	357.77	98.60	4.11	138.40	5.77	186.81	7.78	01	0.00	0.00	50	51	51	53	4	0

ND ,CLAYTO, 094103 12/01/71,

Appendix Table 1 Continued. Daily Weather Data - Solar Radiation
10/16/70 - 11/30/71, Cottonwood, South Dakota[a/]

Month / Date	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
1		106.00	238.51	238.51	225.26	198.76	450.52	609.53	357.76	715.53	636.03	556.52	53.00	278.26
2		106.00	145.75	159.00	304.76	397.52	543.27	662.53	609.53	636.03	609.53	556.52	105.00	291.51
3		79.51	225.26	172.25	185.50	371.01	331.26	569.78	569.78	728.78	556.52	344.51	463.77	132.50
4		238.51	238.51	172.25	291.51	371.01	318.01	649.28	543.27	583.03	636.03	92.75	318.01	225.26
5		291.51	198.76	172.25	291.51	238.51	477.02	410.77	715.53	636.03	622.78	185.50	424.02	344.51
6		291.51	145.75	212.01	291.51	278.26	596.28	689.03	556.52	609.53	662.53	516.77	384.27	291.51
7		92.75	145.75	145.75	331.26	450.52	530.02	503.52	477.02	569.78	675.78	450.52	304.76	251.76
8		26.50	145.75	106.00	251.76	344.51	556.52	662.53	569.78	503.52	662.53	265.01	477.02	278.26
9		265.01	39.75	119.25	331.26	410.77	596.28	556.52	450.52	596.28	569.78	543.27	437.27	291.51
10		132.50	106.00	92.75	265.01	318.01	569.78	79.50	675.78	702.28	636.03	503.52	437.27	225.26
11		92.75	212.01	92.75	238.51	225.26	463.77	662.53	622.78	622.78	583.03	556.52	344.51	265.01
12		172.25	159.00	159.00	278.26	424.02	371.01	662.53	675.78	675.78	609.53	530.02	397.52	225.26
13		66.25	212.01	185.50	185.50	437.27	596.28	702.28	463.77	583.03	265.01	477.02	357.76	119.25
14		159.00	225.26	212.01	238.51	238.51	609.53	477.02	649.28	689.03	649.28	371.01	384.27	278.25
15	384.28	251.76	198.76	185.50	278.26	463.77	516.77	689.03	662.53	702.28	636.03	344.51	79.50	159.00
16	384.28	212.01	225.26	159.00	357.76	530.02	503.52	503.52	543.27	702.28	556.52	384.27	39.75	66.25
17	384.28	145.75	172.25	92.75	278.26	119.25	371.01	609.53	662.53	291.51	490.27	265.01	79.50	53.00
18	371.02	132.50	119.25	185.50	39.75	384.27	212.01	251.76	689.03	675.78	304.76	437.27	318.01	M
19	331.27	198.76	225.26	172.25	278.26	516.77	66.25	583.03	742.03	556.52	543.27	450.52	331.26	M
20	331.27	159.00	225.26	212.01	278.26	530.02	198.76	662.53	530.02	675.78	463.77	278.26	344.51	K
21	318.02	119.25	212.01	225.26	384.27	238.51	278.26	662.53	516.77	463.77	569.78	344.51	291.51	M
22	331.27	238.51	132.50	278.26	331.26	291.51	119.25	172.25	596.28	649.28	583.03	437.28	278.26	119.25
23	278.26	225.26	225.26	265.01	357.76	304.76	583.03	132.50	622.78	636.03	530.02	477.02	357.76	238.51
24	265.02	79.50	119.25	185.50	410.77	265.01	424.02	609.53	728.78	463.77	569.78	490.27	276.26	132.50
25	265.02	79.50	198.76	185.50	357.76	477.02	132.50	702.28	636.03	357.76	543.27	450.52	225.26	79.50
26	119.26	132.50	212.01	145.75	265.01	278.28	212.01	556.52	675.78	649.28	490.27	450.52	273.26	185.50
27	265.02	106.00	145.75	265.01	450.52	556.52	318.01	728.78	543.27	344.51	530.02	437.27	132.25	66.25
28	172.26	185.50	225.26	212.01	331.26	318.01	490.27	662.53	437.27	371.01	556.52	410.77	172.25	66.25
29	159.01	185.50	198.76	172.25		437.27	530.02	278.26	291.51	569.78	463.77	410.77	119.25	132.51
30	251.77	159.00	212.01	132.50		477.02	622.78	225.26	715.53	675.78	185.50	278.26	198.76	106.01
31	304.77		145.75	185.50		265.01		304.76		609.53	251.76		344.51	

a/ Observations from 2400 to 2400. Data from Pasture 2, 10/16/70 to 11/7/70 and 4/12/71 to 11/18/71; other data from Pasture 1.

Appendix Table 1 Continued. Daily Weather Data - Average and 11 AM Relative Humidity 10/16/70 - 11/31/71, Cottonwood, South Dakota[a/]

Oct.		Nov.		Dec.		Jan.		Feb.		March		April		May		June		July		Aug.		Sept.		Oct.		Nov.	
Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am	Avg	11 am
		M	M	70	35	73	52	79	68	96	92	57	45	69	60	90	83	55	40	50	35	61	32	87	91	83	[illegible]
		M	M	74	44	87	85	92	83	86	68	56	38	65	50	74	52	54	42	51	38	42	26	73	83	[illegible]	[illegible]
		89	89	65	50	84	84	90	88	75	56	72	58	69	47	81	66	59	46	56	52	52	46	59	41	[illegible]	[illegible]
		87	82	57	26	79	71	87	82	85	84	75	68	58	39	78	70	65	32	55	40	94	93	70	41	[illegible]	[illegible]
		73	48	62	40	81	76	87	85	82	78	63	46	50	36	61	49	62	41	53	30	87	93	67	37	[illegible]	[illegible]
		74	48	81	54	84	78	83	78	82	74	36	17	57	38	79	58	55	54	44	28	62	42	68	42	63	[illegible]
		95	80	70	46	82	70	81	73	81	69	29	18	78	60	79	64	43	30	43	29	71	53	64	40	[illegible]	[illegible]
		98	97	71	49	93	84	87	83	86	67	52	46	58	36	79	68	47	41	43	32	70	45	61	38	[illegible]	[illegible]
		M	M	92	98	82	80	79	74	76	54	43	25	67	48	73	72	55	39	38	23	96	60	57	30	68	[illegible]
		M	60	95	92	90	90	83	74	85	70	28	24	95	89	71	56	58	31	47	36	61	39	60	40	62	[illegible]
		89	78	89	70	85	78	86	82	82	66	41	27	65	43	71	58	63	53	44	29	55	36	59	36	70	[illegible]
		69	79	77	68	87	85	85	75	78	54	61	36	56	34	76	54	47	33	42	24	46	34	56	45	75	[illegible]
		94	94	79	63	81	79	86	73	73	41	48	24	57	33	86	62	45	35	40	28	51	32	54	28	85	[illegible]
		78	52	92	86	83	79	91	79	83	66	43	28	68	71	71	50	47	25	51	36	59	37	65	50	75	[illegible]
		77	46	84	68	89	90	86	70	80	73	44	25	53	30	79	69	43	29	48	32	64	36	81	66	[illegible]	[illegible]
52	28	77	66	85	62	79	68	77	50	67	45	52	32	66	44	83	70	38	23	52	41	72	44	98	96	[illegible]	[illegible]
53	25	76	50	81	78	93	98	74	40	92	100	66	54	62	42	77	65	63	57	50	30	70	50	93	65	[illegible]	[illegible]
55	44	91	74	87	82	90	80	97	99	77	70	69	60	81	77	72	60	57	37	78	80	70	46	73	48	83	[illegible]
57	35	79	70	85	77	96	100	84	72	75	59	94	97	60	38	70	52	55	40	54	33	57	33	61	37	M	M
48	31	80	56	89	85	83	78	87	84	64	52	80	68	59	38	74	52	41	24	46	33	73	39	64	40	M	M
53	34	81	70	92	92	70	54	91	80	85	67	90	64	67	54	73	59	47	27	48	33	62	38	73	42	M	M
55	34	59	50	87	86	64	52	87	64	76	64	93	94	90	78	70	45	56	33	44	32	62	39	75	50	M	[illegible]
75	52	57	50	77	62	69	60	81	66	90	87	74	48	94	97	64	50	53	38	44	27	55	31	69	40	66	[illegible]
55	28	55	50	78	76	83	76	76	68	82	66	71	52	72	48	70	54	49	27	43	31	61	37	68	40	[illegible]	[illegible]
63	59	74	78	74	67	83	78	74	75	78	57	83	86	68	53	63	54	62	53	42	31	52	33	80	65	[illegible]	[illegible]
77	56	91	82	80	64	87	84	90	97	75	67	97	94	66	56	76	56	51	32	47	36	50	35	65	40	91	[illegible]
75	45	94	76	98	98	86	78	73	63	62	48	83	82	63	48	81	68	49	26	53	38	62	46	73	75	95	[illegible]
M	M	87	83	93	90	84	86	81	65	73	60	71	54	71	57	80	60	69	34	50	43	70	59	95	75	93	[illegible]
M	M	87	44	77	60	81	60			60	30	74	61	89	84	89	90	51	34	51	40	64	40	94	85	93	[illegible]
M	M	65	50	78	65	90	90			46	19	69	52	94	75	56	35	43	26	90	93	74	58	88	90	[illegible]	[illegible]
M	M			79	72	88	82			70	66			93	79			43	19	83	82			81	64		

a/ [Ob]servations from 2400 to 2400. Data from Pasture 2, 10/16/70 to 11/7/70 and 4/12/71 to 11/18/71; other data [fr]om Pasture 1.

Appendix Table 1 Continued. Daily Weather Data - Maximum, Minimum and Average Temperature. 10/16/70 - 11/30/71, Cottonwood, South Dakota[a]

Oct. Max	Oct. Min	Oct. Avg	Nov. Max	Nov. Min	Nov. Avg	Dec. Max	Dec. Min	Dec. Avg	Jan. Max	Jan. Min	Jan. Avg
			M	M		56	23	37	34	18	25
			M	M		48	22	33	24	10	17
			34	29	32	40	20	30	16	0	9
			36	20	28	57	17	34	13	0	6
			60	22	38	29	14	19	4	-9	-2
			58	32	43	44	12	24	11	-6	0
			47	30	38	54	20	30	16	-12	5
			49	35	38	54	26	40	36	7	24
			M	M	M	28	16	22	28	9	16
			M	M	M	16	-2	11	13	0	8
			37	29	32	32	-11	10	1	-8	-3
			39	30	34	34	14	25	4	-7	-2
			34	26	31	29	0	14	9	-3	3
			38	22	29	18	-4	7	4	-10	-3
			56	20	34	33	7	16	10	-14	-8
70	31		53	26	40	34	10	23	38	1	25
72	34		54	28	41	32	13	22	33	10	21
65	27		45	25	34	13	-8	8	20	-2	8
[illegible]	34		45	24	32	10	-12	-5	25	8	14
59	32		45	25	33	4	-18	-5	43	17	35
72	33		40	13	25	1	-9	12	34	18	25
67	31		18	7	13	11	-7	3	28	12	19
54	35		25	6	16	18	-6	7	38	14	25
74	32		52	21	40	21	0	11	38	14	25
51	24		57	22	37	32	0	18	39	14	19
48	24		26	18	22	30	0	20	19	9	14
45	27		34	18	24	14	0	7	39	11	26
M	M		49	19	33	21	-4	7	40	14	29
M	M		60	27	41	38	7	25	46	13	28
M	M		62	33	45	34	20	27	12	4	6
M	M					38	26	34	11	3	7

Feb. Max	Feb. Min	Feb. Avg	March Max	March Min	March Avg	Apr. Max	Apr. Min	Apr. Avg	May Max	May Min	May Avg
23	2	12	28	14	23	42	24	33	63	39	50
24	8	14	28	4	15	50	20	35	67	34	50
11	3	7	44	6	25	52	22	36	79	41	61
18	-10	3	38	21	30	44	19	33	70	48	59
12	-2	7	31	20	26	51	16	35	66	43	55
12	-13	-2	26	14	21	72	22	49	65	37	51
2	-20	-7	32	7	18	86	30	61	60	35	48
11	-6	3	34	15	26	61	33	50	75	37	59
39	-1	20	39	20	30	73	26	55	73	53	62
42	18	34	44	24	34	87	47	66	55	46	52
38	24	34	44	26	34	58	32	47	59	40	49
34	20	25	58	27	40	59	32	43	72	38	57
45	22	35	67	29	43	63	26	46	78	44	62
46	28	36	42	30	35	78	31	56	67	50	58
51	26	37	41	24	32	87	40	64	71	46	59
46	30	37	46	24	33	65	42	53	84	44	64
46	27	35	34	26	29	76	41	60	66	47	56
30	20	25	33	20	28	75	50	62	48	41	44
24	18	21	31	16	24	58	48	53	59	39	48
23	11	19	54	15	34	61	46	53	70	34	56
21	0	13	32	16	26	57	46	49	75	46	63
26	-2	11	27	9	20	48	38	46	63	52	57
32	-7	15	25	18	22	65	35	50	52	40	46
38	10	26	34	24	28	61	42	50	66	39	53
45	27	35	50	20	35	43	36	40	65	41	53
31	21	23	67	21	43	39	33	35	66	43	56
25	5	17	58	35	48	45	34	38	73	45	60
35	4	21	50	26	39	55	30	42	79	49	64
			62	26	44	66	35	50	67	58	60
			75	25	53	63	40	52	67	54	59
			56	30	39				63	52	57

June Max	June Min	June Avg	July Max	July Min	July Avg	Aug. Max	Aug. Min	Aug. Avg	Sept. Max	Sept. Min	Sept. Avg	Oct. Max	Oct. Min	Oct. Avg	Nov. Max	Nov. Min	Nov. Avg
66	51	57	89	49	73	88	54	72	96	65	79	58	48	53	[illegible]	[illegible]	[illegible]
76	53	66	92	62	78	83	49	68	104	64	86	48	40	44	46	[illegible]	37
81	54	69	87	59	73	87	52	72	82	60	71	62	41	52	42	26	[illegible]
78	55	67	84	54	67	95	61	78	58	52	55	74	40	56	63	[illegible]	[illegible]
81	54	67	89	52	71	95	60	78	62	52	57	73	44	57	35	[illegible]	[illegible]
77	52	63	95	61	81	95	60	79	89	51	70	78	46	61	[illegible]	[illegible]	[illegible]
68	54	61	78	58	67	95	62	79	79	56	65	70	37	52	48	[illegible]	[illegible]
76	54	66	81	51	68	101	65	83	68	52	58	56	34	45	52	27	39
80	59	69	97	60	75	104	64	83	79	46	62	66	30	49	64	[illegible]	[illegible]
85	54	70	94	55	77	87	59	73	82	50	66	80	41	60	66	[illegible]	[illegible]
85	60	70	96	64	80	94	53	76	91	53	73	73	36	55	65	31	[illegible]
82	58	70	88	58	75	102	58	82	79	54	64	63	34	53	65	[illegible]	[illegible]
79	57	67	83	56	70	95	65	81	95	50	69	74	29	52	[illegible]	[illegible]	[illegible]
84	54	71	88	56	74	93	57	78	67	40	52	57	45	51	[illegible]	[illegible]	[illegible]
83	58	71	94	51	76	97	60	82	64	36	49	47	36	42	53	[illegible]	[illegible]
84	59	71	100	54	80	96	68	83	58	35	45	42	36	39	34	[illegible]	[illegible]
80	61	71	93	59	78	102	67	82	54	34	44	50	42	47	[illegible]	[illegible]	[illegible]
90	60	75	82	56	71	80	62	71	58	38	47	62	41	52	30	[illegible]	[illegible]
83	59	72	87	51	71	92	58	76	67	36	51	62	39	50	M	M	M
81	58	70	94	52	76	97	57	77	69	38	50	67	39	51	M	M	[illegible]
87	60	73	99	56	77	102	57	80	52	40	43	68	35	51	M	M	M
84	55	71	94	62	78	103	59	83	62	39	48	60	37	47	50	M	M
92	57	76	91	58	76	100	59	77	71	37	54	70	35	52	47	[illegible]	[illegible]
85	66	75	99	66	79	87	48	69	77	40	61	75	[illegible]	58	[illegible]	[illegible]	[illegible]
94	61	79	72	50	63	93	52	74	84	48	65	63	41	51	[illegible]	[illegible]	[illegible]
88	68	78	80	44	64	90	56	75	81	53	66	73	39	55	39	[illegible]	[illegible]
84	59	70	81	49	66	93	58	76	72	49	60	50	26	37	36	[illegible]	[illegible]
73	54	65	68	42	55	94	61	80	63	44	53	27	23	25	38	[illegible]	[illegible]
75	54	66	73	43	59	99	70	83	76	48	60	23	22	22	[illegible]	[illegible]	[illegible]
82	51	68	93	44	73	71	63	67	70	48	58	25	16	23	34	13	25
						78	62	68				42	24	30			

a/ Observations from 2400 to 2400. Data from Pasture 2, 10/16/70 to 11/7/70 and 4/12/71 to 11/18/71, other data from Pasture 1.

Appendix Table 2. Soil Bulk Density (g/cm^3) by Depth Increment Cottonwood, October 1970[a/]

Depth cm	Plot no. 1	2	3	4	5	6	7	8	9	10	Mean
Permanent Exclosure High Range Condition, Replication I											
0-5	1.01	1.02	0.96	1.15	0.90	0.87	0.84	0.95	0.79	0.95	0.94
5-10	1.34	1.34	1.29	0.99	1.12	1.26	1.37	1.37	1.10	1.26	1.24
10-20	1.08	1.20	1.35	1.23	1.12	1.36	1.41	1.38	1.27	1.28	1.27
20-30	0.91	1.26	1.40	0.99	1.24	1.54	1.34	1.55	1.49	1.36	1.31
30-40	1.07	1.61	1.54	1.23	1.56	1.55	1.55	1.31	1.57	1.40	1.44
40-50	1.18	1.55	1.50	1.43	1.44	1.67	1.24	1.37	1.70	1.53	1.46
50-60	1.50	1.46	1.67	1.65	1.65	1.60	1.65	1.49	1.45	1.54	1.57
Permanent Exclosure High Range Condition, Replication II											
0-5	1.08	1.10	1.20	1.01	0.99	1.22	1.05	1.13	0.88	1.22	1.09
5-10	1.41	1.13	1.27	1.39	1.34	1.33	1.25	1.36	1.14	1.22	1.28
10-20	1.46	1.39	1.32	1.29	1.31	1.54	1.09	1.26	1.27	1.50	1.34
20-30	1.54	1.27	1.55	1.43	1.37	1.36	0.95	1.51	1.37	1.38	1.37
30-40	1.58	1.51	1.54	1.77	1.71	1.54	1.34	1.71	1.24	1.57	1.55
40-50	1.39	1.84	1.22	1.42	1.55	1.61	0.83	1.64	1.26	1.63	1.44
50-60	1.54	1.68	1.17	1.56	1.58	1.71	1.48	1.54	1.58	1.42	1.53

Appendix Table 2 Continued

Depth cm	Plot no. 1	2	3	4	5	6	7	8	9	10	Mean
Temporary Exclosure Low Range Condition, Replication I											
0-5	0.91	1.00	1.09	0.96	1.08	1.05	1.10	1.20	0.90	1.16	1.05
5-10	1.24	1.28	1.54	1.12	1.28	1.32	1.26	1.35	1.39	1.43	1.32
10-20	1.26	1.25	1.34	1.11	1.42	1.31	1.20	1.49	1.31	1.11	1.28
20-30	1.65	1.29	1.46	1.33	1.39	1.33	1.27	1.37	1.41	1.45	1.40
30-40	1.28	1.14	1.24	1.17	1.37	1.21	1.08	1.45	1.58	1.49	1.30
40-50	1.51	1.29	1.33	1.64	1.51	1.62	1.45	1.56	1.70	1.31	1.49
50-60	1.50	1.55	1.28	1.51	1.52	1.35	1.62	1.34	1.65	1.41	1.47
Temporary Exclosure Low Range Condition, Replication II											
0-5	1.01	1.08	1.01	1.06	1.00	1.11	1.11	0.99	1.01	1.32	1.07
5-10	1.37	1.38	1.21	1.18	1.20	1.35	1.24	1.22	1.20	1.18	1.25
10-20	1.38	1.23	1.29	1.37	1.32	1.35	1.35	1.20	1.23	1.37	1.31
20-30	1.49	1.42	1.36	1.31	1.50	1.61	1.55	1.31	1.49	1.53	1.46
30-40	1.46	1.51	1.55	1.37	1.41	1.58	1.55	1.11	1.49	1.52	1.46
40-50	1.43	1.48	1.45	1.51	1.60	1.62	1.70	0.95	1.25	1.42	1.44
50-60	1.54	1.51	1.53	1.43	1.50	1.64	1.58	1.35	1.38	1.51	1.50

a/ Samples taken with a 4.2 cm diameter tube on a hydraulic core sampler.

APPENDIX TABLE 3. SUMMARY OF REGRESSION STATISTICS FOR THE VEGETATION ESTIMATION PROCEDURE, COTTONWOOD, 1971

Taxa	Category	Data Set	Sampling Stage	Number of Samples	Mean Ocular Estimates	Mean 'True' Values	Intercept	Regression Coefficient	Residual Variance	Coefficient of Determination	Variance of Regression Coefficient
Agropyron smithii	Live	1	Square	4	.20	.19	.01	1.18	.00	.99	.01
			Plot	5	2.16	2.29	.21	.96	.11	.97	.00
		2	Square	4	.19	.19	.00	1.04	.00	1.00	.00
			Plot	5	1.19	1.19	.02	.99	.00	1.00	.00
		3	Square	8	2.56	3.03	.69	.91	.32	.84	.00
			Plot	9	28.78	30.71	9.45	.74	86.14	.41	.00
		4	Square	6	.23	.22	.04	.77	.00	.97	.00
			Plot	7	2.86	2.73	.71	.70	.05	1.00	.00
		5	Square	5	2.90	3.08	.61	.85	.29	.98	.00
			Plot	6	28.17	30.92	-.79	1.13	29.40	.96	.00
		6	Square	11	1.94	1.88	.07	.93	.02	.99	.00
			Plot	11	35.08	31.57	.71	.88	12.50	.97	.00
		7	Square	7	.16	.20	.05	.97	.00	.88	.00
			Plot	8	1.66	2.12	.49	.98	.13	.94	.00
	Recent Dead	4	Square	3	.44	.54	.03	1.15	.01	.98	.00
			Plot	3	2.85	3.87	.11	1.32	.13	1.00	.00
		5	Square	5	3.65	4.21	-.92	1.40	1.40	.52	.00
			Plot	6	31.83	38.12	11.87	.82	51.82	.74	.00
		6	Square	11	2.75	2.86	-.21	1.12	.08	.98	.00
			Plot	10	37.20	38.20	-.86	1.01	7.52	.99	.00
		7	Square	7	.08	.09	.01	1.06	.00	.81	.00
			Plot	7	1.39	1.23	.37	.56	.04	.95	.00
	Old Dead	1	Square	5	5.95	5.94	1.11	.81	.33	.88	.00
			Plot	5	53.00	50.42	8.83	.78	1.64	.99	.00
		2	Square	6	.02	.03	-.01	2.04	.00	.93	.00
			Plot	7	.36	.70	-.32	2.86	.11	.87	.00
		3	Square	8	2.56	3.03	.69	.91	.32	.84	.00
			Plot	9	28.78	30.71	9.45	.74	86.14	.41	.00
		4	Square	3	.09	.06	-.01	.73	.01	.42	.00
			Plot	3	.27	.13	-.18	1.15	.01	.89	.00
		5	Square	3	.87	.95	-1.07	2.34	.25	.70	.00
			Plot	4	9.00	5.37	62.17	-6.31	27.72	.59	.00
		6	Square	10	.58	.63	.05	1.06	.01	.93	.01
			Plot	11	7.73	11.07	2.52	1.11	7.19	.96	.00
		7	Square	0	.00	.00	.00	.00	.00	.00	.00
			Plot	1	1.00	.00	.00	.00	.00	.00	.00
Bouteloua gracilis	Live	2	Square	9	.12	.14	.01	1.14	.00	1.00	.00
			Plot	11	1.00	1.11	.29	.81	.08	.96	.00
		3	Square	7	.18	.37	.02	1.30	.01	.76	.11
			Plot	9	2.00	2.73	1.65	.54	2.29	.13	.00
		4	Square	8	.56	.57	.15	.84	.01	.95	.01
			Plot	9	8.45	10.39	4.69	.68	5.55	.85	.00
		5	Square	5	.16	.49	.19	1.90	.10	.20	.00
			Plot	6	2.00	5.13	3.35	.89	1.55	.58	.00
		6	Square	10	.33	.37	-.04	1.22	.00	.99	.00
			Plot	9	4.87	5.42	.06	1.17	.80	.96	.01
		7	Square	9	.52	.46	.17	.55	.03	.73	.00
			Plot	9	7.50	7.42	1.79	.75	1.40	.94	.00
	Recent Dead	4	Square	5	.36	.24	-.08	.90	.03	.61	.00
			Plot	5	5.80	5.09	.82	.74	.75	.95	.00
		5	Square	5	.27	.59	.13	1.68	.12	.35	.00
			Plot	6	2.38	5.74	.05	2.40	1.39	.86	.00
		6	Square	10	.44	.50	-.04	1.25	.01	.95	.00
			Plot	9	8.24	7.60	-.29	1.08	4.37	.84	.03
		7	Square	8	.31	.26	.04	.74	.00	.87	.00
			Plot	8	5.38	5.58	2.51	.57	2.77	.50	.00
Buchloe dactyloides	Live	2	Square	11	.12	.14	.00	1.06	.00	.97	.00
			Plot	11	1.06	1.06	.24	.78	.07	.97	.00
		3	Square	5	.24	.41	-.04	1.26	.00	.96	.02
			Plot	9	2.00	2.06	.57	.74	5.28	.33	.00
		4	Square	9	.73	.90	.50	.55	.12	.33	.00
			Plot	9	15.83	14.37	7.82	.41	4.90	.82	.00
		5	Square	4	.34	.26	.02	.53	.00	.84	.03
			Plot	6	4.58	2.22	-.48	.59	.63	.71	.00
		6	Square	10	.38	.41	.03	1.00	.00	.96	.00
			Plot	10	4.88	4.79	.78	.82	2.38	.86	.00
		7	Square	9	.92	.92	.15	.84	.03	.96	.00
			Plot	9	15.31	15.42	3.72	.76	20.42	.90	.00
	Recent Dead	4	Square	5	.84	.72	.05	.80	.16	.49	.00
			Plot	5	14.60	12.58	2.45	.69	16.85	.62	.00
		5	Square	5	.57	.58	.44	.24	.39	.01	.00
			Plot	5	5.46	5.38	3.97	.23	.03	.95	.00
		6	Square	10	.62	.65	-.02	1.09	.00	.98	.00
			Plot	10	7.92	6.10	3.14	.38	9.18	.39	.00
		7	Square	8	.60	.50	.19	.51	.04	.39	.00
			Plot	8	13.75	9.47	2.44	.51	2.49	.57	.00

APPENDIX TABLE 3 CONTINUED

Taxa	Category	Data Set	Sampling Stage	Number of Samples	Mean Ocular Estimates	Mean 'True' Values	Intercept	Regression Coefficient	Residual Variance	Coefficient of Determination	Variance of Regression Coefficient
Shortgrass (BOGR+BUDA)	Old Dead	1	Square	5	1.61	1.45	.17	.79	.01	1.00	.00
			Plot	5	17.30	14.46	1.53	.75	.17	1.00	.00
		2	Square	10	1.13	.88	.15	.61	.00	.87	.01
			Plot	11	13.48	9.66	2.54	.53	1.66	.90	.00
		3	Square	8	.30	.38	-.50	1.43	.05	.54	.00
			Plot	9	5.17	4.16	.53	.70	5.95	.34	.00
		4	Square	9	.40	.19	.07	.31	.00	.75	.00
			Plot	9	7.75	3.58	2.26	.17	.64	.66	.00
		5	Square	3	.27	.52	.48	.18	.27	.01	.00
			Plot	4	5.75	4.74	3.75	.17	.00	.99	.00
		6	Square	6	.15	.18	.02	.93	.00	.86	.00
			Plot	8	2.14	1.86	.09	.83	.26	.86	.03
		7	Square	10	.35	.30	.16	.40	.01	.49	.00
			Plot	10	6.22	5.08	1.71	.57	.17	.97	.00
Bromus japonicus	Live	1	Square	5	.02	.03	.02	.41	.00	.31	.00
			Plot	4	.19	.24	.15	.44	.00	1.00	.00
		2	Square	9	.07	.08	-.01	1.16	.00	.96	.00
			Plot	10	.86	.69	.02	.86	.02	.96	.00
		3	Square	7	.39	.35	.04	.72	.00	.99	.00
			Plot	8	4.24	3.54	1.22	.37	.74	.91	.00
		4	Square	3	.22	.18	.00	1.05	.00	1.00	.00
			Plot	4	3.56	2.66	.22	.68	.57	.94	.00
		5	Square	-	--	--	--	--	--	--	--
			Plot	4	1.75	1.25	.67	.33	3.65	.09	.00
		6	Square	6	1.15	1.28	.28	.88	.05	.93	.00
			Plot	8	11.58	13.52	2.62	.94	6.84	.97	.00
		7	Square	10	.21	.25	.01	1.13	.00	.99	.00
			Plot	10	3.00	2.81	-.02	.94	.25	.97	.00
	Recent Dead	4	Square	4	.12	.16	.02	1.18	.01	.77	.00
			Plot	5	1.00	1.28	.55	.73	.30	.40	.00
		5	Square	5	.30	.80	-.30	3.71	.04	.96	.00
			Plot	5	4.08	9.46	-4.89	3.05	4.79	.97	.10
		6	Square	6	.81	.85	-.05	1.05	.00	.99	.00
			Plot	7	6.31	7.59	5.90	.27	5.76	.07	.00
		7	Square	10	.21	.25	.01	1.13	.00	.99	.00
			Plot	10	3.00	2.81	-.02	.94	.25	.97	.00
Carex eleocharis	Live	1	Square	5	.03	.02	.01	.54	.00	.47	.00
			Plot	5	.26	.20	.05	.55	.00	.76	.00
		2	Square	11	.12	.12	.00	1.00	.00	.98	.00
			Plot	11	1.18	1.14	.18	.82	.18	.85	.00
		3	Square	7	.12	.25	.06	.77	.01	.65	.06
			Plot	9	2.13	1.43	.72	.34	.05	.80	.00
		4	Square	7	.12	.17	.00	1.02	.00	.74	.07
			Plot	9	2.47	1.88	1.12	.31	.34	.43	.00
		5	Square	3	.08	.37	.52	-1.80	.00	.96	.00
			Plot	4	1.25	3.33	2.43	.72	.14	.32	.00
		6	Square	10	.17	.17	-.04	1.26	.00	.94	.00
			Plot	10	1.76	2.18	.24	1.10	.62	.82	.00
		7	Square	5	.16	.21	-.06	1.50	.00	.98	.01
			Plot	7	3.36	2.65	.48	.65	1.39	.53	.00
	Recent Dead	4	Square	3	.13	.24	.04	1.08	.00	1.00	.00
			Plot	4	1.50	1.97	.49	.99	.28	.90	.00
		5	Square	2	.10	.42	.00	.00	.00	.00	.00
			Plot	2	1.38	.00	.00	.00	.00	.00	.00
		6	Square	11	.16	.17	-.01	1.10	.00	.79	.00
			Plot	10	1.34	2.02	.81	.59	.75	.46	.05
		7	Square	6	.14	.13	-.01	1.02	.00	.95	.00
			Plot	6	3.08	1.97	.20	.57	.58	.56	.00
Fresh mulch		1	Square	5	9.65	9.68	.30	.97	.08	.98	.00
			Plot	5	83.26	81.08	27.66	.64	79.86	.51	.00
		2	Square	10	1.36	1.33	.05	.91	.00	.96	.00
			Plot	11	16.00	14.91	2.94	.75	2.02	.96	.00
		3	Square	8	10.06	9.19	1.54	.76	.90	.86	.00
			Plot	9	106.22	106.33	24.22	.77	78.43	.93	.00
		4	Square	9	.68	.56	-.03	.88	.05	.68	.00
			Plot	9	15.00	11.11	5.89	.35	8.71	.29	.00
		5	Square	5	10.44	7.39	-.43	.75	.92	.67	.00
			Plot	6	94.33	70.59	23.24	.50	67.81	.82	.00
		6	Square	11	5.45	4.96	.16	.88	.15	.98	.00
			Plot	11	77.42	70.56	8.87	.80	54.02	.97	.00
		7	Square	11	.62	.59	.20	.62	.04	.61	.00
			Plot	11	14.72	10.88	3.28	.52	3.38	.93	.00

APPENDIX TABLE 3 CONTINUED

Taxa	Category	Data Set	Sampling Stage	Number of Samples	Mean Ocular Estimates	Mean 'True' Values	Intercept	Regression Coefficient	Residual Variance	Coefficient of Determination	Variance of Regression Coefficient
Humic mulch		1	Square	5	.35	.36	.03	.94	.00	1.00	.00
			Plot	4	1.97	9.45	.41	.70	.06	.95	.01
		2	Square	9	.08	.06	.03	.41	.00	.68	.00
			Plot	10	.87	.80	.11	.87	.05	.93	.01
		3	Square	8	.14	.13	-.03	1.14	.00	.92	.00
			Plot	9	2.40	1.35	-.32	.70	.37	.60	.00
		4	Square	7	.04	.02	-.02	1.10	.00	.45	.00
			Plot	9	2.17	1.47	.71	.35	.29	.27	.00
		5	Square	5	.11	.10	.09	.02	.00	.00	.00
			Plot	6	1.75	.87	.86	.00	.00	.63	.00
		6	Square	11	.06	.05	.01	.70	.00	.79	.00
			Plot	11	1.54	.78	.64	.08	.10	.20	.00
		7	Square	5	.03	.04	.00	1.71	.00	.98	.00
			Plot	10	.92	1.15	-.07	1.22	.07	.86	.03
Dead crowns and stolons		1	Square	5	.53	.56	.03	1.00	.00	.99	.00
			Plots	5	5.98	5.66	.90	.80	.05	.99	.00
		2	Square	10	.19	.28	.02	1.26	.00	.88	.03
			Plot	11	1.84	2.57	.70	1.02	.27	.80	.00
		3	Square	7	.42	.50	.02	.99	.00	.96	.01
			Plot	8	7.22	5.03	3.44	.28	1.25	.54	.01
		4	Square	9	.09	.13	.07	.65	.01	.12	.00
			Plot	9	1.32	1.93	1.03	.68	.06	.58	.00
		5	Square	5	.45	.71	.45	.58	.12	.06	.00
			Plot	5	5.08	6.01	5.95	.06	.04	.21	.00
		6	Square	10	.34	.34	.01	.98	.00	1.00	.00
			Plot	11	5.30	4.39	1.28	.58	2.35	.73	.00
		7	Square	11	.14	.15	.00	1.08	.00	.97	.00
			Plot	11	1.50	1.66	-.20	1.24	.30	.30	.00
Live crowns and stolons		1	Square	5	.86	.80	.09	.82	.00	.95	.00
			Plot	5	10.15	8.34	1.40	.68	.05	1.00	.00
		2	Square	10	.17	.19	.01	.93	.00	.96	.00
			Plot	10	1.74	1.50	.34	.73	.09	.87	.01
		3	Square	8	.62	.60	-.01	.99	.02	.86	.00
			Plot	9	8.81	6.61	1.97	.53	4.19	.56	.00
		4	Square	8	.10	.11	.01	.89	.00	.97	.00
			Plot	9	1.07	1.06	-.10	1.09	.04	.77	.00
		5	Square	5	.60	.64	.42	.36	.07	.09	.00
			Plot	6	7.58	5.68	2.42	.43	.68	.49	.00
		6	Square	10	.39	.38	-.01	1.00	.00	.99	.00
			Plot	9	6.94	5.76	1.89	.48	2.94	.59	.02
		7	Square	10	.05	.05	.04	.35	.00	.21	.00
			Plot	11	1.23	.84	.45	.32	.02	.45	.00
Soil		1	Square	4	.44	.42	.01	.93	.00	.98	.00
			Plot	5	7.60	6.48	-.28	.89	.05	1.00	.00
		2	Square	7	.60	.63	.01	1.05	.00	.99	.00
			Plot	11	4.27	4.05	.30	.88	.61	.98	.00
		3	Square	7	.18	.12	-.06	.98	.00	.99	.00
			Plot	8	5.44	3.10	-.39	.53	.27	.96	.00
		4	Square	5	.12	.14	.01	1.06	.00	1.00	.00
			Plot	9	2.11	2.52	.03	1.18	.32	.96	.00
		5	Square	4	.05	.04	.01	.50	.00	.00	.00
			Plot	6	1.42	.32	.21	.08	.00	.91	.00
		6	Square	9	.06	.04	.03	-.09	.00	.05	.00
			Plot	10	4.65	-.17	.33	-.11	.01	.99	.02
		7	Square	2	.02	.02	.04	-.50	.00	1.00	.00
			Plot	3	1.33	-.11	-.12	.00	.02	.00	.00

Appendix Table 4. Species List and Codes of Plants Found in Clip, Weight-Rank and Weight-Estimate Plots. Cottonwood, 1970, 1971

6ACLA	*Achillea millefolium* L. (common yarrow)
6AGGL	*Agoseris glauca* (Nutt.) Greene. (pale agoseris)
1AGSM	*Agropyron smithii* Rydb. (western wheatgrass)
6ALTE	*Allium textile* Nels & Macbr. (textile onion)
4AMRE	*Amaranthus retroflexus* L. (rough pigweed)
4ANOC	*Androsace occidentalis* Pursh. (western rockjasmine)
6ANAP	*Antennaria aprica* Greene (pussytoes)
5ARHI	*Arabis hirsuta* (L.) Scop. (hairy rockcress)
1ARLO	*Aristida longiseta* Steud. (red threeawn)
7ARFR	*Artemisia frigida* Willd. (fringed sagewort)
6ARLU	*Artemisia ludoviciana* Nutt. *var. gnaphalodes* (Nutt.) T & G (Cudweed sagewort)
6ASER	*Aster ericoides* L. (heath aster)
6ASSP	*Astragalus* species (milkvetch)
6ASTR	*Astragalus triphyllus* Pursh. (threeleaf milkvetch)
1BOGR	*Bouteloua gracilis* (H.B.K.) Lag. ex Steud. (blue grama)
2BRJA	*Bromus japonicus* Thurb. (japanese brome)
1BUDA	*Buchloe dactyloides* (Nutt.) Engelm. (buffalograss)
3CAEL	*Carex eleocharis* Bailey (needleleaf sedge)
4CHLE	*Chenopodium leptophyllum* Nutt. (slimleaf goosefoot)
6DEVI	*Delphinium virescens* Nutt. (plains larkspur)
4DRRE	*Draba reptans* (Lam.) Fern. (creeping draba)
6ERCA	*Erigeron canus* A. Gray (hoary fleabane)

Appendix Table 4 Continued. Species List and Codes

4ERSP	*Erigeron* spp. (fleabane)
4ERST	*Erigeron strigosus* Muhl. ex Willd. (daisy fleabane)
5ERAS	*Erysimum asperum* (Nutt.) DC. (plains erysimum)
4EUSP	*Euphorbia* spp. (spurge)
2FEOC	*Festuca octoflora* Walt. (sixweeks fescue)
6GACO	*Gaura coccinea* Nutt. (scarlet gaura)
5GRSQ	*Grindelia squarrosa* (Pursh.) Dural (curlycup gumweed)
6GUSA	*Gutierrezia sarothrae* (Pursh.) Britton & Rusby (broom snakeweed)
4HEHI	*Hedeoma hispida* Pursh. (rough falsepennyroyal)
4HEAN	*Helianthus annuus* L. (common sunflower)
2HOPU	*Hordeum pusillum* Nutt. (little barley)
4KOSC	*Kochia scoparia* (L.) Roth (kochia)
6LAPU	*Lactuca pulchella* (Pursh.) DC. (chicory lettuce)
4LASE	*Lactuca scariola* L. (prickly lettuce)
4LASP	*Lappula* spp. (stickseed)
6LEMO	*Leucocrinum montanum* Nutt. (common starlily)
4LEDE	*Lepidium densiflorum* Schrad. (prairie pepperweed)
6LIPU	*Liatris punctata* Hook. (dotted gayfeather)
6LIIN	*Lithospermum incisum* Lehm (yellow gromwell)
4LIRI	*Linum sulcatum* Riddell (grooved flax)
6LOFO	*Lomatium foeniculaceum* (Nutt.) Coult & Rose (yellowflowered lomatium)
6LOOR	*Lomatium orientale* Coult & Rose (whiteflowered lomatium)
7MAMI	*Mammillaria missouriensis* Sweet (pincushion cactus)

Appendix Table 4 Continued. Species List and Codes

5MEOF	*Melilotus officinalis* (L.) Lam. (yellow sweetclover)
6MELA	*Mertensia lanceolata* (Pursh.) DC. (bluebell)
6MUDI	*Musineon divaricatum* (Pursh.) Coult & Rose (wild parsley)
7OPFR	*Opuntia fragilis* (Nutt.) Haw (brittle pricklypear)
7OPPO	*Opuntia polycantha* Haw (plains pricklypear)
6OXST	*Oxalis stricta* L. (erect woodsorrel)
6PESP	*Penstemon* spp. (penstemon)
4PLPU	*Plantago purshii* Roem & Schult (wooly indianwheat)
1POSE	*Poa secunda* Presl. (sandberg bluegrass)
6POVE	*Polygala verticillata* L. (whorled polygala)
6POPE	*Potentilla* spp. (cinquefoil)
6PSAR	*Psoralea argophylla* Pursh. (silverleaf scurfpea)
6PSCU	*Psoralea cuspidata* Pursh. (tallbread scurfpea)
6PSES	*Psoralea esculenta* Pursh. (common breadroot scurfpea)
6PSTE	*Psoralea tenuiflora* Pursh. (slimflower scurfpea)
6RACO	*Ratibida columnifera* (Nutt.) Wooton & Standley (upright prairieconeflower)
2SCPA	*Schedonnardus paniculatus* (Nutt.) Trel. (tumblegrass)
6SPCO	*Sphaeralcea coccinea* (Pursh.) Rydb. (scarlet globemallow)
1SPAS	*Sporobolus asper* (Michx.) Kunth. (tall dropseed)
1SPCR	*Sporobolus cryptandrus* (Torr.) A. Gray (sand dropseed)
1STVI	*Stipa viridula* Trin. (green needlegrass)
6TAOF	*Taraxacum officinale* Weber (common dandelion)
6TRBR	*Tradescantia bracteata* Small (bracted spiderwort)

Appendix Table 4 Continued. Species List and Codes

5TRPR	*Tragopogon pratensis* L. (meadow salsify)
6VIAM	*Vicia americana* Muhl. (american vetch)
6VINU	*Viola nuttallii* Pursh. (nuttall violet)

Appendix Table 5. Below-Ground Standing Crop (g/m^2 oven dry organic matter of below-ground crowns, rhizomes, and roots), Permanent Exclosure, High Range Condition, Cottonwood, 1971[a/]

Replicate	Depth, cm	Apr 2		Apr 16		May 4		May 21		June 8		June 22	
		Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
1	0-10	903.7	58.5	989.6	75.1	667.8	31.7	771.5	47.0	613.9	33.9	814.3	44.9
	10-20	187.0	14.2	212.2	11.6	211.9	14.6	236.7	14.6	193.5	12.5	256.4	10.0
	20-30	135.7	9.1	192.0	7.6	137.1	4.9	179.6	12.7	204.1	35.8	171.1	8.6
	0-30	1226.4		1393.8		1016.8		1187.8		1011.5		1241.8	
	30-40	109.0	5.9	129.9	6.6					92.9	3.5		
	40-50	82.3	5.0	112.6	3.5					108.8	12.3		
	50-60	61.4	3.0	80.8	4.3					74.4	3.4		
	0-60	1479.1		1717.1						1287.6			
	Ratio (30-60)/(0-30)	.21		.21						.27			
2	0-10	786.0	33.2	741.3	57.3	697.4	35.6	699.5	49.8	972.2	69.9	622.0	36.5
	10-20	166.7	9.6	209.3	12.5	195.6	13.3	186.3	11.3	234.2	7.8	182.4	12.8
	20-30	127.8	3.4	165.3	5.5	123.3	4.9	113.9	4.6	169.0	12.3	180.2	14.3
	0-30	1080.5		1115.9		1016.3		999.7		1375.4		984.6	
	30-40	96.7	5.5	126.3	6.0					138.6	5.3		
	40-50	78.0	3.8	102.5	5.6					124.1	5.4		
	50-60	56.3	3.0	88.8	6.7					97.2	4.3		
	0-60	1311.5		1433.5						1735.3			
	Ratio (30-60)/(0-30)	.18		.28						.26			
Mean	0-10	844.9		865.4		682.6		735.5		793.0		718.2	
	10-20	176.8		210.8		203.7		211.5		213.9		219.4	
	20-30	131.7		178.6		130.2		146.8		186.5		175.6	
	0-30	1153.4		1254.8		1016.5		1093.8		1193.4		1113.2	
	30-40	102.8		128.1						115.8			
	40-50	80.1		107:6						116.4			
	50-60	58.8		84.1						85.8			
	0-60	1395.3		1574.6						1511.4			

a/ Means of 10 cores/replicate. Samples were not taken on November 12 because of equipment failure.
b/ Nine cores.

Appendix Table 5 Continued. Below-Ground Standing Crop

Replicate	Depth, cm	July 6		July 20		Aug 3		Aug 17		Sep 2		Oct 1	
		Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
1	0-10	982.2	74.1	701.9	37.7	640.8b/	33.7	648.2	32.2	822.1	54.2	806.8	53.5
	10-20	229.6	16.6	192.9	13.7	201.9b/	13.8	192.3	9.5	231.3	20.0	192.9	18.6
	20-30	162.6	6.7	132.3	7.1	150.0b/	7.7	148.1	7.0	129.2	11.2	133.2	8.3
	0-30	1374.4		1027.1		992.7		988.6		1182.6		1132.9	
	30-40	121.9	7.2			105.5b/	6.8			89.7	6.8		
	40-50	104.6	4.1			86.1b/	6.2			74.5	5.5		
	50-60	83.4	4.3			77.1b/	6.7			68.2	5.9		
	0-60	1684.3				1261.4				1415.0			
	Ratio $\frac{30-60}{0-30}$	.23				.27				.20			
2	0-10	948.4	68.3	944.5	48.1	603.4	39.4	712.7	21.7	878.4	48.8	804.6	79.1
	10-20	222.2	14.1	195.9b/	18.0	171.1	8.7	171.4	14.0	232.6	13.5	170.6	15.1
	20-30	145.2	8.5	221.6	8.2	138.4	7.0	156.5	11.9	163.0	3.7	151.6	15.8
	0-30	1315.8		1362.0		912.9		1040.6		1274.0		1126.8	
	30-40	142.9	8.2			123.4	8.4			102.1	5.2		
	40-50	119.8	5.5			96.9	6.0			77.8	4.2		
	50-60	87.5	4.1			65.3	4.5			67.8	3.8		
	0-60	1666.0				1198.5				1521.7			
	Ratio $\frac{30-60}{0-30}$	.27				.31				.19			
Mean	0-10	965.3		823.2		622.1		680.5		850.3		805.7	
	10-20	225.9		194.4		186.5		181.8		231.9		181.8	
	20-30	153.9		176.9		144.2		152.3		146.1		142.4	
	0-30	1345.1		1194.5		952.8		1014.6		1228.3		1129.9	
	30-40	132.4				114.4				95.9			
	40-50	112.2				91.5				76.2			
	50-60	85.5				71.2				68.0			
	0-60	1675.2				1229.9				1468.4			

Appendix Table 6. Below-Ground Standing Crop (g/m^2 oven dry organic matter of below-ground crowns, rhizomes, and root), Temporary Exclosure, Low Range Condition, Cottonwood, 1971[a/]

Replicate	Depth, cm	Apr 2		Apr 16		May 4		May 21		June 8		June 22	
		Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
1	0-10	1207.6	70.3	1287.7	38.3	1212.4	48.3	1202.2	66.1	1494.5	50.9	1546.1	35.3
	10-20	290.9	79.6	410.7	16.1	390.9	19.4	374.2	22.3	396.4	14.4	592.2	38.1
	20-30	140.8	8.6	259.8	12.0	192.9	9.7	289.8[b/]	12.5	252.2	11.4	350.6	24.6
	0-30	1639.3		1958.2		1796.2		1866.2		2143.1		2489.4	
	30-40	85.1	4.6	161.0	7.9					155.4	8.3		
	40-50	49.8	3.8	110.4	4.2					135.8	8.6		
	50-60	33.2	2.3	70.7	3.5					88.4	3.4		
	0-60	1807.4		2300.3						2522.6			
	Ratio $\frac{30-60}{0-30}$	.10		.17						.18			
2	0-10	1236.5	32.9	1416.2	59.1	1281.1	44.6	1379.4	35.7	1387.5	51.8	1566.5	60.2
	10-20	301.7	16.1	423.0	18.6	417.7	12.5	480.2[b/]	20.0	412.4	18.3	482.2	18.8
	20-30	165.3	9.0	254.8	12.8	224.8	7.9	313.3	11.9	262.4	11.8	289.0	10.6
	0-30	1703.5		2094.0		1923.6		2172.9		2062.3		2337.7	
	30-40	103.2	7.0	181.2	6.1					154.6	7.0		
	40-50	65.0	4.8	128.5	4.0					150.2	12.3		
	50-60	38.3	3.7	87.3	4.6					88.7[b/]	4.7		
	0-60	1910.0		2491.0						2455.8			
	Ratio $\frac{30-60}{0-30}$	.12		.19						.19			
Mean	0-10	1222.0		1352.0		1246.8		1290.8		1441.0		1556.6	
	10-20	296.3		416.8		404.3		427.2		404.4		537.2	
	20-30	153.0		257.3		208.8		301.5		257.3		319.8	
	0-30	1671.3		2026.1		1859.9		2019.5		2102.7		2413.6	
	30-40	94.2		171.1						155.0			
	40-50	57.4		119.5						143.0			
	50-60	35.7		79.0						88.5			
	0-60	1858.6		2395.7						2489.2			

a/ Means of 10 cores/replicate. Only 1 replicate was sampled because of equipment failure.
b/ Nine cores.
c/ Eight cores.

Appendix Table 6 Continued. Below-Ground Standing Crop

Replicate	Depth, cm	July 6 Mean	July 6 S.E.	July 20 Mean	July 20 S.E.	Aug 3 Mean	Aug 3 S.E.	Aug 17 Mean	Aug 17 S.E.	Sep 2 Mean	Sep 2 S.E.	Oct 1 Mean	Oct 1 S.E.	Nov 12 Mean	Nov 12 S.E.
1	0-10	1632.2	66.2	1653.3	89.0	888.6	39.6	1403.8	55.1	1199.7	52.0	1310.0	69.4	1291.1	33.9
	10-20	393.1	11.5	390.7	19.2	301.9	6.2	373.1	24.8	305.5	20.3	418.6	24.3	382.1	30.8
	20-30	260.6	11.8	231.5	13.5	197.0	13.6	283.5	22.2	190.9	12.8	242.6	10.6	266.1	18.0
	0-30	2285.9		2275.5		1587.5		2066.4		1696.1		1971.2		1939.3	
	30-40	167.4	6.0			166.8	14.0			95.9	4.8				
	40-50	141.0	5.0			106.0	8.1			76.0	3.8				
	50-60	88.0	2.0			70.4	8.1			52.4	1.9				
	0-60	2682.3				1730.7				1920.4					
	Ratio 30-60 / 0-30	.17				.25				.13					
2	0-10	1560.2	58.5	1346.8	64.1	1054.1	53.7	1451.1	64.1	1198.9	41.6	1338.7[b]	85.7		
	10-20	528.2	75.9	432.7	34.2	298.1	17.5	597.6	31.8	360.3	32.0	440.9	33.0		
	20-30	299.5[c]	28.7	246.8	16.9	235.4	19.9	396.3	30.5	209.1	14.3	315.8	28.3		
	0-30	2387.9		2026.3		1587.6		2395.0		1768.3		2095.4			
	30-40	274.0	24.5			165.7	19.8			142.6	6.6				
	40-50	166.9	12.2			124.0	15.3			104.5	3.8				
	50-60	154.2	18.7			126.5	22.0			60.0	2.7				
	0-60	2983.0				2003.8				2075.4					
	Ratio 30-60 / 0-30					.26				.17					
Mean	0-10	1596.2		1500.1		971.3		1427.4		1199.3		1324.4			
	10-20	460.6		411.7		300.0		463.4		332.9		429.8			
	20-30	280.0		239.2		216.2		339.9		200.0		279.2			
	0-30	2336.8		2151.0		1487.5		2230.7		1732.2		2033.4			
	30-40	220.7				166.2				119.3					
	40-50	153.9				115.0				90.3					
	50-60	121.1				98.5				56.2					
	0-60	2832.5				1867.2				1998.0					

Appendix Table 7. Transfer From Herbage to Mulch--Individual Plot Data (g/0.0225 m2)
High Condition Range, Replicate I, 1971[a/]

Component		Agropyron smithii				Buchloe dactyloides				Bouteloua gracilis			
Mo./day		6/16	6/28	7/28	9/27	6/16	6/28	7/28	9/27	6/16	6/28	7/28	9/27
Plot													
1	L[b/]	--	--	--	--	.01	--	--	--	--	--	--	--
	D[b/]	--	.01	.04	.01	.02	.01	--	.01	--	--	.01	--
2	L	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	--	--	.02	--	--	--	--	.01	--	--	--
3	L	--	--	--	--	--	.01	--	--	--	--	--	--
	D	.02	--	--	--	--	--	--	--	--	--	--	--
4	L	--	--	--	--	--	.01	--	.04	--	--	--	--
	D	--	--	--	--	--	.01	--	--	--	--	--	--
5	L	--	--	--	--	--	.01	--	--	--	--	--	--
	D	.02	.01	--	.01	--	--	--	--	--	--	--	--
6	L	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	--	--	--	--	.01	--	--	.02	--	--	--
7	L	--	--	--	--	.01	--	--	--	--	--	--	--
	D	--	--	.01	.05	--	--	--	.03	.02	--	--	--
8	L	--	--	--	--	--	--	--	--	--	--	--	--
	D	.01	.01	--	.02	--	.01	--	--	--	--	--	--
9	L	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	.01	.04	.07	--	--	--	--	.01	--	--	--
10	L	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	--	--	--	--	--	--	--	--	--	--	.02
Total		.05	.04	.03	.18	.04	.07	--	.08	.06	--	.01	.02
Mean		.005	.004	.009	.018	.004	.007	--	.008	.006	--	.001	.002
Days in interval		12	12	30	71	12	12	30	71	12	12	30	71
$g/m^2/day$		.013	.015	.013	.011	.015	.026	--	.005	.022	--	.001	.001

Component		Carex eleocharis				Bromus japonicus				Other species				Total			
Mo./day		6/16	6/28	7/28	9/27	6/16	6/28	7/28	9/27	6/16	6/28	7/28	9/27	6/16	6/28	7/28	9/27
Plot																	
1	L[b/]	--	--	--	--	--	--	.01	--	--	--	--	--	.01	--	[illegible]	--
	D[b/]	--	--	.01	.01	--	--	--	--	.03	--	--	--	.05	.02	[illegible]	[illegible]
2	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	--	--	--	.01	--	.11	.06	--	--	--	.03	.02	--	[illegible]	[illegible]
3	L	--	.01	--	--	.01	.01	--	--	.04	--	.01	--	.05	.03	[illegible]	[illegible]
	D	--	--	--	--	--	.01	.04	.03	--	.02	.35	.04	.02	.03	[illegible]	[illegible]
4	L	--	--	--	--	--	--	--	--	.02	--	--	--	.02	[illegible]	--	[illegible]
	D	--	--	--	--	--	--	.09	.01	--	.01	--	--	--	.02	[illegible]	[illegible]
5	L	--	--	--	--	.01	--	--	--	--	--	--	--	.01	[illegible]	--	--
	D	--	--	--	--	--	--	.03	.06	--	.01	--	--	.02	.02	[illegible]	[illegible]
6	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	--	--	--	.03	.02	.06	--	--	--	--	--	.05	.03	[illegible]	--
7	L	--	--	--	--	--	--	--	--	--	--	.08	--	.01	--	[illegible]	--
	D	.03	.01	--	--	--	--	.01	--	--	--	.34	--	.05	[illegible]	[illegible]	[illegible]
8	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	--	--	--	--	.02	.01	--	--	--	--	--	.01	[illegible]	[illegible]	[illegible]
9	L	--	--	--	--	.01	--	--	--	.04	.12	.01	--	.05	[illegible]	[illegible]	--
	D	--	--	--	--	--	.02	.03	--	--	.01	.03	--	.01	[illegible]	[illegible]	[illegible]
10	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	.02	--	--	.01	.01	.03	.01	--	.01	.04	.01	.01	[illegible]	[illegible]	[illegible]
Total		.03	.04	.01	.01	.08	.09	.44	.17	.13	.18	.86	.08	.39	.42	1.41	[illegible]
Mean		.003	.004	.001	.001	.008	.009	.044	.017	.013	.018	.086	.008	.039	.042	.141	[illegible]
Days in interval		12	12	30	71	12	12	30	71	12	12	30	71	12	12	30	71
$g/m^2/day$		.011	.015	.001	.001	.030	.033	.065	.011	.048	.067	.128	.005	.144	.156	[illegible]	[illegible]

a/ Plots initially cleared of bright colored litter on June 4, 1971.
b/ Live (L) and this year's dead (D) components.

Appendix Table 8. Transfer From Herbage to Mulch--Individual Plot Data (g/0.0225 m^2)
High Condition Range, Replicate II, 1971[a]

Component		Agropyron smithii				Buchloe dactyloides				Bouteloua gracilis				Carex eleocharis				Bromus japonicus				Other species				Total			
Mo./day		6/17	6/30	7/28	9/27	6/17	6/30	7/28	9/27	6/17	6/30	7/28	9/27	6/17	6/30	7/28	9/27	6/17	6/30	7/28	9/27	6/17	6/30	7/28	9/27	6/17	6/30	7/28	9/27
Plot																													
1	L[b]	--	--	--	--	--	--	.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.02	--
	D[b]	.01	--	.08	--	--	--	.04	.01	--	--	--	--	--	--	.03	.01	--	--	.05	.03	.06	--	--	.01	.07	--	.20	.06
2	L	--	--	--	--	--	--	--	--	--	.03	--	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	.04	--	--
	D	.01	.01	--	.01	--	--	--	--	--	--	.01	.02	--	--	--	--	--	.02	.03	.01	--	--	--	--	.01	.03	.04	.04
3	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	--	.01	--	--	--
	D	--	--	.02	.03	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	.03	.02	.02	--	.01	--	--	--	.06	.06
4	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	.04	--	.10	.08	--	--	--	--	--	.01	.01	--	--	--	--	--	--	--	.16	.01	--	.04	.09	--	.04	.05	.36	.09
5	L	--	--	--	--	--	--	--	--	--	.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.02	--	--
	D	--	--	.02	--	--	--	--	--	--	--	--	--	--	--	.02	--	.01	.04	.02	--	--	--	--	--	.01	.04	.06	--
6	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	.01	--	--	.03	--	--	--	.01	--	--	--	--	--	--	--	--	--	.02	.08	.03	.05	--	.12	.02	.06	.02	.20	.09
7	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	.01	--	--	--	--	--	.01	--	.01	--	--	--	--	--	--	--	--	.02	.04	--	--	.02	--	--	.02	.04	.05	--
8	L	--	--	--	--	--	--	.01	--	--	--	--	.01	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	.01	.02
	D	--	--	--	.04	--	.01	.01	.03	.01	--	--	--	--	--	--	--	--	--	.05	.03	--	--	.01	--	.01	.01	.07	.10
9	L	--	--	--	--	.03	--	.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.03	--	.01	--
	D	--	--	.01	--	--	.02	.01	.01	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	.04	--	.01	.02	.06	.01
10	L	--	--	--	--	--	--	.01	--	--	--	--	--	--	--	--	--	--	--	--	.01	.01	--	--	.01	.01	--	.01	.02
	D	.01	--	--	.04	--	--	.02	.01	--	--	.01	--	--	--	--	--	--	--	.04	--	.01	.01	.18	--	.02	.01	.25	.05
Total		.09	.01	.23	.23	.03	.03	.14	.07	.02	.06	.03	.04	--	--	.05	.01	.03	.10	.50	.15	.15	.08	.45	.04	.30	.28	1.40	.54
Mean		.009	.001	.023	.023	.003	.003	.014	.007	.002	.006	.003	.004	--	--	.005	.001	.003	.010	.050	.015	.015	.008	.045	.004	.030	.028	.140	.054
Days in Interval		13	13	28	71	13	13	28	71	13	13	28	71	13	13	28	71	13	13	28	71	13	13	28	71	13	13	28	71
g/m^2/day		.031	.003	.037	.014	.010	.010	.022	.004	.007	.021	.005	.003	--	--	.008	.001	.010	.034	.079	.009	.051	.027	.079	.003	.101	.096	.222	.033

a/ Plots initially cleared of bright colored litter on June 4, 1971.
b/ Live (L) and this year's dead (D) components.

Appendix Table 9. Transfer From Herbage to Mulch--Individual Plot Data (g/0.0225 m^2)
Low Condition Range, Replicate I, 1971[a]

Component		*Agropyron smithii*				*Buchloe dactyloides*				*Bouteloua gracilis*				*Carex eleocharis*				*Bromus japonicus*				Other species				Total			
Mo./day		6/16	6/30	7/26	9/24	6/16	6/30	7/26	9/24	6/16	6/30	7/26	9/24	6/16	6/30	7/26	9/24	6/16	6/30	7/26	9/24	6/16	6/30	7/26	9/24	6/16	6/30	7/26	9/24
Plot																													
1	L[b]	--	--	--	--	--	.01	.07	--	--	--	--	--	--	--	--	--	--	--	--	--	.02	--	--	--	.02	.01	.07	--
	D[b]	--	--	--	.06	.05	--	.02	.07	--	--	.01	--	.02	--	.01	--	--	--	.15	.08	--	--	.02	--	.07	--	.21	.21
2	L	--	--	--	--	--	.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.01	--	--
	D	--	--	.04	--	--	--	.01	.01	--	--	--	--	--	--	--	--	--	--	.07	.04	--	--	.03	--	--	--	.15	.05
3	L	--	--	--	--	.02	.01	.16	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.02	.01	.16	--
	D	--	--	--	--	--	--	.04	.06	.01	--	--	--	.01	--	--	--	--	--	.23	.12	.02	--	.19	--	.04	--	.46	.18
4	L	--	--	--	--	--	.03	.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.03	.02	--
	D	--	--	--	--	.01	--	.01	.02	--	--	--	--	--	--	--	--	--	--	.05	.12	.01	--	.08	.04	.02	--	.14	.18
5	L	--	--	--	--	.04	.03	.04	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	.04	.04	.04	--
	D	--	--	--	--	--	--	--	.02	.02	--	--	--	.03	--	--	--	--	--	.28	.08	.01	.01	.01	--	.06	.01	.29	.10
6	L	--	--	--	--	--	.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.02	--	--
	D	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	--	--	--	.06	--	--	--	--	--	.01	--	.06	--
7	L	--	--	--	--	.01	.02	.04	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	.01	.03	.04	--
	D	--	--	--	--	.01	--	--	.02	--	--	--	--	--	--	--	--	--	--	.18	.05	.01	--	--	.04	.02	--	.18	.11
8	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	--	--	--	--	--	--	.01	--	--	--	--	.01	--	--	--	--	--	--	.02	.02	.01	--	.01	.02	.01	--	.04	.05
9	L	--	--	--	--	.01	--	.03	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	.01	.01	.03	--
	D	--	--	--	--	.02	--	.01	.10	.03	--	--	.02	--	--	--	.01	--	--	.03	.02	.02	.02	.04	.01	.07	.02	.08	.16
10	L	--	--	--	--	--	.03	.24	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	--	.04	.24	--
	D	--	--	--	.02	--	--	.10	.15	--	--	--	--	--	--	.01	--	--	--	.19	.17	--	.01	.09	.04	--	.01	.39	.38
Total		--	--	.04	.08	.17	.16	.80	.45	.07	--	.01	.03	.06	--	.02	.01	--	.04	1.26	.70	.10	.04	.47	.15	.40	.24	2.60	1.42
Mean		--	--	.004	.008	.017	.016	.080	.045	.007	--	.001	.003	.006	--	.002	.001	--	.004	.126	.070	.010	.040	.047	.015	.040	.024	.260	.142
Days in interval		9	14	26	60	9	14	26	60	9	14	26	60	9	14	26	60	9	14	26	60	9	14	26	60	9	14	26	60
$g/m^2/day$		--	--	.007	.006	.084	.051	.137	.033	.034	--	.002	.002	.030	--	.003	.001	--	.013	.215	.052	.049	.013	.079	.011	.198	.076	.444	.105

a/ Plots initially cleared of bright colored litter on June 7, 1971.
b/ Live (L) and this year's dead (D) components.

Appendix Table 10. Transfer From Herbage to Mulch--Individual Plot Data (g/0.0225 m^2)
Low Condition Range, Replicate II, 1971[a]

Component		Agropyron smithii				Buchloe dactyloides				Bouteloua gracilis				Carex eleocharis				Bromus japonicus				Other species				Total			
No./day		6/16	6/30	7/27	9/24	6/16	6/30	7/27	9/24	6/16	6/30	7/27	9/24	6/16	6/30	7/27	9/24	6/16	6/30	7/27	9/24	6/16	6/30	7/27	9/24	6/16	6/30	7/27	9/24
Plot																													
1	L[b]	--	--	--	--	--	.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.11	--	--	--	.11	.02	--	--
	D[b]	--	--	--	--	.01	--	--	.03	--	--	.01	--	.01	--	--	--	--	--	.08	.05	--	.06	.04	.11	.02	.06	[illegible]	[illegible]
2	L	--	--	--	--	--	.04	.03	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	--	.05	[illegible]	--
	D	--	--	--	.02	--	--	--	.04	--	--	.01	--	--	--	.01	--	--	--	--	.02	.01	.01	.11	.01	.01	.01	[illegible]	[illegible]
3	L	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	D	.02	--	--	--	.01	--	--	.02	--	--	.01	--	.03	--	--	--	--	.01	.04	.10	--	--	--	--	.06	.01	[illegible]	[illegible]
4	L	--	--	--	--	--	.01	.03	--	--	--	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	.01	.01	[illegible]	--
	D	--	--	--	--	.01	--	.01	.02	--	--	--	--	--	--	--	--	--	--	.12	.06	.03	.02	.09	--	.04	.02	[illegible]	[illegible]
5	L	--	--	--	--	.02	.02	.01	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	--	--	--	.03	.02	[illegible]	--
	D	--	--	--	.02	--	--	.03	.01	--	--	--	--	.02	--	.01	--	--	.03	.18	.04	.02	--	--	--	.04	.03	[illegible]	[illegible]
6	L	--	--	--	--	--	.04	.12	.06	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.04	[illegible]	[illegible]
	D	--	--	--	.03	--	--	.03	.04	.01	--	--	--	--	--	.01	--	--	--	.18	.09	--	--	--	--	.01	--	[illegible]	[illegible]
7	L	--	--	--	--	.02	.02	.01	--	--	--	--	--	--	--	--	--	--	--	--	.01	--	--	--	--	.02	.02	[illegible]	[illegible]
	D	--	--	--	--	--	--	.01	.04	--	--	.01	--	.01	--	--	--	--	.03	.14	.08	--	--	--	--	.01	.03	[illegible]	[illegible]
8	L	--	--	--	--	.01	.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.01	.01	--	--
	D	--	--	--	--	.02	--	.01	--	--	--	--	.01	--	--	--	--	--	--	.03	--	--	--	--	.04	.02	--	[illegible]	[illegible]
9	L	--	--	--	--	--	.02	.03	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.02	[illegible]	--
	D	--	--	--	.02	.01	--	.03	.01	--	--	--	--	.04	--	--	--	--	.02	.11	.07	.02	--	--	--	.07	.02	[illegible]	[illegible]
10	L	--	--	--	--	--	.01	.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.01	[illegible]	--
	D	--	--	--	--	--	--	.03	.05	--	--	--	--	--	--	.01	.02	--	--	.18	.05	--	--	--	--	--	--	[illegible]	[illegible]
Total		.02	--	--	.09	.11	.19	.40	.32	.01	--	.04	.01	.11	--	.04	.02	.01	.10	1.06	.57	.20	.09	.24	.16	.46	.38	[illegible]	[illegible]
Mean		.002	--	--	.009	.011	.019	.040	.032	.001	--	.004	.001	.011	--	.004	.002	.001	.010	.106	.057	.020	.009	.024	.016	.046	.038	[illegible]	[illegible]
Days in Interval		9	14	27	59	9	14	27	59	9	14	27	59	9	14	27	59	9	14	27	59	9	14	27	59	9	14	27	[illegible]
$g/m^2/day$		.010	--	--	.007	.054	.060	.066	.024	.005	--	.007	.001	.054	--	.007	.002	.005	.031	.174	.043	.099	.027	.040	.012	.227	[illegible]	[illegible]	[illegible]

a/ Plots initially cleared of bright colored litter on June 7, 1971.
b/ Live (L) and this year's dead (D) components.

Appendix Table 11. Transfer From Herbage to Mulch--Cumulative Totals by Replicate, Treatment and Data Collection Periods High Condition Range (g/m^2), 1971

	AGSM	BUDA	BOGR	CAEL	BRJA	OTHR	Total
			High Condition Range, Replicate I				
6/10-6/23	0.24	0.29	0.15	0.18	0.44	0.81	2.11
6/24-7/7	0.43	0.42	0.16	0.26	1.19	2.29	4.75
7/8-7/21	0.61	0.42	0.18	0.26	2.10	4.08	7.65
7/22-8/4	0.78	0.45	0.19	0.26	2.63	4.98	9.30
8/5-8/18	0.93	0.52	0.21	0.28	2.79	5.05	9.78
8/19-9/2	1.10	0.60	0.22	0.29	2.95	5.13	10.29
9/3-10/1	1.42	0.74	0.25	0.32	3.27	5.27	11.27
			High Condition Range, Replicate II				
6/10-6/23	0.27	0.14	0.18	--	0.28	0.57	1.44
6/24-7/7	0.55	0.36	0.36	0.06	1.08	1.31	3.72
7/8-7/21	1.06	0.67	0.43	0.17	2.18	2.42	6.94
7/22-8/4	1.42	0.85	0.49	0.23	2.80	2.99	8.79
8/5-8/18	1.62	0.91	0.53	0.25	2.92	3.03	9.26
8/19-9/2	1.83	0.97	0.58	0.26	3.06	3.08	9.77
9/3-10/1	2.23	1.09	0.66	0.29	3.32	3.17	10.76
			High Condition Range, Mean Both Reps				
6/10-6/23	0.25	0.21	0.17	0.09	0.36	0.69	1.78
6/24-7/7	0.49	0.39	0.26	0.16	1.13	1.80	4.23
7/8-7/21	0.84	0.55	0.31	0.21	2.14	3.25	7.29
7/22-8/4	1.10	0.65	0.34	0.25	2.72	3.99	9.04
8/5-8/18	1.28	0.72	0.37	0.26	2.86	4.04	9.52
8/19-9/2	1.46	0.78	0.40	0.28	3.01	4.10	10.03
9/3-10/1	1.83	0.92	0.46	0.31	3.30	4.22	11.02

Appendix Table 12. Transfer From Herbage to Mulch--Cumulative Totals By Replicate, Treatment, and Data Collection Periods, Low Condition Range (g/m^2), 1971

	AGSM	BUDA	BOGR	CAEL	BRJA	OTHR	Total
			Low Condition Range, Replicate I				
6/10-6/23	--	0.95	0.24	0.21	0.09	0.43	1.92
6/24-7/7	0.05	2.26	0.25	0.22	1.69	1.12	5.59
7/8-7/21	0.15	4.18	0.28	0.25	4.70	2.31	11.87
7/22-8/4	0.24	5.16	0.31	0.27	6.24	2.83	15.05
8/5-8/18	0.32	5.62	0.34	0.29	6.97	2.99	16.52
8/19-9/2	0.41	6.12	0.37	0.30	7.75	3.15	18.10
9/3-10/1	0.58	7.08	0.42	0.33	9.26	3.47	21.14
			Low Condition Range, Replicate II				
6/10-6/23	0.07	0.80	0.04	0.38	0.25	0.85	2.38
6/24-7/7	0.07	1.68	0.08	0.43	1.69	1.28	5.23
7/8-7/21	0.07	2.60	0.18	0.53	4.12	1.84	9.35
7/22-8/4	0.13	3.15	0.23	0.58	5.38	2.15	11.62
8/5-8/18	0.23	3.49	0.24	0.61	5.98	2.32	12.86
8/19-9/2	0.34	3.85	0.26	0.64	6.63	2.50	14.20
9/3-10/1	0.54	4.54	0.28	0.69	7.87	2.85	16.78
			Low Condition Range, Mean Both Reps				
6/10-6/23	0.04	0.87	0.14	0.29	0.17	0.64	2.15
6/24-7/7	0.06	1.10	0.17	0.33	1.69	1.20	5.41
7/8-7/21	0.11	3.39	0.23	0.39	4.41	2.08	10.61
7/22-8/4	0.19	4.16	0.27	0.43	5.81	2.49	13.33
8/5-8/18	0.28	4.56	0.29	0.45	6.48	2.65	14.69
8/19-9/2	0.37	4.98	0.31	0.47	7.19	2.82	16.15
9/3-10/1	0.56	5.81	0.35	0.51	8.57	3.16	18.96

Appendix Table 13. Transfer From Herbage to Mulch--Totals by Replicate, Treatment, and Data Collection Period, High Condition Range (g/m^2), 1971

Interval	AGSM	BUDA	BOGR	CAEL	BRJA	OTHR	Total
			High Condition Range, Replicate I				
6/10-6/23	0.24	0.29	0.15	0.18	0.44	0.81	2.11
6/24-7/7	0.19	0.13	0.01	0.08	0.75	1.49	2.65
7/8-7/21	0.18	--	0.01	--	0.91	1.79	2.89
7/22-8/4	0.17	0.04	0.01	0.01	0.53	0.90	1.66
8/5-8/18	0.15	0.07	0.01	0.01	0.15	0.07	0.46
8/19-9/2	0.17	0.08	0.02	0.02	0.17	0.08	0.54
9/3-10/1	0.32	0.15	0.03	0.03	0.32	0.15	1.00
Total	1.42	0.76	0.24	0.33	3.27	5.29	11.31
			High Condition Range, Replicate II				
6/10-6/23	0.27	0.14	0.18	--	0.28	0.57	1.44
6/24-7/7	0.28	0.22	0.18	0.06	0.79	0.74	2.27
7/8-7/21	0.52	0.31	0.07	0.11	1.11	1.11	3.23
7/22-8/4	0.36	0.18	0.06	0.06	0.62	0.57	1.85
8/5-8/18	0.20	0.06	0.04	0.01	0.13	0.04	0.48
8/19-9/2	0.21	0.06	0.05	0.02	0.14	0.05	0.53
9/3-10/1	0.41	0.12	0.09	0.03	0.26	0.09	1.00
Total	2.25	1.09	0.67	0.29	3.33	3.17	10.80
			High Condition Range, Mean Both Reps				
6/10-6/23	0.25	0.21	0.17	0.09	0.36	0.69	1.77
6/24-7/7	0.24	0.18	0.10	0.07	0.77	1.11	2.47
7/8-7/21	0.35	0.15	0.04	0.06	1.01	1.45	3.06
7/22-8/4	0.26	0.11	0.04	0.04	0.57	0.74	1.76
8/5-8/18	0.18	0.06	0.03	0.01	0.14	0.06	0.48
8/19-9/2	0.19	0.07	0.03	0.02	0.15	0.06	0.52
9/2-10/1	0.36	0.13	0.06	0.03	0.29	0.12	0.99
Total	1.83	0.91	0.47	0.32	3.29	4.23	11.05

Appendix Table 14. Transfer From Herbage to Mulch--Totals by Replicate, Treatment, and Data Collection Period, Low Condition Range (g/m^2), 1971

Interval	AGSM	BUDA	BOGR	CAEL	BRJA	OTHR	Total
			Low Condition Range, Replicate I				
6/10-6/23	--	0.95	0.24	0.21	0.09	0.43	1.92
6/24-7/7	0.05	1.32	0.01	0.01	1.60	0.69	3.68
7/8-7/21	0.10	1.92	0.03	0.03	3.01	1.19	6.27
7/22-8/4	0.09	0.98	0.03	0.02	1.54	0.52	3.19
8/5-8/18	0.08	0.46	0.03	0.01	0.73	0.15	1.47
8/19-9/2	0.09	0.50	0.03	0.02	0.78	0.17	1.58
9/3-10/1	0.17	0.96	0.06	0.03	1.51	0.32	3.05
Total	0.58	7.09	0.43	0.33	9.26	3.47	21.16
			Low Condition Range, Replicate II				
6/10-6/23	0.07	0.80	0.04	0.38	0.25	0.85	2.39
6/24-7/7	--	0.88	0.05	0.05	1.44	0.43	2.85
7/8-7/21	--	0.92	0.10	0.10	2.44	0.56	4.12
7/22-8/4	0.06	0.55	0.04	0.05	1.26	0.31	2.27
8/5-8/18	0.10	0.34	0.01	0.03	0.60	0.17	1.25
8/19-9/2	0.11	0.36	0.02	0.03	0.65	0.18	1.35
9/3-10/1	0.20	0.70	0.03	0.06	1.25	0.35	2.59
Total	0.54	4.55	0.29	0.70	7.89	2.85	16.82
			Low Condition Range, Mean Both Reps				
6/10-6/23	0.04	0.87	0.14	0.29	0.17	0.64	2.15
6/24-7/7	0.03	1.10	0.03	0.03	1.52	0.56	3.27
7/8-7/21	0.05	1.42	0.06	0.06	2.72	0.88	5.19
7/22-8/4	0.08	0.76	0.04	0.04	1.40	0.42	2.74
8/5-8/18	0.09	0.40	0.02	0.02	0.67	0.16	1.36
8/19-9/2	0.10	0.43	0.02	0.02	0.71	0.17	1.45
9/3-10/1	0.19	0.83	0.04	0.04	1.38	0.33	2.81
Total	0.58	5.81	0.35	0.50	8.57	3.16	18.97

APPENDIX B

Appendix B1. Field Weight Estimate Form

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

FIELD DATA SHEET - ABOVEGROUND BIOMASS

DATA TYPE	SITE	INITIALS	DATE DAY	DATE MO.	DATE YR.	TREATMENT	REPLICATE	PLOT SIZE	QUADRAT	CLIP-EST.	GROWTH FM.	GENUS	SPECIES	SUBSPECIES	CATEGORY	WEIGHT ESTIMATE	SACK NO.	DRY WEIGHT	CROWN PLOT SIZE	CROWN WEIGHT
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	21-23	25	27	29-30	31-32	34	35	36-40	42-45	47-52	54-57	59-64
01																				

DATA TYPE
- 01 Aboveground Biomass
- 02 Litter
- 03 Belowground Biomass
- 10 Vertebrate - Live Trapping
- 11 Vertebrate - Snap Trapping
- 12 Vertebrate - Collection
- 20 Avian Flush Census
- 21 Avian Road Count
- 22 Avian Road Count Summary
- 23 Avian Collection - Internal
- 24 Avian Collection - External
- 25 Avian Collection - Plumage
- 30 Invertebrate
- 40 Microbiology - Decomposition
- 41 Microbiology - Nitrogen
- 42 Microbiology - Biomass
- 43 Microbiology - Root Decomposition
- 44 Microbiology - Respiration

SITE
- 01 Ale
- 02 Bison
- 03 Bridger
- 04 Cottonwood
- 05 Dickinson
- 06 Hays
- 07 Hopland
- 08 Jornada
- 09 Osage
- 10 Pantex
- 11 Pawnee

CLIP-ESTIMATE
- 1 Harvested
- 2 Harvest and Est.
- 3 Estimated
- 4 Est. for Insect
- 5 Est. for Reference
- 6 Est. for Future Clip

GROWTH FORM
- 1 Perennial grass
- 2 Annual grass
- 3 Sedge, rush, etc.
- 4 Annual forb
- 5 Biennial forb
- 6 Perennial forb
- 7 Half-shrub
- 8 Shrub
- 9 Tree
- 0 Miscellaneous

TREATMENT
- 1 Ungrazed
- 2 Lightly grazed
- 3 Moderately grazed
- 4 Heavily grazed
- 5 Grazed 1969, ungrazed 1970
- 6 Grazed 1970, ungrazed 1971
- 7
- 8
- 9

CATEGORY
- 1 Live
- 2 Old dead
- 3 Recent dead

Appendix B2. Laboratory Weight Estimate Form, Cottonwood, 1971

Data Set ______

Project ________

Treatment ______

Replicate ______

Plot __________

AGSM+STVI

1 ________

2 ________

3 ________

BUDA+BOGR

1 ________

3 ________

FMUL+HMUL+
SHRT 2 ________

CAEL
1 + 3 ________

BRJA ________

FEOC + POSE ____

LCAS ________

DCAS ________

SOIL ________

FORBS ________

Coll. Date ________

Estimator,Use ______

Dry Matter % ______

Sample __________

AGSM 1 ________

2 ________

3 ________

STVI 1 ________

2 ________

3 ________

BUDA 1 ________

3 ________

BOGR 1 ________

3 ________

SHRT 2 ________

FMUL ________

HMUL ________

CAEL 1 ________

3 ________

BRJA ________

FEOC ________

POSE ________

LCAS ________

DCAS ________

SOIL ________

____

____

____

Data Set ______

Project ________

Treatment ______

Replicate ______

Plot __________

AGSM+STVI

1 ________

2 ________

3 ________

BUDA+BOGR

1 ________

3 ________

FMUL+HMUL+
SHRT 2 ________

CAEL
1 + 3 ________

BRJA ________

FEOC + POSE ____

LCAS ________

DCAS ________

SOIL ________

FORBS ________

Coll. Date ________

Estimator,Use ______

Dry Matter % ______

Sample __________

AGSM 1 ________

2 ________

3 ________

STVI 1 ________

2 ________

3 ________

BUDA 1 ________

3 ________

BOGR 1 ________

3 ________

SHRT 2 ________

FMUL ________

HMUL ________

CAEL 1 ________

3 ________

BRJA ________

FEOC ________

POSE ________

LCAS ________

DCAS ________

SOIL ________

____

____

____

Appendix B3. Above-Ground Herbage Biomass Laboratory Estimation Data Format Code, Cottonwood, 1971

1,2	07 Cottonwood Preliminary AGSM
3,4	Project (01 = Grassland Biome, 37 = Rogers' Diet Study, etc.
5,6	04 Site Cottonwood
7,8	Data set number (See Table 5, p. 25)
9,10	Day of month
11,12	Month
13,14	Year
15	Treatment
16	Rep
17,18	Plot
19,20	Estimator
21	Kind of plot (Field estimate only = 0, Field and lab estimate of total plot only = 1, Lab estimate of total plot + square estimates = 2, Lab square estimates only = 3, Lab square estimate + separated square = 4)
22,23	Dry matter percent if 21 is 1 or 2, square number if 21 is 3 or 4
24-29	Sample weight, g/0.5 M^2 if 21 is 1 or 2, weight of square is 21 is 3 or 4
30-33	Component (4 letter code), growth form is omitted
34,35	Phenology (01 = live, 02 = old dead, 03 = recent dead)
36-41	Estimated component wt., xxx.xx (g/0.5 M^2 if 21 is 1 or 2, g/square if 21 is 3 or 4)
42-47	Separated component wt., xxx.xx (g/square, present only if 21 is 4)

Appendix B4. Computer Programs Used to Process the Aboveground Plant Standing Crop Data, Cottonwood, 1971 and 1972

THIS PROGRAM CORRECTS THE DATA AS NEEDED.

```
JOB CARD,MT1,T200.            TA621
FTN(R=0,OPT=2)
RFL(10000)
REQUEST,MTAPE,HY,VSN=A1162,WRITE,SWIFT.
REWIND(MTAPE)
COPYCF(MTAPE,DATA)
REWIND(DATA)
RFL(43000)
LGO.
RFL(10000)
REWIND(COMMON,MTAPE)
COPYCF(COMMON,MTAPE)
END-OF-RECORD
      PROGRAM CHANGE(DATA,COMMON,INPUT,OUTPUT,TAPE1=DATA,TAPE2=COMMON,
     1 TAPE5=INPUT,TAPE6=OUTPUT)
C
C ...    THIS PROGRAM WILL TRANSFER ALL RECORDS FROM THE DATA FILE TO
C     THE COMMON FILE , INSERTING REQUESTED CHANGES INTO EACH RECORD.
C     EACH CHANGE IS REQUESTED BY 2 INPUT CARDS. THE FIRST OF WHICH
C     DESCRIBES THE FIELD AND VALUE FOR THE SELECTION OF RECORDS TO BE
C     CHANGED AND THE SECOND DESCRIBES THE CHANGES TO BE MADE.
C     THE FORMAT FOR THE CARDS ARE
C
C         CARD 1    (THIS IS A BLANK CARD IF ALL RECORDS ARE TO BE CHANGED.)
C                   COL.  1- 5   FIRST COLUMN OF FIELD FOR SELECTION.
C                   COL.  6-10  LAST COLUMN OF FIELD FOR SELECTION.
C                   COL. 11-80  VALUE THAT THE FIELD IS TO HAVE BEFORE
C                               THE RECORD WILL BE CHANGED
C         CARD 2    (THIS IS A BLANK CARD IF THE RECORD IS TO BE DELETED.)
C                   COL.  1- 5  FIRST COLUMN OF FIELD TO BE CHANGED
C                   COL.  6-10  LAST COLUMN OF FIELD TO BE CHANGED
C                   COL. 11-80  NEW VALUE FOR THE FIELD  (LEFT JUSTIFIED)
C
      INTEGER NEW(9,100),REC(14),OLD(9,100)
      LOGICAL CHNG
      I=0
C ... READ THE CHANGE CARDS--FIRST COLUMN, LAST COLUMN, AND VALUE OF FIELD
1     I=I+1
      READ(5,100) (OLD(J,I),J=1,9)
      IF(EOF(5).NE.0) GO TO 3
      READ(5,100) (NEW(J,I),J=1,9)
      IF(EOF(5).EQ.0) GO TO 1
      WRITE(6,202)
      CALL ABORT
      STOP
3     N=I-1
C ... REWIND DATA AND COMMON
      REWIND 1
      REWIND 2
      NREC=0
      NCH=0
      NDEL=0
C ... READ A RECORD FROM THE DATA FILE
5     READ(1,101) (REC(I),I=1,14)
      IF(EOF(1).NE.0) GO TO 15
C ... STORE THE APPROPRIATE FIELDS INTO THE RECORD
```

THIS PROGRAM CORRECTS THE DATA AS NEEDED.

```
      CHNG=.FALSE.
      DO 10 I=1,N
      IF(OLD(1,I).EQ.0) GO TO 8
      ICOL=OLD(1,I)
      NCOL=OLD(2,I)-ICOL+1
      IF(CMPRF(REC,ICOL,OLD(3,I),1,NCOL)) 10,8,10
8     IF(NEW(1,I).EQ.0) GO TO 12
      ICOL=NEW(1,I)
      NCOL=NEW(2,I)-ICOL+1
      CALL SCHARS(REC,ICOL,NCOL,NEW(3,I))
      CHNG=.TRUE.
10    CONTINUE
C ... WRITE THE RECORD ONTO THE COMMON FILE
      WRITE(2,101) (REC(I),I=1,14)
      NREC=NREC+1
      IF(CHNG) NCH=NCH+1
      GO TO 5
C ... THIS RECORD IS TO BE DELETED
12    NDEL=NDEL+1
      NREC=NREC+1
      GO TO 5
C ... PRINT THE FINAL MESSAGES AND STOP
15    WRITE(6,200) NREC,NCH,NDEL
      DO 20 I=1,N
      IF(NEW(1,I).NE.0) GO TO 16
      WRITE(6,204)
      GO TO 18
16    WRITE(6,201)  (NEW(J,I),J=1,9)
18    IF(OLD(1,I).NE.0) WRITE(6,203) (OLD(J,I),J=1,9)
20    CONTINUE
      STOP
100   FORMAT(2I5,7A10)
101   FORMAT(13A10,A3)
200   FORMAT(1H1,I10,* RECORDS WERE ENCOUNTERED,   *I10* RECORDS WERE CH
     1ANGED, AND*I10* RECORDS WERE DELETED.*)
201   FORMAT(*0COLUMNS*I4,* THRU*I4* WERE CHANGED TO *7A10)
202   FORMAT(*0THERE ARE AN ODD NO. OF REQUEST CARDS, SOMETHING IS WRONG
     1.*)
203   FORMAT(4X,*WHEN*I4* THRU*I4* WERE EQUAL TO   *7A10)
204   FORMAT(*0EACH RECORD WAS DELETED FROM THE FILE*)
      END
```

THIS PROGRAM EXTRACTS STATICS FOR THE REGRESSIONS.

```
JOB CARD.CM47000.T240.MT1.     TA622
FTN(R=0.OPT=2)
RFL(10000)
REQUEST.MTAPE.HY.VSN=A1162.WRITE.SWIFT.
REWIND(MTAPE)
COPYCF(MTAPE.ORIG)
REWIND(ORIG)
RFL(47000)
LGO.
RFL(15000)
REWIND(MTAPE)
SKIPF(MTAPE.1.17.C)
REWIND(INTER.FINAL)
COPYCF(INTER.MTAPE)
COPYBF(FINAL.MTAPE)
REWIND(MTAPE)
RFL(25000)
TRANSF(TA623.TA624.TA625)
END-OF-RECORD
      PROGRAM CAGHBM(INPUT.OUTPUT.ORIG.INTER.FINAL.TAPE1=ORIG.TAPE2=INTE
     1R. TAPE3=FINAL.TAPE5=INPUT.TAPE6=OUTPUT)
      DIMENSION LIST(200).ADW(200).KAT(200).A(200.7).B1(200.7)
      COMMON L(8).X(200.5).LS(8)
      INTEGER TIPE.PDM.PDMS.D
      LOGICAL CLIP.EST.SEP.FIRST
      DATA NCOMP.LIST/0.200*(0)/
      FIRST=.FALSE.
      FIRST=.TRUE.
      IPLT=0
      REWIND 1
      REWIND 2
      REWIND 3
C ... READ IN THE REGRESSION PARAMETERS
      DO 29 K=1.200
      DO 29 D=1.7
      A(K.D)=B1(K.D)=0.0
29    CONTINUE
      IF(FIRST) GO TO 3
30    READ(3.400) D.KOMP.ALPHA.BETA
400   FORMAT(I2.4X.A6.55X.2F10.4)
      IF(EOF(3)) 34.31
31    DO 32 K=1.NCOMP
      IF(KOMP.EQ.LIST(K)) GO TO 33
32    CONTINUE
      NCOMP=NCOMP+1
      IF(NCOMP.GT.200) GO TO 35
      K=NCOMP
      LIST(K)=KOMP
33    A(K.D)=ALPHA
      B1(K.D)=BETA
      CALL GBYTE(KOMP.KAT(K).30.6)
      GO TO 30
35    WRITE(6.401)
401   FORMAT(*0NUMBER OF COMPONENTS IS GREATER THAN 200.*)
      STOP
34.   CONTINUE
```

THIS PROGRAM EXTRACTS STATICS FOR THE REGRESSIONS.

```
      WRITE(6,38)
38    FORMAT(*1REGRESSION STATISTICS BY DATASET*/*  COMP.*5(9X,*A*,9X,
     1*B*))
      DO 37 K=1,NCOMP
      IF(LIST(K).EQ.0) GO TO 37
      WRITE(6,36) LIST(K),(A(K,D),B1(K,D),D=1,7)
36    FORMAT(1H ,A6,14F8.4)
37    CONTINUE
      REWIND 3
C ... READ A RECORD
3     READ(1,100) L(1),L(8),(L(I),I=2,4),IS,(L(I),I=5,7),ISQ,PDM,WT,KOMP
     1,XX,YY
      IF(EOF(1)) 18,4
4     IF(PDM.EQ.0) PDM=ISQ
      IF(L(7).EQ.IPLT) GO TO 10
      IF(IPLT.EQ.0) GO TO 8
      IF(CLIP) METHOD=1
      IF(EST) METHOD=3
      IF(CLIP.AND.EST) METHOD=2
      TIPE=2
      IF(SEP) TIPE=1
      IF(METHOD.EQ.3) TIPE=3
      DO 7 K=1,NCOMP
      ADW(K)=0.0
      DO 5 J=1,5
      IF(X(K,J).NE.0.0) GO TO 6
5     CONTINUE
      GO TO 7
6     CONTINUE
      IF(FIRST) WRITE(2,200) (LS(I),I=1,8),TIPE,METHOD,PDMS,WTS,LIST(K),
     1 NC,(X(K,J),J=1,5)
C ... PREDICT THE ACTUAL DRY WEIGHT
      IF(.NOT.CLIP) GO TO 7
      IF(X(K,2).EQ.0.0) GO TO 7
      IF(A(K,D).EQ.0.0.AND.B1(K,D).EQ.0.0) GO TO 2
      ADW(K)=A(K,D)+B1(K,D)*X(K,2)
      IF(ADW(K).LT.0.0) ADW(K)=0.0
      GO TO 7
2     ADW(K)=X(K,2)
7     CONTINUE
C ... ADJUST THE PREDICTED AIR DRY WEIGHT TO THE TOTAL SAMPLE WEIGHT.
      IF(FIRST) GO TO 8
      IF(.NOT.CLIP) GO TO 8
      TOT=0.0
      DO 19 K=1,NCOMP
19    TOT=TOT+ADW(K)
      CORFAC=WTS/TOT
      IF(ABS(1.0-CORFAC).GT.0.20) WRITE(6,350) D,LS(7),TOT,WTS
350   FORMAT(* DATA SET*I2* QUADRAT *I3* EXCEEDS 20 PERCENT DEVIATION*
     1 * PRED. TOTAL=*F10.2* SAMPLE WEIGHT=*F10.2)
      DO 20 K=1,NCOMP
      IF(ADW(K).EQ.0.0) GO TO 20
      PERCENT=PDMS/100.0
      ODW=ADW(K)*CORFAC*PERCENT
      IF(K.EQ.12.OR.K.EQ.13.OR.K.EQ.19.OR.K.EQ.20) GO TO 21
      IF(K.EQ.21) GO TO 20
```

THIS PROGRAM EXTRACTS STATICS FOR THE REGRESSIONS.

```
      WRITE(3,300) LS(8),(LS(I),I=2,7),METHOD,LIST(K),KAT(K),X(K,1),ODW
300   FORMAT(*0104*I3,3I2,2A1,*0.50*,I4,I2,3X,A4,R3,F5.1,6X,F6.2)
      GO TO 20
21    WRITE(2,301) (LS(I),I=2,7),LIST(K),ODW
301   FORMAT(*0204*3X,3I2,2A1,*0.50*I4,* 1 *,A4,F7.2)
20    CONTINUE
8     DO 9 K=1,NCOMP
      DO 9 J=1,5
9     X(K,J)=0.0
      SEP=CLIP=EST=.FALSE.
      NC=0
      LASTSQ=0
C ... ACCUMULATE THE VALUES FOR THE NEXT PLOT
      IPLT=L(7)
10    DO 11 K=1,NCOMP
      IF(LIST(K).EQ.KOMP) GO TO 13
11    CONTINUE
      NCOMP=NCOMP+1
      LIST(NCOMP)=KOMP
      K=NCOMP
      DO 12 LL=1,7
      IF(LL.LE.5) X(K,LL)=0.0
      A(K,LL)=0.0
12    B1(K,LL)=0.0
      CALL GBYTE(KOMP,KAT(K),30,6)
C ... IF THIS IS A STAGE 4 SAMPLE RECORD THE SEPARATED SQUARE WT.
13    IF(IS.NE.4) GO TO 14
      X(K,5)=YY
      X(K,4)=XX
C ... IF THIS IS A STAGE 3 OR 4 SAMPLE ACCUMULATE THE SUM OF SQUARE ESTIMATES
14    IF(IS.LT.3) GO TO 15
      X(K,3)=X(K,3)+XX
      SEP=.TRUE.
      IF(PDM.EQ.LASTSQ) GO TO 3
      LASTSQ=PDM
      NC=NC+1
      GO TO 3
C ... IF THIS IS A STAGE 2 OR 1 SAMPLE, RECORD THE LAB ESTIMATE
15    IF(IS.LT.1) GO TO 17
      X(K,2)=XX
      CLIP=.TRUE.
      DO 16 I=1,8
16    LS(I)=L(I)
      PDMS=PDM
      WTS=WT
      D=LS(1)
      GO TO 3
C ... RECORD THE FIELD ESTIMATE FOR A STAGE 0 SAMPLE
17    X(K,1)=XX
      EST=.TRUE.
      GO TO 3
18    WRITE(6,202) NCOMP,(LIST(K),K=1,NCOMP)
      IF(FIRST) WRITE (3) NCOMP,(LIST(I),I=1,NCOMP)
      STOP
100   FORMAT(6X,5I2,6X,I1,2A1,I3,2I2,F6.0,17X,A5,2F6.0)
201   FORMAT(6X,4A3,2A2,2I3,I2,I3,F8.3,A8,2F8.3)
```

THIS PROGRAM EXTRACTS STATICS FOR THE REGRESSIONS.

```
200   FORMAT(1H ,5X,4I2,2A1,2I2,2I1,I2,F8.3,A6,I2,5F8.3)
202   FORMAT(1H1,I10,* COMPONENTS IN THE LIST*//(1H ,10A10))
      END
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
JOB CARD.CM47000,T240,MT1.    TA623
RFL(15000)
REQUEST,MTAPE,HY,VSN=A1162,WRITE.SWIFT.
REWIND(MTAPE)
SKIPF(MTAPE,1,17,C)
COPYCF(MTAPE,INTER)
COPYBF(MTAPE,FINAL)
REWIND(INTER,FINAL)
REQUEST,ORIG,*A*.
RFL(47000)
SORTMRG.
REWIND(ORIG)
FTN(R=0,OPT=2)
LGO.
RFL(15000)
REWIND(FINAL,COMBO)
REWIND(MTAPE)
SKIPF(MTAPE,2,17,C)
SKIPF(MTAPE,1,17,B)
COPYCF(FINAL,MTAPE)
COPYCF(COMBO,MTAPE)
REWIND(MTAPE)
RFL(25000)
TRANSF(TA624,TA625)
END-OF-RECORD
SORT(1,7,90, ,2, , )
FILE(INTER,S,D, ,R,N)
FILE(ORIG,O,D, ,R,N)
KEY(A,C,7,2,1)      DATA SET
KEY(A,C,33,6,2)      GENUS, SPECIES, AND COMPONENT
KEY(A,C,21,2,3)       TYPE AND METHOD
KEY(A,C,13,2,4)        YEAR
KEY(A,C,11,2,5)         MONTH
KEY(A,C,9,2,6)           DAY
KEY(A,C,15,4,7)           TREATMENT AND REPLICATE
RECORD(I,U,90)
END
END-OF-RECORD
      PROGRAM CAGHBM2(INPUT,OUTPUT,ORIG,FINAL,TAPE1=ORIG,TAPE3=FINAL,
     1 TAPE5=INPUT,TAPE6=OUTPUT,COMBO,TAPE7=COMBO)
      COMMON XFDRHIK(500),XLDRHIK(500),XSDIK(500),XSDIJK(500),
     1         YFDRHIK(500),YLDRHIK(500),YHIDIK(500),YSDIJK(500),
     2 AS(100),BS1(100),BS2(100),A1(100),B11(100),B12(100),AL(100),
     3 BL1(100),BL2(100),C(500)
      DIMENSION LIST(100)
      INTEGER TIPE,PDM,OLDKOMP
      LOGICAL FIELD
C ... READ THE COMPONENT LIST
      REWIND 3
      READ(3) NCOMP,(LIST(I),I=1,NCOMP)
      REWIND 3
      REWIND 1
      REWIND 7
      OLDKOMP=0
      N=N1=N2=N3=N4=N5=0
19    N=N+1
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
      IF(N.GT.500) GO TO 51
      READ(1,101) IDST,IEST,TIPE,METHOD,KOMP,C(N),XFDRHIK(N),XLDRHIK(N),
     1 XSDIK(N),XSDIJK(N),YSDIJK(N)
      IF(EOF(1)) 40,17
17    IF(KOMP.EQ.OLDKOMP) GO TO 25
      IF(OLDKOMP.EQ.0) GO TO 24
C ... LOCATE THE COMPONENT IN THE LIST
      DO 20 K=1,NCOMP
      IF(OLDKOMP.EQ.LIST(K)) GO TO 21
20    CONTINUE
      K=NCOMP+1
      WRITE(6,44) OLDKOMP
21    IF(N2.EQ.0.AND.N4.EQ.0.AND.N5.EQ.0) FIELD=.F.
      IF(N2.EQ.0) N2=N1
      IF(N4.EQ.0) N4=N3
      WRITE(6,201) IDST,OLDKOMP
C ... CALCULATE THE REGRESSION STATISTICS FOR STAGE 3
      CALL REGRESS(XSDIJK,YSDIJK,AS(K),BS1(K),BS2(K),1,N2,LIST(K),3,NC,
     1 IDST,IEST)
C ... PREDICT THE SUM OF SEPARATED WEIGHTS OF THE SQUARES
      CALL PREDICT(XSDIK,YH1DIK,AS(K),BS1(K),BS2(K),1,N2,C,3)
C ... CALCULATE THE REGRESSION STATISTICS FOR STAGE 2
      CALL REGRESS(XLDRHIK,YH1DIK,A1(K),B11(K),B12(K),1,N2,OLDKOMP,2,NC,
     1 IDST,IEST)
C ... PREDICT THE SEPARATED WEIGHT FOR THE ENTIRE PLOT
      CALL PREDICT(XLDRHIK,YLDRHIK,A1(K),B11(K),B12(K),1,N4,C,2)
C ... CALCULATE THE REGRESSION STATISTICS FOR STAGE 1
      IF(.NOT.FIELD) GO TO 22
      CALL REGRESS(XFDRHIK,YLDRHIK,AL(K),BL1(K),BL2(K),N1+1,N4,OLDKOMP,
     1 1,NC,IDST,IEST)
C ... RESET THE LIST
22    N1=N2=N3=N4=N5=0
      XFDRHIK(1)=XFDRHIK(N)
      XLDRHIK(1)=XLDRHIK(N)
      XSDIK(1)=XSDIK(N)
      XSDIJK(1)=XSDIJK(N)
      YSDIJK(1)=YSDIJK(N)
      C(1)=C(N)
      N=1
24    OLDKOMP=KOMP
      NC=IC
      FIELD=.T.
25    IF(TIPE.NE.1) GO TO 26
      IF(METHOD.EQ.1) N1=N
      IF(METHOD.EQ.2) N2=N
      GO TO 19
26    IF(TIPE.NE.2) GO TO 27
      IF(METHOD.EQ.1) N3=N
      IF(METHOD.EQ.2) N4=N
      GO TO 19
27    N5=N
      GO TO 19
C ... REWIND THE TAPE AND RECORD ALL PREDICTIONS
40    REWIND 1
      OLDKOMP=0
41    READ(1,100) IDST,IDAY,IMO,IYR,ITRT,IREP,IPLT,IEST,TIPE,METHOD,PDM,
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
     1 WT,KOMP,NC,XF,XL,XS,X,Y
      IF(EOF(1)) 50,42
42    IF(KOMP.EQ.OLDKOMP) GO TO 45
C ... LOCATE THE COMPONENT
      DO 43 K=1,NCOMP
      IF(KOMP.EQ.LIST(K)) GO TO 45
43    CONTINUE
      WRITE(6,44) KOMP
      Y1=XS $ YL=XL $ YF=XF
44    FORMAT(1H ,A6,* CANT BE LOCATED IN THE COMPONENT LIST.*)
      GO TO 48
C ... PREDICT THE SEPARATED SUM OF SQUARES
45    Y1=0.0
      IF(XS.EQ.0.0) GO TO 46
      Y1=AS(K)+BS1(K)*XS+BS2(K)*XS*XS
C ... PREDICT THE SEPARATED LAB WEIGHT
46    YL=0.0
      IF(XL.EQ.0.0) GO TO 47
      YL=A1(K)+B11(K)*XL+B12(K)*XL*XL
C ... PREDICT THE SEPARATED FIELD WEIGHT
47    YF=0.0
      IF(XF.EQ.0.0) GO TO 48
      YF=AL(K)+BL1(K)*XF+BL2(K)*XF*XF
48    WRITE(3,200) IDST,IDAY,IMO,IYR,ITRT,IREP,IPLT,IEST,TIPE,METHOD,
     1 PDM,WT,KOMP,NC,XF,XL,XS,X,Y,Y1,YL,YF
      GO TO 41
50    REWIND 1
      REWIND 3
      STOP
51    WRITE(6,202)
      STOP
100   FORMAT(6X,4I2,2I1,2I2,2I1,I2,F8.3,A6,I2,5F8.3)
101   FORMAT(6X,I2,10X,I2,2I1,10X,A6,F2.0,5F8.3)
200   FORMAT(6X,+I2,2I1,2I2,2I1,I2,F8.3,A6,I2,8F8.3)
201   FORMAT(*1COTTONWOOD ABOVE-GROUND BIOMASS, 1971*/*0DATA SET:*I4/
     1 *0LINEAR REGRESSION*/*0COMPONENT:  *A6/*0 STAGE   N*6X*XBAR*6X
     2 *YBAR*   9X*A*9X*B*2X*VAR(Y.X)*7X*RSQ*4X*VAR(B)*1X*DEV(YHAT)*9X
     3 *X*9X*Y*6X*YHAT*6X*DEV.*)
202   FORMAT(*0ARRAYS MUST BE INCREASED ABOVE 500*)
      END
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
      SUBROUTINE REGRESS(X,Y,A,B1,B2,NA,NB,KOMP,IST,NC,DST,EST)
      INTEGER DST,EST
      DIMENSION X(NB),Y(NB)
      N=0
      SUMX=SUMY=SUMXX=SUMYY=SUMXY=0.0
      A=B1=B2=XBAR=YBAR=VARYX=RSQ=VARYB1=VARYHAT=VARYB2=0.0
      YHAT=YDEV=0.0
      NC=NA
C ... ACCUMULATE THE SUM AND SUM OF SQUARES
      DO 1 I=NA,NB
      TX=X(I)
      TY=Y(I)
C ... DO NOT INCLUDE ZERO DATA VALUES
      IF(TX.EQ.0.0.AND.TY.EQ.0.0) GO TO 1
      IF(IST.EQ.1.AND.TX.EQ.0) GO TO 1
      SUMX=SUMX+TX
      SUMY=SUMY+TY
      SUMXX=SUMXX+TX*TX
      SUMYY=SUMYY+TY*TY
      SUMXY=SUMXY+TX*TY
      N=N+1
1     CONTINUE
      IF(N.EQ.0) GO TO 2
      XN=N
      XBAR=SUMX/XN
      YBAR=SUMY/XN
      IF(N.EQ.1) GO TO 2
      SUMXX=SUMXX-SUMX*SUMX/XN
      SUMYY=SUMYY-SUMY*SUMY/XN
      SUMXY=SUMXY-SUMX*SUMY/XN
      IF(SUMXX.EQ.0.0.OR.SUMYY.EQ.0.0) GO TO 2
      B1=SUMXY/SUMXX
      A=YBAR-B1*XBAR
      B2=0
      RSQ=B1*B1*SUMXX/SUMYY
      NC=NA
6     IF(X(NC).EQ.0.0.AND.Y(NC).EQ.0.0) GO TO 8
      IF(IST.NE.1.OR.X(NC).NE.0.0) GO TO 7
8     NC=NC+1
      GO TO 6
7     TX=X(NC)-XBAR
      YHAT=A+B1*X(NC)
      YDEV=ABS(YHAT-Y(NC))
      MAX=NC
      NP=MOT=1
      YDEVMAX=YDEV
      IF(N.EQ.2) GO TO 2
      VARYX=(SUMYY-B1*B1*SUMXX)/(XN-2.0)
      IF(VARYX.LE.1.0E-30) VARYX=0.0
      VARB1=VARYX/SUMXX
      VARYHAT=SQRT(VARYX*(1.0+1.0/XN+TX*TX/SUMXX))
2     WRITE(6,200)   IST,N,XBAR,YBAR,A,B1,VARYX,RSQ,VARYB1,VARYHAT,X(NC),
     1 Y(NC),YHAT,YDEV
      IF(SUMXX.EQ.0.0.OR.SUMYY.EQ.0.0) GO TO 4
      IF(N.LE.1) GO TO 4
      M=NC+1
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
      DO 3 I=M,N9
      IF(X(I).EQ.0.AND.Y(I).EQ.0) GO TO 3
      IF(IST.EQ.1.AND.X(I).EQ.0) GO TO 3
      NP=NP+1
      TX=X(I)-XBAR
      VARYHAT=SQRT(VARYX*(1.0+1.0/XN+TX*TX/SUMXX))
      YHAT=A+B1*X(I)
      YDEV=ABS(YHAT-Y(I))
      IF(YDEV.LT.YDEVMAX) GO TO 5
      YDEVMAX=YDEV
      MAX=I
      MOT=NP
5     WRITE(6,201) VARYHAT,X(I),Y(I),YHAT,YDEV
3     CONTINUE
C ... CHECK FOR OUTLIERS
      IF(N.LE.3) GO TO 4
      IF(RSQ.GE.0.95) GO TO 4
C     SUBTRACT THE EFFECT OF THE POINT WITH THE MAXIMUM DEVIATION
      SXX  =SUMXX+SUMX*SUMX/XN
      SYY  =SUMYY+SUMY*SUMY/XN
      SXY  =SUMXY+SUMX*SUMY/XN
      SXX  =SXX  -X(MAX)*X(MAX)
      SYY  =SYY  -Y(MAX)*Y(MAX)
      SXY  =SXY  -X(MAX)*Y(MAX)
      SX  =SUMX-X(MAX)
      SY  =SUMY-Y(MAX)
      SN=XN-1
      SXX=SXX-SX*SX/SN
      SYY=SYY-SY*SY/SN
      SXY=SXY-SX*SY/SN
      SXBAR=SX/SN
      SYBAR=SY/SN
      IF(SXX.EQ.0.0.OR.SYY.EQ.0.0) GO TO 4
C ... RECOMPUTE THE PARAMETERS
      BB1=SXY/SXX
      AA=SYBAR-BB1*SXBAR
      VARYX=(SYY-BB1*BB1*SXX)/(SN-2.0)
      IF(VARYX.LE.1.0E-30) VARYX=0.0
      TX=X(MAX)-SXBAR
      YHAT=AA+BB1*X(MAX)
      VARYHAT=SQRT(VARYX*(1.0+1.0/SN+TX*TX/SXX))
      IF(VARYHAT.NE.0.0) GO TO 77
C ... THIS POINT ACCOUNTS FOR THE ENTIRE DEVIATION ABOUT THE REGRESSION
      P=0.0
      T=100.0
      GO TO 78
77    T=ABS((YHAT-Y(MAX))/VARYHAT)
      NDF=SN-2.0
      P=PROB(T,NDF)
      P=P*(SN+1.0)
      IF(P.GE.0.20) GO TO 4
C ... THROW THE POINT OUT AND CHANGE A AND B1
78    A=AA
      B1=BB1
      SUMX=SX
      SUMY=SY
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
      SUMXX=SXX
      SUMYY=SYY
      SUMXY=SXY
      XN=SN
      WRITE(6,202) MOT,P,T
      RSQ=B1*B1*SUMXX/SUMYY
      VARB1=VARYX/SUMXX
      N=XN
      WRITE(6,200) IST,N,XBAR,YBAR,A,B1,VARYX,RSQ,VARB1
4     WRITE(7,300) DST,IST,EST,KOMP,SUMX,SUMY,SUMXX,SUMYY,SUMXY,XN,A,B1,
     1 B2
      RETURN
300   FORMAT(3I2,A6,5F10.4,F5.0,3F10.4)
200   FORMAT(1H0,I6,I4,12F10.3)
201   FORMAT(1H ,80X,5F10.3)
202   FORMAT(*0THE PROBABILITY LEVEL FOR Y(*I2*) TO BE AN OUTLIER IS*F7.
     13*   T=*F7.3)
      END
```

```
      SUBROUTINE PREDICT(X,Y,A,B1,B2,NA,NB,C,IST)
      DIMENSION X(NB),Y(NB),C(NB)
      IF(IST.EQ.3) GO TO 2
      DO 1 I=NA,NB
1     Y(I)=A+B1*X(I)+B2*X(I)*X(I)
      RETURN
2     DO 3 I=NA,NB
3     Y(I)=C(I)*A+B1*X(I)+B2*X(I)*X(I)
      RETURN
      END
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
      FUNCTION PROB(T,NDF)
      DIMENSION A(30,9),P(9)
      DATA P/0.5,0.4,0.2,0.1,0.05,0.025,0.01,0.005,0.001/
      DATA (A(I,1),I=1,30)/ 1.000,  .816,  .765,  .741,  .727,
     C  .718,  .711,  .706,  .703,  .700,  .697,  .695,  .694,
     C  .692,  .691,  .690,  .689,  .688,  .688,  .687,  .686,
     C  .686,  .685,  .685,  .684,  .684,  .684,  .683,  .683,
     C  .683/
      DATA (A(I,2),I=1,30)/ 1.376, 1.061,  .978,  .941,  .920,
     C  .906,  .896,  .889,  .883,  .879,  .876,  .873,  .870,
     C  .868,  .866,  .865,  .863,  .862,  .861,  .860,  .859,
     C  .858,  .858,  .857,  .856,  .856,  .855,  .855,  .854,
     C  .854/
      DATA (A(I,3),I=1,30)/ 3.078, 1.886, 1.638, 1.533, 1.476,
     C 1.440, 1.415, 1.397, 1.383, 1.372, 1.363, 1.356, 1.350,
     C 1.345, 1.341, 1.337, 1.333, 1.330, 1.328, 1.325, 1.323,
     C 1.321, 1.319, 1.318, 1.316, 1.315, 1.314, 1.313, 1.311,
     C 1.310/
      DATA (A(I,4),I=1,30)/ 6.314, 2.920, 2,353, 2.132, 2.015,
     C 1.943, 1.895, 1.860, 1.833, 1.812, 1.796, 1.782, 1.771,
     C 1.761, 1.753, 1.746, 1.740, 1.734, 1.729, 1.725, 1.721,
     C 1.717, 1.714, 1.711, 1.708, 1.706, 1.703, 1.701, 1.699,
     C 1.697/
      DATA (A(I,5),I=1,30)/ 12.706, 4.303, 3,182, 2.776, 2.571,
     C 2.447, 2.365, 2.306, 2.262, 2.228, 2.201, 2.179, 2.160,
     C 2.145, 2.131, 2.120, 2.110, 2.101, 2.093, 2.086, 2.080,
     C 2.074, 2.069, 2.064, 2.060, 2.056, 2.052, 2.048, 2.045,
     C 2.042/
      DATA (A(I,6),I=1,30)/ 25.452, 6.205, 4.176, 3.495, 3.163,
     C 2.969, 2.841, 2.752, 2.685, 2.634, 2.593, 2.560, 2.533,
     C 2.510, 2.490, 2.473, 2.458, 2.445, 2.433, 2.423, 2.414,
     C 2.406, 2.398, 2.391, 2.385, 2.379, 2.373, 2.368, 2.364,
     C 2.360/
      DATA (A(I,7),I=1,30)/ 63.657, 9.925, 5.841, 4.604, 4.032,
     C 3.707, 3.499, 3.355, 3.250, 3.169, 3.106, 3.055, 3.012,
     C 2.977, 2.947, 2.921, 2.898, 2.878, 2.861, 2.845, 2.831,
     C 2.819, 2.807, 2.797, 2.787, 2.779, 2.771, 2.763, 2.756,
     C 2.750/
      DATA (A(I,8),I=1,30)/330.678, 14.089, 7.453, 5.598, 4.773,
     C 4.317, 4.029, 3.832, 3.690, 3.581, 3.497, 3.428, 3.372,
     C 3.326, 3.286, 3.252, 3.222, 3.197, 3.174, 3.153, 3.135,
     C 3.119, 3.104, 3.090, 3.078, 3.067, 3.056, 3.047, 3.038,
     C 3.030/
      DATA (A(I,9),I=1,30)/636.619, 31.598, 12.941, 8.610, 6.859,
     C 5.959, 5.405, 5.041, 4.781, 4.587, 4.437, 4.318, 4.221,
     C 4.140, 4.073, 4.015, 3.965, 3.922, 3.883, 3.850, 3.819,
     C 3.792, 3.767, 3.745, 3.725, 3.707, 3.690, 3.674, 3.659,
     C 3.646/
C ... CHECK FOR DEGREES OF FREEDOM BETWEEN 1 AND 30
      IF(NDF.GT.30.OR.NDF.LT.1) GO TO 6
C ... LOCATE THE UPPER AND LOWER PROBALITIES
      DO 1 J=1,9
      IF(A(NDF,J)-T) 1,2,3
1     CONTINUE
C ... THERE IS NO UPPER PROBABILITY
      PROB=P(9)
```

THIS PROGRAM COMPUTES THE NECESSARY REGRESSIONS.

```
      GO TO 5
C ... P(J) IS THE EXACT PROBABILITY
2     PROB=P(J)
      GO TO 5
C ... THE UPPER PROBABILITY IS P(J)
3     IF(J.GT.1) GO TO 4
C ... THERE IS NO LOWER PROBABILITY
      PROB=P(1)
      GO TO 5
C ... INTERPOLATE FOR PROBABILITY BETWEEN P(J-1) AND P(J)
4     FRAC=(T-A(NDF,J-1))/(A(NDF,J)-A(NDF,J-1))
      PROB=P(J-1)+FRAC*(P(J)-P(J-1))
5     RETURN
6     WRITE(6,100) NDF
100   FORMAT(*0DEGREES OF FREEDOM OUT OF RANGE AT*I10)
      RETURN
      END
```

THIS PROGRAM APPLIES THE REGRESSIONS TO GET CONVERTED RAW DATA.

```
JOB CARD.CM47000,T240,MT1.     TA624
FTN(R=0,OPT=2)
RFL(15000)
REQUEST,MTAPE,HY,VSN=A1162,WRITE,SWIFT.
REWIND(MTAPE)
COPYCF(MTAPE,ORIG)
REWIND(ORIG)
SKIPF(MTAPE,1,17,C)
SKIPF(MTAPE,1,17,B)
SKIPF(MTAPE,1,17,C)
COPYCF(MTAPE,FINAL)
RFL(47000)
LGO.
RFL(15000)
REWIND(MTAPE)
SKIPF(MTAPE,2,17,C)
SKIPF(MTAPE,1,17,B)
SKIPF(MTAPE,2,17,C)
REWIND(INTER,FINAL)
COPYCF(INTER,MTAPE)
COPYCF(FINAL,MTAPE)
REWIND(MTAPE)
RFL(25000)
TRANSF(TA625)
END-OF-RECORD
```

PROGRAM CAGHBM (SEE TA622) IS USED AGAIN HERE, WITH THE LOGICAL VARIABLE FIRST SET TO FALSE.

THIS PROGRAM ADDS SAMPLE DATE NUMBERS AND PERFORMS AGHB ANALYSIS.

```
JOB CARD.T240,MT1.              TA625
FTN(R=0,OPT=2,B=TRANS)
RFL(15000)
REQUEST,MTAPE,HY,VSN=A1162,WRITE.SWIFT.
REWIND(MTAPE)
SKIPF(MTAPE,2,17,C)
SKIPF(MTAPE,1,17,B)
SKIPF(MTAPE,3,17,C)
COPYCF(MTAPE,TAPES)
REWIND(TAPES)
RFL(43000)
REDUCE.
TRANS(TAPES,TAPE5)
ATTACH(LGO,HERBS,ID=CVB,MR=1,CY=1)
ATTACH,TAPE9,AGBMSP,ID=CVB,MR=1.
SWITCH,3.
REWIND(TAPE5)
RFL(43000)
LGO.
RFL(10000)
REWIND(TAPE6)
COPYCF(TAPE6,OUTPUT)
REWIND(MTAPE)
REWIND(TAPE4)
SKIPF(MTAPE,2,17,C)
SKIPF(MTAPE,1,17,B)
SKIPF(MTAPE,3,17,C)
COPYCF(TAPE4,MTAPE)
REWIND(TAPE6)
COPYCF(TAPE6,MTAPE)
REWIND(TAPE8)
COPYCF(TAPE8,MTAPE)
END-OF-RECORD
      PROGRAM TRANS(TAPE5,TAPE6)
      DIMENSION K(7)
      N=1
      LREP=340000000000B
1     READ(5,100) K
      IF(EOF(5).NE.0) GO TO 3
      IREP=K(2).AND.770000000000B
      IF(IREP.EQ.LREP) GO TO 2
      LREP=IREP
      IF(LREP.EQ.350000000000B) GO TO 2
      N=N+1
2     CONTINUE
      M=(N+1)/2
      IF (M.NE.9) GO TO 30
      DECODE(4,300,K(2)) ITRT
  300 FORMAT (3X,A1)
      IF (ITRT.EQ.1H7) M=8
   30 CONTINUE
      WRITE (6,100) K,M
      GO TO 1
3     STOP
  100 FORMAT (6A10,A4,I5)
      END
```

THIS PROGRAM COMBINES LITTER DATA FOR STANDARD ANALYSIS.

```
JOB CARD,T100,MT1.              TA626
FTN(R=0,OPT=2)
RFL(15000)
COPYCR(INPUT,LTFILE)
REQUEST,MTAPE,HY,ID-A1162,WRITE.SWIFT.
REWIND(MTAPE)
SKIPF(MTAPE,2,17,C)
SKIPF(MTAPE,1,17,B)
SKIPF(MTAPE,2,17,C)
COPYCF(MTAPE,AGFILE)
REWIND(MTAPE,AGFILE)
RFL(43000)
LGO.
RFL(15000)
REWIND(FINAL)
COPYSBF(FINAL,OUTPUT)
REWIND(FINAL)
REWIND(MTAPE)
SKIPF(MTAPE,2,17,C)
SKIPF(MTAPE,1,17,B)
SKIPF(MTAPE,6,17,C)
COPYCF(FINAL,MTAPE)
END-OF-RECORD
      PROGRAM LITTER(AGFILE,LTFILE,FINAL,OUTPUT,TAPE1=AGFILE,TAPE2=LTFIL
     1E,TAPE3=FINAL,TAPE6=OUTPUT)
C ...
C         THIS PROGRAM IS WRITTEN TO MERGE THE LITTER DATA FROM THE ABOVE
C     GROUND BIOMASSS WITH THAT FROM THE REGULAR LITTER DATA AT THE
C     COTTONWOOD SITE.  THIS IS MADE POSSIBLE ONLY WITH THE ABLE ASSISTANCE
C     FROM SUBROUTINE CONVERT.
C
      LOGICAL LREC,IEND
      COMMON LQ,SACK,DRYWT,SACKWT,ASHWT,PDM,AVEPA,AVESWT,NAV,SUBWT
      LREC=.FALSE. $ IEND=.FALSE. $ KQ=0
      AVESWT=3.5 $ AVEPA=.25 $ NAV=1
      REWIND 1
      REWIND 2
      REWIND 3
      WRITE(6,203)
C ... READ A RECORD FROM THE AGFILE
1     READ(1,100) IDAY,IMO,IYR,IT,IR,IQ,ISP,ODW
      IF(EOF(1)) 16,2
2     IF(IQ.EQ.KQ) GO TO 15
      IF(KQ.EQ.0) GO TO 14
C ... LOCATE THE SAME QUADRATE IN THE LITFILE
3     IF(LREC) GO TO 4
      READ(2,101) INIT,LDAY,LMO,LYR,LT,LR,LQ,SACK,DRYWT,SACKWT,ASHWT,PDM
      IF(EOF(2)) 13,4
4     IF(LQ.EQ.KQ) GO TO 12
C ... THIS IS NOT THE PROPER RECORD. DOES IT PRECEDE OR FOLLOW THE QUADRATE
      IF(LYR-KYR) 10,5,11
5     IF(LMO-KMO) 10,6,11
6     LD=LDAY/10
      KD=KDAY/10
      IF(LD-KD) 10,7,11
7     IF(LT-KT) 10,8,11
```

THIS PROGRAM COMBINES LITTER DATA FOR STANDARD ANALYSIS.

```
8      IF(LR-KR)10,9,11
9      IF(LQ-KQ)10,12,11
C ...  THE LITFILE RECORD PRECEDES THE AGFILE RECORD
10     WRITE(6,201) INIT,LDAY,LMO,LYR,LT,LR,LQ
       CALL CONVERT
       WRITE(3,200) INIT,LDAY,LMO,LYR,LT,LR,LQ,DRYWT,SUBWT,ASHWT
       LREC=.FALSE.
       GO TO 3
C ...  THE LITFILE FOLLOWS THE AGFILE RECORD
11     INI=10H0204
       WRITE(6,202) INI,KDAY,KMO,KYR,KT,KR,KQ
       SWT=AVESWT
       AWT=SWT*AVEPA
       WRITE(3,200) INI,KDAY,KMO,KYR,KT,KR,KQ,TOT,SWT,AWT
       LREC=.TRUE.
       GO TO 14
C ...  BOTH FILES CORRESPOND, COMBINE THE INFORMATION FROM BOTH RECORDS
12     CALL CONVERT
       DRYWT=DRYWT+TOT
       WRITE(3,200) INIT,LDAY,LMO,LYR,LT,LR,LQ,DRYWT,SUBWT,ASHWT
       LREC=.FALSE.
       GO TO 14
C ...  THERE ARE NO MORE RECORDS ON LITFILE
13     WRITE(6,202) KDAY,KMO,KYR,KT,KR,KQ
       INI=10H0204
       SWT=AVESWT
       AWT=SWT*AVEPA
       WRITE(3,200) INI,KDAY,KMO,KYR,KT,KR,KQ,TOT,SWT,AWT
       LREC=.FALSE.
C ...  RESET THE STORAGE FOR THE AGFILE RECORD
14     IF(IEND) GO TO 17
       KDAY=IDAY
       KMO=IMO
       KYR=IYR
       KT=IT
       KR=IR
       KQ=IQ
       TOT=0.0
C ...  ADD THIS INFORMATION TO THE AGFILE RECORD
15     TOT=TOT+ODW
       GO TO 1
C ...  THE END OF AGFILE HAS BEEN REACHED
16     IEND=.TRUE.
       GO TO 3
C ...  FINISH LITFILE
17     READ(2,101) INIT,LDAY,LMO,LYR,LT,LR,LQ,SACK,DRYWT,SACKWT,ASHWT,PDM
       IF(EOF(2)) 19,18
18     WRITE(6,201) INIT,LDAY,LMO,LYR,LT,LR,LQ
       CALL CONVERT
       WRITE(3,200) INIT,LDAY,LMO,LYR,LT,LR,LQ,DRYWT,SUBWT,ASHWT
       GO TO 17
C ...  THATS ALL FOLKS
19     STOP
100    FORMAT(7X,3I2,2I1,5X,I3,3X,A5,F6.0)
101    FORMAT(A7,3I2,2I1,5X,I3,2X,F5.0,F7.0,F5.0,F7.0,F3.0)
200    FORMAT(A7,3I2,2I1,*0.50*I4* 1*6X,F6.2,1X,F4.2,1X,F6.2)
```

THIS PROGRAM COMBINES LITTER DATA FOR STANDARD ANALYSIS.

```
201   FORMAT(1H ,A7,3I3,2I2,I4)
202   FORMAT(1H ,66X,A7,3I3,2I2,I4)
203   FORMAT(1H1,50X,*COTTONWOOD LITTER MERGING PROGRAM*/1H0*RECORDS MIS
     1SING FROM ABOVE-GROUND DATA*29X,*RECORDS MISSING FROM LITTER DATA*
     2/1H0,2(8X,*DA MO YR T R PLT*,44X)/)
      END



      SUBROUTINE CONVERT
C     CONVERT IS CALLED AFTER EACH RECORD IS READ IN  TO INTERPRET AND
C     ANALYZE ITS INFORMATION CONTENT.
C
      COMMON LQ,SACK,DRYWT,SACKWT,ASHWT,PDM,AVEPA,AVESWT,NAV,SUBWT
C ... SOMETIMES THE MULCH WT. IS IN THE COLUMN FOR THE SACK NO.
C     AND SOMETIMES ITS IN THE COLUMN FOR DRYWT.
      WTMULCH=SACK
      IF(DRYWT.GT.SACK) WTMULCH=DRYWT
C ... THE WEIGHT OF THE SUBSAMPLE IS IN THE OTHER FIELD
      SUBWT=DRYWT
      IF(DRYWT.GT.SACK) SUBWT=SACK
C ... THE SUBSAMPLE WAS REMOVED BEFORE THE SAMPLE WAS WEIGHED
      WTMULCH=WTMULCH+SUBWT
C ... SOMETIMES THE WEIGHT IS DRY-WEIGHT, BUT NOT ALL OF THE TIME.
C     IF IT ISNT THE PERCENT DRY MATTER WAS RECORDED IN THE FIELD FOR
C     THE DAY OF THE PREVIOUS DATE.
      IF(PDM.EQ.0.0) PDM=100.0
      DRYWT=WTMULCH*PDM/100.0
      SUBWT=SUBWT*PDM/100.0
C ... INSTEAD OF THE ASHWT FOR THE SUBSAMPLE, THEY RECORDED A PERCENT,
C     BUT INSTEAD OF PERCENT ASH IT IS ACTUALLY PERCENT ORGANIC MATTERS
C     IT IS IN THE COLUMN FOR THE ASH WT. THOUGH.
      PA=(100.0-ASHWT)/100.0
      ASHWT=SUBWT*PA
C ... SOMETIMES THERE WASNT ANY LITTER DATA RECORDED WHEN THE ABOVE
C     GROUND DATA WAS RECORDED, SO A RUNNING AVERAGE WILL BE USED AS A
C     SUBSTITUTE.
      AVESWT=((AVESWT*NAV)+SUBWT)/(NAV+1)
      AVEPA=((AVEPA*NAV)+PA)/(NAV+1)
      NAV=NAV+1
      RETURN
      END
```

Appendix B5. Sample Output of the Regression Program, Aboveground Plant Standing Crop Data Cottonwood, 1971 and 1972

Appendix B5

COTTONWOOD ABOVE-GROUND BIOMASS, 1971

DATA SET: 4

LINEAR REGRESSION

COMPONENT: AGSM 1

STAGE	N	XBAR	YBAR	A	B	VAR(Y.X)	RSQ	VAR(B)	DEV(YHAT)	X	Y	YHAT	DEV.
3	6	.230	.223	.045	.773	.002	.967	0.000	.047	.100	.130	.123	.007
									.047	.080	.150	.107	.043
									.047	.050	.040	.084	.044
									.047	.050	.060	.084	.024
									.047	.400	.400	.355	.045
									.057	.700	.560	.587	.027
2	7	2.857	2.727	.712	.705	.051	.995	0.000	.247	.500	.994	1.065	.071
									.242	3.600	3.368	3.251	.117
									.245	1.000	1.702	1.418	.284
									.245	1.050	1.342	1.453	.111
									.248	.250	1.011	.889	.123
									.242	2.100	1.837	2.193	.356
									.313	11.500	8.837	8.822	.014
1	36	2.453	2.764	2.076	.259	3.375	.044	0.000	1.864	3.000	3.251	2.854	.397
									2.166	8.000	1.418	4.151	2.734
									1.867	2.000	1.453	2.595	1.142
									1.894	1.000	2.193	2.336	.142
									1.925	5.000	8.822	3.373	5.449
									1.867	2.000	2.334	2.595	.261
									1.867	2.000	1.171	2.595	1.424
									1.883	4.000	2.969	3.114	.145
									1.925	5.000	4.238	3.373	.865
									1.894	1.000	1.805	2.336	.530
									1.864	3.000	3.004	2.854	.150
									1.864	3.000	5.825	2.854	2.971
									1.867	2.000	6.002	2.595	3.407
									1.867	2.000	1.629	2.595	.966
									1.925	5.000	2.899	3.373	.475
									1.864	3.000	2.123	2.854	.732
									1.867	2.000	2.158	2.595	.437
									1.883	4.000	2.017	3.114	1.097
									1.894	1.000	1.347	2.336	.989
									1.883	4.000	2.546	3.114	.568
									1.867	2.000	2.229	2.595	.366
									1.867	2.000	2.123	2.595	.472
									1.878	1.500	2.123	2.465	.343
									1.894	1.000	1.418	2.336	.918
									1.867	2.000	7.412	2.595	4.817
									1.883	4.000	.712	3.114	2.401
									1.867	2.000	.712	2.595	1.883
									1.867	2.000	4.591	2.595	1.996
									1.867	2.000	2.828	2.595	.233
									1.867	2.000	2.123	2.595	.472
									1.864	3.000	4.591	2.854	1.737
									1.867	2.000	1.841	2.595	.754
									1.894	1.000	3.181	2.336	.845
									1.867	2.000	.712	2.595	1.883
									1.883	4.000	2.828	3.114	.286
									1.894	1.000	.889	2.336	1.447

DEGREES OF FREEDOM OUT OF RANGE AT 33

THE PROBABILITY LEVEL FOR Y(5) TO BE AN OUTLIER IS -.000 T= 3.043

Appendix B6

APPROXIMATIONS OF THE VARIANCE OF DOUBLE SAMPLING AT THE COTTONWOOD SITE

Richard O. Gilbert
Richard J. Olson

January, 1972

Battelle Memorial Institute
Pacific Northwest Laboratories
Richland, Washington

Table of Contents

INTRODUCTION

The Cottonwood site in South Dakota is unique among all the IBP Grassland sites in the field and laboratory sampling techniques they use to obtain estimates of mean biomass for individual species as well as groups or components of biomass. This uniqueness stems from the large cost involved in separating and weighing individual species and components as they occur together at the Cottonwood site. The purpose of this paper is to derive approximate formulae for the variance of the estimates of mean biomass obtained at Cottonwood for their particular field and laboratory sampling plan. These approximations are obtained using truncated Taylor series expansions. Exact formulae are unknown and no doubt complex and difficult to derive.

In common with most grassland sites in 1971, the Cottonwood site is using a sampling technique known as double sampling or two-phase sampling (Cochran, 1963, Chapter 12), but with modifications to suit the particular sampling problems encountered at Cottonwood. The basic idea behind double sampling as used by the Grassland Biome is to obtain a calibration equation relating the true weight of biomass samples (which are costly to obtain) with relatively inexpensive field weight estimates of the same samples. Then, an estimate of mean biomass is obtained by finding the mean of a large, inexpensive sample of weight estimates and substituting this in the calibration equation relating true and estimated weights. The results of Frances et. al. (1971) suggest that for many species found at the various Grassland biome sites, the use of double sampling under the assumption that the calibration equation is linear, results in a more precise estimate of mean biomass than would be obtained if all resources were expended on obtaining true weights by clipping, drying and weighing field samples.

The modifications of this basic procedure used at the Cottonwood site are motivated (as mentioned above) by the large cost involved in obtaining true weights (by clipping and weighing) of the various species and components on each clipped field plot. To reduce this cost they have obtained true weights on only a small fraction of the biomass material obtained from each clipped plot, and from these data have estimated the true weight of each species or component in each field plot. Hence, their linear calibration equation relates field estimated weights with estimated "true" weights. Clearly, the variance of their resulting estimate of mean biomass must be larger than in the usual double sampling scheme since their "true" weights are in fact estimates.

In the next section we describe the Cottonwood sampling plan in more detail and define the notation used in this paper. This will enable us to state explicitly the assumptions under which our results have been obtained.

FIELD AND LABORATORY PROCEDURE

For each species or component to be estimated, between 50 and 100 circular field plots of size .5 m^2 are weight estimated for each harvest day, replication and treatment. A subsample of 10 plots are clipped with electric shears and taken to the laboratory. The field and laboratory data are combined over several harvest days into a "data set" assuming that the regression coefficients defined below do not change over harvest days within the data set. The data sets are subjectively constructed with this constraint in mind.

The contents of each clipped plot are air dried in the laboratory and spread out on a table ruled in squares. The weight of each species or component is then weight estimated (ignoring the squares) so that their sum equals the total plot weight. One or more plots within a replicate (denoted here as calibration plots) are chosen at random, the contents of which are spread out uniformly over the squares a second time and divided into squares. The total weight of each square is obtained. Then each species or component within each square is weight estimated so that they sum to the square weight. Finally, one of the squares from each calibration plot (denoted here as a calibration square) is chosen at random to be hand separated and weighed by species or component.

From the above description we see that while 10 plots per replication are clipped and brought to the laboratory, only 1 small square of one or more of the 10 sacks is actually separated and weighed by species. It is for this reason (small sample size) that the data are grouped into data sets. We recall that in the usual double sampling procedure the entire contents of the 10 clipped plots are separated and weighed by species. The purpose of subsampling the clipped plots by randomly choosing calibration squares within randomly chosen calibration plots is to obtain an estimate of the true weight of each species and components in the clipped field plots.

As will become apparent in the derivation of the approximate variance formula, the Cottonwood sampling plan can be written down as a series of 3 equations. The first equation relates true and estimated small square weights. The second uses information obtained from the first equation to obtain an estimate of the "true" laboratory weight of the clipped field plots, and the third equation makes use of equation 2 to obtain the final estimate of mean biomass using the estimated field weights. It will be shown that these 3 equations can be combined into one to which Taylor series expansions can be applied.

The notation used in this paper is as follows:

Y_{ijh} = true weight of a given species or component in the j^{th} square of i^{th} plot on the h^{th} day,

x_{ijh} = estimated weight of a given species or component in the j^{th} square of the i^{th} plot on the h^{th} day,

x^{L}_{ih} = estimated laboratory weight of a given species or component in the i^{th} plot on the h^{th} harvest day ,

x^{F}_{ih} = estimated field weight of a given species or component in the i^{th} plot on the h^{th} harvest day,

H = number of harvest days in a data set

m_h = number of calibration plots on the h^{th} harvest day,

s_{ih} = number of calibration squares in the i^{th} calibration plot on the h^{th} harvest day,

c_{ih} = total number of squares in the i^{th} calibration plot on the h^{th} harvest day,

n_h = number of field plots both clipped and estimated on the h^{th} harvest day

n'_h = number of estimated field plots on the h^{th} harvest day

ASSUMPTIONS

All results obtained in this paper are based on two assumptions: (A) that the relationship between true and estimated species and component weights is linear and does not necessarily pass through the origin, and (B) that within data sets, regression coefficients defining this linear relationship are constant from harvest day to harvest day.

Assumption (A) is not unique to the Cottonwood site, but is common throughout all Grassland biome sites in 1971. It is probably true that a more realistic assumption would be to assume a curvilinear relationship between true and estimated species weights that passes through the origin. While an investigation of this hypothesis and the subsequent derivation of appropriate variance formula would be of theoretical if not practical importance, such an undertaking is beyond the scope of the present paper.

Assumption (B) is unique to the Cottonwood site and is imposed to increase the number of small square true species weights upon which to base the estimated linear calibration equation. On a given harvest day, small square true species weights are usually obtained on only one square in each of two replicates in a given grazing condition. This sample size of 2 for each grazing treatment is sufficient to obtain an estimate of the linear calibration equation for that day, but it is not sufficient for obtaining an estimate of its precision. If small square true weights from several days are pooled together into a data set for which assumption B holds, then the 10 or so small square observations in a data set can be utilized to obtain an estimate of the variance of a more precisely defined linear calibration equation. This is the rationale behind assumption (B). We note, however that we have not assumed that the mean of the true (y_{ijh}) and estimated (x_{ijh}) small square weights or of the estimated field (x^F_{ih}) and laboratory (x^L_{ih}) plot weights need be constant on all harvest days within a data set. Indeed, the Cottonwood plan under assumption (B) allows for estimating the mean biomass of a given species or component as well as its precision on each harvest day within a data set if 2 or more small square true weights are obtained each day. Unfortunately, a sample size of only 2 small squares per harvest day does not allow us to statistically test assumption (B). This can be done only if 3 or more small square true weights are obtained on each harvest day (Snedecor and Cochran, 1967, page 435).

Under the confines of assumptions (A) and (B) we have obtained approximations to the variance of mean biomass for the Cottonwood sampling plan under two levels of generality on c_{ih} and s_{ih} (the total number of squares, and the number of calibration squares, respectively, in the i^{th} calibration plot on the h^{th} harvest day). Under Case 1 we make no restrictions on the size or constancy of c_{ih} or s_{ih} from plot to plot. In this case we also obtain upper and lower bounds on the variance. For Case 2 we require that $c_{ih} = c$ and $s_{ih} = s$ for all i and h in a data set, i.e. for all calibration plots on all H harvest days. In general, most data sets at Cottonwood will be analyzed under Case 1 since the number of small squares per calibration plot usually change from plot to plot. The estimate of mean biomass and an approximation to its variance under Case 1 are given by equations (4) and (5), respectively, while the corresponding results for Case 2 are given by equations (6) and (9).

Our primary purpose for considering Case 2 in this paper is to motivate our derivation of what we call Case 3. In Case 3 we superimpose upon Case 2 the somewhat unrealistic assumption that $x^L_{ih} = x^F_{ih}$ and $\sum_{j=1}^{c} x_{ijh} = x^L_{ih}$ for all i and h within a data set. That is, superimposed on the assumptions of Case 2 we are assuming the laboratory and field plot estimates are equal, and that the sum of the estimated small square weights for a given species sum to the independently obtained plot estimate for that species, for all calibration plots in the data set. Equations (10) and (11) give the equations for the estimated mean biomass and its variance under Case 3. The important point is that these equations are of the same form as given by Cochran (1963, p. 334, 339) for the usual double sampling technique. Thus, if the weight estimation of squares and plots in the laboratory on dry material are equal to those obtained by different persons in the field on standing green material, and the assumptions under Case 2 hold, the variance formula is relatively simple and well known. For all three cases the derived variance formula are conditional on the fixed values of c_{ih} and s_{ih}, i.e., c_{ih} and s_{ih} are considered to be fixed parameters rather than random variables.

It is not our purpose here in discussing Case 3 to suggest its use on the Cottonwood data but only to point out the relationship between it, Case 2 and Case 1 in the hope that a deeper understanding of the Cottonwood plan will emerge. It is well to remark at this stage also, that while the form of equation (10) is the same as found in Cochran's book, there is nevertheless a significant difference. Equation (10) is based on small square true and estimated weights, while Cochran's formula assumes the true weight of the <u>entire</u> clipped plot is known. It is reasonable to expect, however, that the expected value of equation (10) is given by Cochran's formula, unless a bias arises due to obtaining true weights of small squares rather than entire plots.

The results obtained for Case 1 are appropriate for all Cottonwood data. If the assumptions under Case 2 happen to be fulfilled for a particular data set, it would be informative to compute the variance approximations under both cases 1 and 2 and note their discrepancy. No data are presently available to the authors to numerically compare equations (5), (9) and (11).

We now derive our formula for mean biomass and its approximate variance for Cases 1, 2 and 3.

RESULTS

Case 1: No Restrictions on Equality of c_{ih} or s_{ih}

It is convenient to begin with the most general case in which we do not assume there is an equal number of small squares in each calibration plot.

Under Case 1 and Assumption A, the first of the 3 regression equations is given by

$$\hat{y}_{ijh} = \bar{y}_{sq,h} + b_1 (x_{ijh} - \bar{x}_{sq,h}) \tag{1}$$

= estimated "true" weight of the j^{th} square in the i^{th} calibration plot on the h^{th} harvest day ($i=1,2,\ldots, m_h$; $j=1,2,\ldots, c_{ih}$, $h=1,2,\ldots, H$)

where

$\bar{y}_{sq,h}$ = mean true weight of the calibration squares on the h^{th} harvest day (the subscript "sq" indicates square)

$$= \frac{1}{\sum_{i=1}^{m_h} s_{ih}} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} y_{ijh} ,$$

$\bar{x}_{sq,h}$ = mean estimated weight of the calibration squares on the h^{th} harvest day

$$= \frac{1}{\sum_{i=1}^{m_h} s_{ih}} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} x_{ijh}$$

and
$$b_1 = \frac{\sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} (y_{ijh}-\bar{y}_{sq,h})(x_{ijh}-\bar{x}_{sq,h})}{\sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} (x_{ijh} - \bar{x}_{sq,h})^2}$$

We note that b_1 is a pooled estimate of slope computed over the H harvest days in the data set. This is the appropriate estimate if the slopes on the individual harvest days are equal.

From equation (1) we have that

$$\hat{y}_{ih} = \sum_{j=1}^{c_{ih}} \hat{y}_{ijh}$$

is the estimated "true" weight of the i^{th} calibration plot on day h, and

$$\bar{\hat{y}}_h = \frac{1}{m_h} \sum_{i=1}^{m_h} \hat{y}_{ih}$$

their average "true" weight on day h.

Now, if we assume that the m_h pairs of "true" and estimated calibration plot weights are linearily related (assumption A) we are led to the 2nd regression equation given by

$$\hat{\hat{y}}_{ih} = \bar{\hat{y}}_h + b_2\,(x^L_{ih} - \bar{x}^{\ell}_{ih}),\ (i = 1,2,\ldots,n_h) \qquad (2)$$

= estimated "true" weight of the i^{th} clipped plot,

where

$$\bar{x}^{\ell}_h = \frac{1}{m_h}\sum_{i=1}^{m_h} x^L_{ih}$$

= mean estimated laboratory weight of the calibration plots on day h

and

$$b_2 = \frac{\sum_{h=1}^{H}\sum_{i=1}^{m_h}(\hat{y}_{ih}-\bar{\hat{y}}_h)(x^L_{ih}-\bar{x}^{\ell}_h)}{\sum_{h=1}^{H}\sum_{i=1}^{m_h}(x^L_{ih}-\bar{x}^{\ell}_h)^2}$$

Note that b_2 is based on data from the entire data set.

The 3rd regression equation also assumes a linear relationship (assumption A), this time between the n_h "true" and estimated field plot weights. This regression gives the final estimate of mean biomass which we desire for each of the harvest days within a data set:

$$\hat{\bar{y}}_{D,h} = \bar{\hat{\hat{y}}}_h + b_3\,(\bar{x}^F_h - \bar{x}^f_h) \qquad (h=1,2,\ldots,H) \quad (3)$$

where the subscript D refers to double sampling,

$\bar{\hat{\hat{y}}}_h$ = mean of the estimated "true" weights of the n_h clipped plots

$$= \frac{1}{n_h} \sum_{i=1}^{n_h} \hat{\hat{y}}_{ih} ,$$

$\bar{x}_h^f$ = mean of the estimated field weights of the n_h plots both clipped and estimated

$$= \frac{1}{n_h} \sum_{i=1}^{n_h} x_{ih}^F ,$$

$\bar{x}_h^F$ = mean of the estimated field weights of the n_h' estimated plots

$$= \frac{1}{n_h'} \sum_{i=1}^{n_h'} x_{ih}^F$$

and

$$b_3 = \frac{\sum_{h=1}^{H} \sum_{i=1}^{n_h} (\hat{\hat{y}}_{ih} - \bar{\hat{\hat{y}}}_h)(x_{ih}^F - \bar{x}_h^f)}{\sum_{h=1}^{H} \sum_{i=1}^{n_h} (x_{ih}^F - \bar{x}_h^f)^2} .$$

In order to derive an approximation to the variance of $\hat{\bar{y}}_{D,h}$ it is convenient to express Equation (3) in terms of Equations (1) and (2). It is shown in Appendix A that

$$\hat{\bar{y}}_{D,h} = \bar{c}_h \, \bar{y}_{sq,h} + b_1 \, (\bar{x}_h - \bar{c}_h \, \bar{x}_{sq,h}) + b_2 \, (\bar{x}_h^L - \bar{x}_h^\ell) + b_3 \, (\bar{x}_h^F - \bar{x}_h^f) \qquad (4)$$

whose terms have been previously defined except for

$$\bar{c}_h = \frac{1}{m_h} \sum_{i=1}^{m_h} c_{ih} \quad ,$$

$\bar{x}_h$ = mean estimated weight of the m_h calibration plots on day h

$$= \frac{1}{m_h} \sum_{i=1}^{m_h} \sum_{j=1}^{c_{ih}} x_{ijh} \quad ,$$

and

$\bar{x}_n^L$ = mean estimated laboratory weight of the n_h clipped plots on day h

$$= \frac{1}{n_h} \sum_{i=1}^{n_h} x_{ih}^L \quad .$$

It is shown in Appendix B that an estimate of a rough approximation to the large sample conditional (on c_{ih} and s_{ih}) variance of $\hat{\bar{y}}_{D,h}$ [Equation (4)] is given by

$$\text{Var}\ [\hat{\bar{y}}_{D,h}] \simeq \bar{c}_h^2\, s_{y\cdot x}^2 \left[\frac{1}{\sum_{h=1}^{H} \sum_{i=1}^{m_h} s_{ih}} + \frac{\left[\bar{x}_h - \bar{c}_h\, \bar{x}_{sq,h}\right]^2}{\bar{c}_h^2 \sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} (x_{ijh} - \bar{x}_{sq,h})^2} \right]$$

$$+ \bar{c}_h^2 \frac{[s_y^2 - s_{y\cdot x}^2]}{\sum_{h=1}^{H} \sum_{i=1}^{m_h} c_{ih}}$$

$$+ [\bar{x}_h^L - \bar{x}_h^\ell]^2\ \text{Var}\ (b_2) + [\bar{x}_h^F - \bar{x}_h^f]^2\ \text{Var}\ (b_3)$$

$$+ b_2^2\ [\text{Var}\ (\bar{x}_h^L) + \text{Var}\ (\bar{x}_h^\ell)]$$

$$+ b_3^2 \, [\mathrm{Var}\, (\bar{x}_h^F) + \mathrm{Var}\, (\bar{x}_h^f)] \qquad (5)$$

where

$$s_{y\cdot x}^2 = \frac{1}{\sum_{h=1}^{H} \sum_{i=1}^{m_h} s_{ih} - H - 1} \left[\sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} (y_{ijh} - \bar{y}_{sq,h})^2 \right.$$

$$\left. - b_1^2 \sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} (x_{ijh} - \bar{x}_{sq,h})^2 \right] ,$$

$$s_y^2 = \frac{1}{\sum_{h=1}^{H} \sum_{i=1}^{m_h} s_{ih} - H} \sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s_{ih}} (y_{ijh} - \bar{y}_{sq,h})^2 ,$$

$$\mathrm{Var}\,(b_2) = s_{y\cdot x,2}^2 \Bigg/ \sum_{h=1}^{H} \sum_{i=1}^{m_h} (x_{ih}^L - \bar{x}_h^\ell)^2 ,$$

where

$$s_{y\cdot x,2}^2 = \frac{1}{\sum_{h=1}^{H} m_h - H - 1} \left[\sum_{h=1}^{H} \sum_{i=1}^{m_h} (\hat{y}_{ih} - \bar{\hat{y}}_h)^2 - b_2^2 \sum_{h=1}^{H} \sum_{i=1}^{m_h} (x_{ih}^L - \bar{x}_h^\ell)^2 \right] ,$$

$$\mathrm{Var}\,(b_3) = s_{y\cdot x,3}^2 \Bigg/ \sum_{h=1}^{H} \sum_{i=1}^{n_h} (x_{ih}^F - \bar{x}_h^f)^2$$

where

$$s_{y\cdot x,3}^2 = \frac{1}{\sum_{h=1}^{H} n_h - H - 1} \left[\sum_{h=1}^{H} \sum_{i=1}^{n_h} (\hat{\hat{y}}_{ih} - \bar{\hat{\hat{y}}}_h)^2 \right.$$

$$\left. - b_3^2 \sum_{h=1}^{H} \sum_{i=1}^{n_h} (x_{ih}^F - \bar{x}_h^f)^2 \right] ,$$

$$\text{Var}\ (\bar{x}_h^{\ell}) = \frac{1}{m_h\ (m_h-1)} \sum_{i=1}^{m_h} (x_{ih}^L - \bar{x}_h^{\ell})^2 \quad ,$$

$$\text{Var}\ (\bar{x}_h^{L}) = \frac{1}{n_h\ (n_h-1)} \sum_{i=1}^{n_h} (x_{ih}^L - \bar{x}_h^{L})^2 \quad ,$$

$$\text{Var}\ (\bar{x}_h^{f}) = \frac{1}{n_h\ (n_h-1)} \sum_{i=1}^{n_h} (x_{ih}^F - \bar{x}_h^{f})^2 \quad ,$$

and

$$\text{Var}\ (\bar{x}_h^{F}) = \frac{1}{n_h'\ (n_h'-1)} \sum_{i=1}^{n_h'} (x_{ih}^F - \bar{x}_h^{F})^2 \quad ,$$

In Appendix D we derive approximate upper and lower bounds to the true variance of $\hat{\bar{y}}_{D,h}$ which will bracket the value obtained using equation (5). These should prove very useful in practice. The reader is directed to Appendix D for details.

An estimate of $\hat{y}_{D,ih}$, the "true" weight of a given species or component in the i^{th} field plot, and the approximation to Var $(\hat{y}_{D,ih})$ are given by Equations (4) and (5), respectively, after $\bar{x}_h^F$ is replaced by x_{ih}^F. In Equation (5) we need Var (x_{ih}^F) which is given by n_h' Var $(\bar{x}_h^F)$.

Case 2: Equal Number of Squares in Each Calibration Plot

In this case we assume that $c_{ih} = c$ and $s_{ih} = s$ for all i and h. We find that the expressions for $\hat{\bar{y}}_{D,h}$ and Var $(\hat{\bar{y}}_{D,h})$ are altered from those given by Equations (4) and (5) in Case 1. It is easily verified that under Case 2, Equation (4) can be written as

$$\hat{\bar{y}}_{D,h} = c\ \bar{y}_{sq,h} + b_1\ (\bar{x}_h - c\ \bar{x}_{sq,h}) + b_1\ b_L\ (\bar{x}_h^L - \bar{x}_h^{\ell})$$

$$+ b_1\ b_L\ b_F\ (\bar{x}_h^F - \bar{x}_h^f) \quad (6)$$

where

$$b_L = \frac{\sum_{h=1}^{H} \sum_{i=1}^{m_h} \left(\sum_{j=1}^{c} x_{ijh} - \bar{x}_h \right) \left(x_{ih}^{L} - \bar{x}_h^{\ell} \right)}{\sum_{h=1}^{H} \sum_{i=1}^{m_h} \left(x_{ih}^{L} - \bar{x}_h^{\ell} \right)^2} , \qquad (7)$$

and

$$b_F = \frac{\sum_{h=1}^{H} \sum_{i=1}^{n_h} \left(x_{ih}^{L} - \bar{x}_h^{L} \right) \left(x_{ih}^{F} - \bar{x}_h^{f} \right)}{\sum_{h=1}^{H} \sum_{i=1}^{n_h} \left(x_{ih}^{F} - \bar{x}_h^{f} \right)^2} . \qquad (8)$$

Note that $b_2 = b_1 b_L$ and $b_3 = b_1 b_L b_F$. The other terms have been defined previously.

Following the general procedure outlined in Appendix B, an estimate of a rough approximation to the conditional variance of Equation (6) can be shown to be

$$\begin{aligned}
\text{Var}\,(\hat{\bar{y}}_{D,h})_{\text{Case 2}} \approx\; & c^2 s_{y\cdot x}^2 \left[\frac{1}{s \sum_{h=1}^{H} m_h} + \frac{[\bar{x}_h - c\,\bar{x}_{sq,h}]^2}{c^2 \sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s} (x_{ijh} - \bar{x}_{sq,h})^2} \right] \\
& + c^2 \frac{[s_y^2 - s_{y\cdot x}^2]}{c \sum_{h=1}^{H} m_h} \\
& + [\bar{x}_h^{L} - \bar{x}_h^{\ell}]^2 \, [b_L^2 \text{ Var } (b_1) + b_1^2 \text{ Var } (b_L)] \\
& + [\bar{x}_h^{F} - \bar{x}_h^{f}]^2 \, [b_L^2 b_F^2 \text{ Var } (b_1) + b_1^2 b_F^2 \text{ Var } (b_L) \\
& + b_1^2 b_L^2 \text{ Var } (b_F)] \\
& + b_1^2 b_L^2 \, [\text{Var } (\bar{x}_h^{L}) + \text{Var } (\bar{x}_h^{\ell})] \\
& + b_1^2 b_L^2 b_F^2 \, [\text{Var } (\bar{x}_h^{F}) + \text{Var } (\bar{x}_h^{f})] \\
& + 2 b_L (\bar{x}_h - c\,\bar{x}_{sq,h}) \, [\bar{x}_h^{L} - \bar{x}_h^{\ell} + b_F (\bar{x}_h^{F} - \bar{x}_h^{F})] \text{ Var } (b_1)
\end{aligned}$$

$$+ 2[b_L^2 \text{ Var } (b_1) + b_1^2 \text{ Var } (b_L)] [b_F (\bar{x}_h^L - \bar{x}_h^\ell) (\bar{x}_h^F - \bar{x}_h^f)] \quad (9)$$

where

$$\text{Var } (b_1) = s_{y \cdot x}^2 \Big/ \sum_{h=1}^{H} \sum_{i=1}^{m_h} \sum_{j=1}^{s} (x_{ijh} - \bar{x}_{sq,h})^2 ,$$

$$\text{Var } (b_L) = s_{y \cdot x,L}^2 \Big/ \sum_{h=1}^{H} \sum_{i=1}^{m_h} (x_{ih}^L - \bar{x}_h^\ell)^2 ,$$

$$s_{y \cdot x,L}^2 = \frac{1}{\sum_{h=1}^{H} m_h - H - 1} \left[\sum_{h=1}^{H} \sum_{i=1}^{m_h} \left(\sum_{j=1}^{c} x_{ijh} - \bar{x}_h \right)^2 - b_L^2 \sum_{h=1}^{H} \sum_{i=1}^{m_h} (x_{ih}^L - \bar{x}_h^\ell)^2 \right] ,$$

$$\text{Var } (b_F) = s_{y \cdot x,F}^2 \Big/ \sum_{h=1}^{H} \sum_{i=1}^{n_h} (x_{ih}^F - \bar{x}_h^f)^2 ,$$

and

$$s_{y \cdot x,F}^2 = \frac{1}{\sum_{h=1}^{H} n_h - H - 1} \left[\sum_{h=1}^{H} \sum_{i=1}^{n_h} (x_{ih}^L - \bar{x}_h^L)^2 - b_F^2 \sum_{h=1}^{H} \sum_{i=1}^{n_h} (x_{ih}^F - \bar{x}_h^f)^2 \right] .$$

An estimate of $\hat{y}_{D,ih}$ and its variance for Case 2 is given by Equations (6) and (9), respectively, after replacing $\bar{x}_h^F$ by x_{ih}^F.

Equation (9) for Case 2 is somewhat more complex than Equation (5) derived for Case 1. This occurs because under Case 1 the quantity b_2 is equal to a more complicated expression than b_1 b_L, which is its value in Case 2. A similar statement holds for b_3. Thus in Case 1 the variance terms to be approximated are less complex than in Case 2, which results in a less complicated (and possibly less accurate) variance formula approximation.

For Case 2 we could have persued a similar course to that used for Case 1, i.e. found approximations to the variance of terms $b_1\ (\bar{x}_h - c\ \bar{x}_{sq,h})$, $b_2\ (\bar{x}_h^L - \bar{x}_h^\ell)$ and $b_3\ (\bar{x}_h^F - \bar{x}^f)$ rather than $b_1\ (\bar{x}_h - c\ \bar{x}_{sq,h})$, $b_1\ b_L\ (\bar{x}_h^L - \bar{x}_h^\ell)$ and $b_1\ b_L\ b_F\ (\bar{x}_h^F - \bar{x}^f)$. If this were done then the resulting variance approximation under Case 2 is given by Equation (5)

To summarize, Equation (5) can be used for both Case 1 and Case 2, but if the assumptions under Case 2 are true, then the more complicated formulate given by Equation (9) should be used.

Case 3: More Restrictive Assumptions

Let us now consider Case 2 in the previous section when we make the additional assumptions that $x_{ih}^L = x_{ih}^F$ and $\sum_{j=1}^{c} x_{ijh} = x_{ih}^L$ for all i and h. In this case we see that b_L and b_F equal 1, $\bar{x}_h^f = \bar{x}_h^L$ and $\bar{x}_h^\ell = \bar{x}_h$. Therefore, Equation (6) reduces to

$$\hat{\bar{y}}_{D,h} = c\ \bar{y}_{sq,h} + b_1\ (\bar{x}_h^F - c\ \bar{x}_{sq,h}) \quad . \tag{10}$$

Thus, if for a given species or biomass component the sum of the small square estimates equals the independent laboratory estimate for that plot, which is in turn equal to the estimate obtained in the field then our estimate of mean biomass reduces to that given by Equation (10). The form of this equation suggests we use the approximate formula given by Cochran (1963, p. 339):

$$\hat{Var}(\bar{y}_{D,h}) = c^2 s^2_{y\cdot x}\left[\frac{1}{s\sum_{h=1}^{H} m_h} + \frac{(\bar{x}^F_h - c\,\bar{x}_{sq,h})^2}{c^2 \sum_{h=1}^{H}\sum_{i=1}^{m_h}\sum_{j=1}^{s}(x_{ijh} - \bar{x}_{sq,h})^2}\right] + c^2\left[\frac{s^2_y - s^2_{y\cdot x}}{\acute{n}_h}\right] \qquad (11)$$

where $s^2_{y\cdot x}$ and s^2_y are as given on page (13) except that $s_{ih} = s$ for all i and h. We see that Equation (11) is identical to the first two terms of Equation (9) except that $\bar{x}_h$ is replaced by $\bar{x}^F_h$, and $c\sum_{h=1}^{H} m_h$ by $\acute{n}_h$.

While the assumptions used in this section will in most instances not be valid, their use results in substantially less complicated variance formula. It would be informative to compare Equations (11) and (9) using real biomass data from the Cottonwood site. If the results of the former are nearly equal to the latter using these data, then perhaps the simpler approach is sufficiently accurate.

In Appendix C we illustrate the notation used in this paper for a single harvest day in a data set.

DISCUSSION AND CONCLUSIONS

The sampling plan currently in use at the Cottonwood site, while no doubt defensible on practical and biological grounds, nevertheless creates problems in the analysis of the data, and perhaps most importantly, in determining an estimate of the variance of mean biomass.

There are basically two problem areas with the current plan: (i) the final formula for mean biomass is fairly complex, resulting in the necessity of using approximate techniques such as truncated Taylor Series expansions to estimate the variance of these estimated means, and (ii) when only two small squares are separated and weighed by species on each harvest day (the usual case) it is impossible to test the assumption used throughout this paper that the regression coefficients in the formula for mean biomass do not change over harvest days within data sets. We note, however, that it is possible to test whether the regression coefficients change from one data set to another (if there are 3 or more data sets). If this latter test indicates unchanging coefficients with time this suggests the coefficients within data sets are also relatively constant.

All results obtained in this paper assume a linear relationship between true and estimated species weights, and that regression coefficients are constant for all harvest days within a data set (assumptions A and B, page 5). Equations giving the mean biomass and approximations to the variance of this mean for each species or component are derived for three levels of generality; Cases 1, 2 and 3, respectively. An estimate of the "true" weight of each clipped plot by species or component is also given for each case. All data presently being collected at Cottonwood may be analyzed under Case 1 (equations (4) and (5)) for which c_{ih} and s_{ih} are not necessarily constant for all values of i and h within a data set. (See page 4 for definitions). If $c_{ih}=c$ and $s_{ih}=s$ for all i and h in a data set (Case 2) then equations (6) and (9) may be used; and if in addition $x^L_{ih} = x^F_{ih}$ and $\sum_{j=1}^{c} x_{ijh} = x^L_{ih}$ for all i and h (Case 3) then equations (10) and (11) are appropriate. If the conditions on c_{ih} and s_{ih} in Case 2 are fulfilled, it would be interesting to compute the formula obtained under all three cases and to note their discrepancy.

It would be desirable, obviously, to estimate the accuracy of the approximate variance formula derived here. This could be accomplished via a monte carlo computer simulation experiment. That is, for specified field and laboratory parameters the true variance could be closely approximated and compared with the results obtained using Equations (5), (9), or (11). The cost of such an endeavor would depend on how many sets of parameters were investigated and upon the accuracy desired in the monte carlo estimate of the true variance.

Finally, and perhaps most important, upper and lower bounds to the variance of mean biomass are derived for Case 1 and given in Appendix D. We can be reasonably sure that the true variance of our estimate is no larger than this upper bound and most likely no smaller than $Var(\hat{\bar{y}}_{D,h})$ given by equation (5).

APPENDIX A

$$\hat{\bar{y}}_{D,h} = \hat{\hat{\bar{y}}}_h + b_3\,(\bar{x}_h^F - \bar{x}_h^f)$$

$$= \frac{1}{n_h}\sum_{i=1}^{n_h}[\hat{\bar{y}}_h + b_2\,(x_{ih}^L - \bar{x}_h^{\ell})] + b_3\,(\bar{x}_h^F - \bar{x}_h^f)$$

$$= \hat{\bar{y}}_h + b_2\,(\frac{1}{n_h}\sum_{i=1}^{n_h} x_{ih}^L - \bar{x}_h^{\ell}) + b_3\,(\bar{x}_h^F - \bar{x}_h^f)$$

$$= \frac{1}{m_h}\sum_{i=1}^{m_h}\sum_{j=1}^{c_{ih}}[\bar{y}_{sq,h} + b_1\,(x_{ijh} - \bar{x}_{sq,h})]$$

$$+ b_2\,(\bar{x}_h^L - \bar{x}_h^{\ell}) + b_3\,(\bar{x}_h^F - \bar{x}_h^f)$$

$$= \bar{c}_h\,\bar{y}_{sq,h} + b_1\,(\bar{x}_h - \bar{c}_h\,\bar{x}_{sq,h}) + b_2\,(\bar{x}_h^L - \bar{x}_h^{\ell}) + b_3\,(\bar{x}_h^F - \bar{x}_h^f) \quad .$$

Thus, equation (3) in the text can be expressed in terms of equations (1) and (2).

APPENDIX B

$$\mathrm{Var}\,[\hat{\bar{y}}_{D,h}] = \mathrm{Var}\,[\bar{c}_h\,\bar{y}_{sq,h} + b_1\,(\bar{x}_h - \bar{c}_h\,\bar{x}_{sq,h})]$$

$$+ \mathrm{Var}\,[b_2\,(\bar{x}_h^L - \bar{x}_h^\ell)] + \mathrm{Var}\,[b_3\,(\bar{x}_h^F - \bar{x}_h^f)]$$

$$+ 2\,\mathrm{Cov}\,[\bar{c}_h\,\bar{y}_{sq,h} + b_1\,(\bar{x}_h - \bar{c}_h\,\bar{x}_{sq,h});\ b_2\,(\bar{x}_h^L - \bar{x}_h^\ell)]$$

$$+ 2\,\mathrm{Cov}\,[\bar{c}_h\,\bar{y}_{sq,h} + b_1\,(\bar{x}_h - \bar{c}_h\,\bar{x}_{sq,h});\ b_3\,(\bar{x}_h^F - \bar{x}_h^f)]$$

$$+ 2\,\mathrm{Cov}\,[b_2\,(\bar{x}_h^L - \bar{x}_h^\ell);\ b_3\,(\bar{x}_h^F - \bar{x}_h^f)] \qquad \text{(B-1)}$$

Now,

$$\mathrm{Var}\,[\bar{c}_h\,\bar{y}_{sq,h} + b_1\,(\bar{x}_h - \bar{c}_h\,\bar{x}_{sq,h})]$$

$$= \bar{c}_h^2\,\mathrm{Var}\,[\bar{y}_{sq,h} + b_1\,(\frac{\bar{x}_h}{\bar{c}_h} - \bar{x}_{sq,h})]$$

$$\approx \bar{c}_h^2\,s_{y\cdot x}^2 \left[\frac{1}{\sum\limits_{h=1}^{H}\sum\limits_{i=1}^{m_h} s_{ih}} + \frac{[\bar{x}_h - \bar{c}_h\,\bar{x}_{sq,h}]^2}{\bar{c}_h^2 \sum\limits_{h=1}^{H}\sum\limits_{i=1}^{m_h}\sum\limits_{j=1}^{s_{ih}} (x_{ijh} - \bar{x}_{sq,h})^2}\right]$$

$$+ \frac{\bar{c}_h^2\,[s_y^2 - s_{y\cdot x}^2]}{\sum\limits_{h=1}^{H}\sum\limits_{i=1}^{m_h} c_{ih}}\ , \qquad \text{(B-2)}$$

using the approximate variance formula suggested by Cochran (1963, p. 339) when sample sizes are small.

We approximate Var $[b_2 (\bar{x}_h^L - \bar{x}_h^\ell)]$ assuming b_2, $\bar{x}_h^L$ and $\bar{x}_h^\ell$ are independent. Using the Taylor Series approximation under this assumption of independence given e.g. by Hahn and Shapiro [1967, p. 231, Equation (7-6)] we obtain

$$\text{Var}\,[b_2\,(\bar{x}_h^L - \bar{x}_h^\ell)] \simeq [\bar{x}_h^L - \bar{x}_h^\ell]^2\ \text{Var}\,(b_2) + b_2^2\,[\text{Var}\,(\bar{x}_h^L) + \text{Var}\,(\bar{x}_h^\ell)] \quad . \tag{B-3}$$

In an entirely similar manner we find that

$$\text{Var}\,[b_3\,(\bar{x}_h^F - \bar{x}_h^f)] \simeq [\bar{x}_h^F - \bar{x}_h^f]^2\ \text{Var}\,(b_3) + b_3^2\,[\text{Var}\,(\bar{x}_h^F) + \text{Var}\,(\bar{x}_h^f)] \quad . \tag{B-4}$$

This is clearly a rough approximation since we know that b_2, $\bar{x}_h^L$ and $\bar{x}_h^\ell$ are not independent. The covariances between these factors, however, are unknown and doubtless quite complicated.

Each of the three covariance terms in Equation (B-1) can be expressed in terms of expected values and each of these expected values approximated by a Taylor Series expansion [Hahn and Shapiro (1967), p. 256, Equation(7B-1)]. However, under the assumption that the individual factors in each term to be approximated are independent, all three covariance terms in Equation (B-1) are zero. Since it is known that these individual factors are not independent, our rational for making this assumption is as given above; namely that the covariance terms are unknown, complicated to derive and no doubt complex in nature.

Combining Equations (B-2) and (B-4), we obtain the result given by Equation (5) in the text.

APPENDIX C

Notation summary for one harvest day.

	Numbers	Observations	Observe Mean	Predicted Values	Predicted Equation
Field Estimates All Plots	$n'_1=100$	$x^F_{1,1};x^F_{2,1};\ldots\ldots x^F_{100,1}$	$\bar{x}^F_1$	$\hat{\bar{y}}_{D,1}$	(4)
Clipped Plots	$n_1=20$	$x^F_{1,1};x^F_{2,1};\ldots x^F_{20,1}$ (Randomly Selected)	$\bar{x}^f_1$		
Lab Sack Estimates All Sacks	$n_1=20$	$x^L_{1,1};x^L_{2,1};\ldots x^L_{20,1}$	$\bar{x}^L_1$	$\hat{\hat{y}}_1;\hat{\hat{\bar{y}}}_1$	(2)
Calibration Sacks	$m_1=2$	$x^L_{8,1};x^L_{12,1}$ (Randomly Selected)	$\bar{x}^\ell_1$	$\hat{y}_{i,1};\hat{\bar{y}}_1$	
Square Estimates from Calibration Sacks All Squares-Sack 1	$c_{1,1}=8$	$x_{1,1,1};x_{1,2,1};\ldots x_{1,8,1}$			
Sack 2	$c_{2,1}=9$	$x_{2,1,1};x_{2,2,1};\ldots x_{2,9,1}$	$\bar{x}_1$	$\hat{y}_{ijh,1};\bar{y}_{sq,1}$	(1)
Calibration Squares	$s_{1,1}=1$	$x_{1,4,1}$ (Randomly Selected)			
	$s_{2,1}=1$	$x_{2,7,1}$ (Randomly Selected)	$\bar{x}_{sq,1}$		
Calibration Square Weights	$s_{1,1}=1$	$y_{1,1,1}$			
	$s_{2,1}=1$	$y_{1,2,1}$	$\bar{y}_{sq,1}$		

APPENDIX D

Upper and Lower Bounds on Equation (5)

If we express equation (4) as

$$\hat{\bar{y}}_{D,h} = T_1 + T_2 + T_3$$

where

$$T_1 = \bar{c}_h \, \bar{y}_{sq,h} + b_1(\bar{x}_h - \bar{c}_h \, \bar{x}_{sq,h}) \;,$$

$$T_2 = b_2(\bar{x}_h^L - \bar{x}_h^\ell) \;,$$

and

$$T_3 = b_3(\bar{x}_h^F - \bar{x}_h^f) \;,$$

then it is pointed out in Appendix B that $Var(\hat{\bar{y}}_{D,h})$ given by equation (5) was derived assuming $Cov(T_i, T_{i'}) = 0$ for $i, i' = 1,2,3$ $(i \neq i')$. However, an approximate upper bound to the true variance of $\hat{\bar{y}}_{D,h}$ can be obtained by assuming the correlation between each pair $(T_i, T_{i'})$, $i \neq i'$ is 1. We deonte this correlation by $\rho(T_i, T_{i'})$. Since by definition we have that

$$-1 \leq \rho(T_i, T_{i'}) = \frac{Cov(T_i, T_{i'})}{\sqrt{Var(T_i) \; Var(T_{i'})}} \leq 1 \;,$$

when $\rho(T_i, T_{i'}) = 1$, then $Cov(T_i, T_{i'}) \leq \sqrt{Var(T_i) \; Var(T_{i'})}$ which can readily be computed. Therefore an approximate upper bound to the variance of $\hat{\bar{y}}_{D,h}$ is given by

$$Var(\hat{\bar{y}}_{D,h,\text{UPPER BOUND}}) = \sum_{i=1}^{3} Var(T_i) + [Var(T_1) \; Var(T_2)]^{\frac{1}{2}}$$

$$+ [Var(T_1) \; Var(T_3)]^{\frac{1}{2}}$$

$$+ [Var(T_2) \; Var(T_3)]^{\frac{1}{2}} \;, \qquad \text{(D-1)}$$

where

$$\mathrm{Var}(T_2) = [\bar{x}_h^L - \bar{x}_h^\ell]^2 \ \mathrm{Var}(b_2) + b_2^2 \ [\mathrm{Var}(\bar{x}_h^L) + \mathrm{Var}(\bar{x}_h^\ell)] \ ,$$

$$\mathrm{Var}(T_3) = [\bar{x}_h^F - \bar{x}_h^f]^2 \ \mathrm{Var}(b_3) + b_3^2 \ [\mathrm{Var}(\bar{x}_h^F) + \mathrm{Var}(\bar{x}_h^f)] \ ,$$

and

$$\mathrm{Var}(T_1) = \mathrm{Var}(\hat{\bar{y}}_{D,h}) - \mathrm{Var}(T_2) - \mathrm{Var}(T_3)$$

where $\mathrm{Var}(\hat{\bar{y}}_{D,h})$ is given by equation (5). Similarly, a lower bound can be obtained by setting $\rho(T_i, T_{i'}) = -1$ for $i \neq i'$. In this case we have

$$\mathrm{Var}(\hat{\bar{y}}_{D,h,\text{LOWER BOUND}}) = \sum_{i=1}^{3} \mathrm{Var}(T_i) - [\mathrm{Var}(T_1)\ \mathrm{Var}(T_2)]^{\frac{1}{2}} - [\mathrm{Var}(T_1)\ \mathrm{Var}(T_3)]^{\frac{1}{2}} - [\mathrm{Var}(T_2)\ \mathrm{Var}(T_3)]^{\frac{1}{2}}$$

Since it is to be expected that the covariances $\mathrm{Cov}(T_i, T_{i'})$ are gerater than zero, the upper bound is of most importance here. We can be reasonably sure that the true variance lies somewhere between $\mathrm{Var}(\hat{\bar{y}}_{D,h})$ given by equation (5) and $\mathrm{Var}(\hat{\bar{y}}_{D,h,\text{UPPER BOUND}})$ given by equation (D-1).

REFERENCES

1. Cochran, W. G., (1963). Sampling Techniques, 2nd edition, John Wiley and Sons, New York, 413 pages.

2. Frances, R. C., Baker, C. V., Van Dyne, G. M. and Gustafson, J. F., (1971). A Study of the Weight Estimation Method of Botanical Analysis, Technical Report No. 117, Grassland Biome, U. S. International Biological Program, 147 pages.

3. Hahn, G. J. and Shapiro, S. S., (1968). Statistical Models in Engineering, John Wiley and Sons, New York, 355 pages.

4. Snedecor, G. W. and Cochran, W. G., (1967). Statistical Methods, 6th edition, The Iowa State University Press, Ames, Iowa, 593 pages.

APPENDIX C
FIELD DATA

Aboveground Herbage Data

The aboveground herbage data collected in 1971 at the Cottonwood Site are Grassland Biome data set A2U0114. The data are recorded as specified in Appendices B2 and B3. A sample listing follows.

*** EXAMPLE OF DATA ***

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


1 4 61 2 471110.50   1 10  AGSM  1  0.0         3.64                1
1 4 61 2 471110.50   1 10  AGSM  2  0.0        40.92                1
1 4 61 2 471110.50   1 10  BOGR 21  0.0          .41                1
1 4 61 2 471110.50   1 10  BOBU +2  0.0        17.52                1
1 4 61 2 471110.50   1 10  CAEL 21  0.0          .22                1
1 4 61 2 471110.50   1 10  BRJA  1  0.0          .31                1
1 4 61 2 471110.50   1 10  ARFR 41  0.0          .36                1
1 4 61 2 471110.50   1 10  MIOT  1  0.0         3.78                1
1 4 61 2 471110.50   2 10  AGSM  1  0.0         1.54                1
1 4 61 2 471110.50   2 10  AGSM  2  0.0        30.12                1
1 4 61 2 471110.50   2 10  BOBU +2  0.0        18.11                1
1 4 61 2 471110.50   2 10  CAEL 21  0.0          .18                1
1 4 61 2 471110.50   2 10  BRJA  1  0.0          .20                1
1 4 61 2 471110.50   2 10  MIOT  1  0.0         3.38                1
1 4 61 2 471110.50   3 10  AGSM  1  0.0         1.43                1
1 4 61 2 471110.50   3 10  AGSM  2  0.0        83.45                1
1 4 61 2 471110.50   3 10  BOBU +2  0.0         8.67                1
1 4 61 2 471110.50   3 10  CAEL 21  0.0          .14                1
1 4 61 2 471110.50   3 10  BRJA  1  0.0          .20                1
1 4 61 2 471110.50   3 10  MIOT  1  0.0         1.57                1
1 4 61 2 471110.50   4 10  AGSM  1  0.0         1.14                1
1 4 61 2 471110.50   4 10  AGSM  2  0.0        61.99                1
1 4 61 2 471110.50   4 10  BOBU +2  0.0         6.58                1
1 4 61 2 471110.50   4 10  CAEL 21  0.0          .16                1
1 4 61 2 471110.50   4 10  BRJA  1  0.0          .21                1
1 4 61 2 471110.50   4 10  MIOT  1  0.0         2.20                1
1 4 61 2 471110.50   5 10  AGSM  1  0.0          .49                1
1 4 61 2 471110.50   5 10  AGSM  2  0.0        10.91                1
1 4 61 2 471110.50   5 10  BOBU +2  0.0        22.98                1
1 4 61 2 471110.50   5 10  BRJA  1  0.0          .18                1
1 4 61 2 471110.50   5 10  MIOT  1  0.0          .86                1
1 4 61 2 471110.50   6 10  AGSM  1  0.0         2.11                1
1 4 61 2 471110.50   6 10  AGSM  2  0.0        70.30                1
1 4 61 2 471110.50   6 10  BOBU +2  0.0         7.80                1
1 4 61 2 471110.50   6 10  CAEL 21  0.0          .20                1
1 4 61 2 471110.50   6 10  BRJA  1  0.0          .29                1
1 4 61 2 471110.50   6 10  MIOT  1  0.0         1.40                1
1 4 61 2 471110.50   7 10  AGSM  1  0.0         1.26                1
1 4 61 2 471110.50   7 10  AGSM  2  0.0        67.58                1
1 4 61 2 471110.50   7 10  BOBU +2  0.0         9.74                1
1 4 61 2 471110.50   7 10  CAEL 21  0.0          .22                1
1 4 61 2 471110.50   7 10  BRJA  1  0.0          .30                1
1 4 61 2 471110.50   7 10  MIOT  1  0.0         1.50                1
1 4 61 2 471110.50   8 10  AGSM  1  0.0         1.30                1
1 4 61 2 471110.50   8 10  AGSM  2  0.0        40.75                1
1 4 61 2 471110.50   8 10  BOBU +2  0.0        12.19                1
1 4 61 2 471110.50   8 10  CAEL 21  0.0          .13                1
1 4 61 2 471110.50   8 10  BRJA  1  0.0          .22                1
1 4 61 2 471110.50   8 10  LOOR  1  0.0          .06                1
1 4 61 2 471110.50   8 10  SPCO  1  0.0          .02                1
```

1	4	61	2	471110.50	8	10	MIOT	1	0.0	1.07	1
1	4	61	2	471110.50	9	10	AGSM	1	0.0	1.54	1
1	4	61	2	471110.50	9	10	AGSM	2	0.0	60.22	1
1	4	61	2	471110.50	9	10	BOBU	.2	0.0	7.46	1
1	4	61	2	471110.50	9	10	CAEL	21	0.0	.19	1
1	4	61	2	471110.50	9	10	BRJA	1	0.0	.21	1
1	4	61	2	471110.50	9	10	MIOT	1	0.0	2.93	1
1	4	61	2	471110.50	10	10	AGSM	1	0.0	1.08	1
1	4	61	2	471110.50	10	10	AGSM	2	0.0	37.02	1
1	4	61	2	471110.50	10	10	BOBU	.2	0.0	4.92	1
1	4	61	2	471110.50	10	10	CAEL	21	0.0	.15	1
1	4	61	2	471110.50	10	10	BRJA	1	0.0	.20	1
1	4	61	2	471110.50	10	10	MIOT	1	0.0	3.20	1
1	4	61	3	471120.50	1	10	AGSM	1	0.0	1.03	1
1	4	61	3	471120.50	1	10	AGSM	2	0.0	19.70	1
1	4	61	3	471120.50	1	10	BOBU	.2	0.0	26.47	1
1	4	61	3	471120.50	1	10	CAEL	21	0.0	.63	1
1	4	61	3	471120.50	1	10	MIOT	1	0.0	4.28	1
1	4	61	3	471120.50	2	10	AGSM	1	0.0	1.05	1
1	4	61	3	471120.50	2	10	AGSM	2	0.0	36.18	1
1	4	61	3	471120.50	2	10	BOBU	.2	0.0	7.43	1
1	4	61	3	471120.50	2	10	CAEL	21	0.0	.49	1
1	4	61	3	471120.50	2	10	BRJA	1	0.0	.17	1
1	4	61	3	471120.50	2	10	MIOT	1	0.0	2.65	1
1	4	61	3	471120.50	3	10	AGSM	1	0.0	1.46	1
1	4	61	3	471120.50	3	10	AGSM	2	0.0	52.13	1
1	4	61	3	471120.50	3	10	BOBU	.2	0.0	10.53	1
1	4	61	3	471120.50	3	10	CAEL	21	0.0	.27	1
1	4	61	3	471120.50	3	10	BRJA	1	0.0	.24	1
1	4	61	3	471120.50	3	10	ACMI	L1	0.0	.04	1
1	4	61	3	471120.50	3	10	MIOT	1	0.0	3.64	1
1	4	61	3	471120.50	4	10	AGSM	1	0.0	.40	1
1	4	61	3	471120.50	4	10	AGSM	2	0.0	22.86	1
1	4	61	3	471120.50	4	10	BOBU	.2	0.0	11.44	1
1	4	61	3	471120.50	4	10	CAEL	21	0.0	.11	1
1	4	61	3	471120.50	4	10	BRJA	1	0.0	.14	1
1	4	61	3	471120.50	4	10	MIOT	1	0.0	1.14	1
1	4	61	3	471120.50	5	10	AGSM	1	0.0	2.03	1
1	4	61	3	471120.50	5	10	AGSM	2	0.0	67.58	1
1	4	61	3	471120.50	5	10	BOBU	.2	0.0	27.65	1
1	4	61	3	471120.50	5	10	CAEL	21	0.0	.47	1
1	4	61	3	471120.50	5	10	BRJA	1	0.0	.41	1
1	4	61	3	471120.50	5	10	MIOT	1	0.0	3.71	1
1	4	61	3	471120.50	6	10	AGSM	1	0.0	.95	1
1	4	61	3	471120.50	6	10	AGSM	2	0.0	54.34	1
1	4	61	3	471120.50	6	10	BOBU	.2	0.0	16.01	1
1	4	61	3	471120.50	6	10	CAEL	21	0.0	.29	1
1	4	61	3	471120.50	6	10	BRJA	1	0.0	.27	1
1	4	61	3	471120.50	6	10	MIOT	1	0.0	2.86	1
1	4	61	3	471120.50	7	10	AGSM	1	0.0	.46	1
1	4	61	3	471120.50	7	10	AGSM	2	0.0	37.66	1
1	4	61	3	471120.50	7	10	BOBU	.2	0.0	11.93	1
1	4	61	3	471120.50	7	10	CAEL	21	0.0	.10	1
1	4	61	3	471120.50	7	10	BRJA	1	0.0	.16	1
1	4	61	3	471120.50	7	10	MIOT	1	0.0	3.47	1
1	4	61	3	471120.50	8	10	AGSM	1	0.0	1.98	1
1	4	61	3	471120.50	8	10	AGSM	2	0.0	68.19	1
1	4	61	3	471120.50	8	10	BOBU	.2	0.0	4.40	1
1	4	61	3	471120.50	8	10	CAEL	21	0.0	.21	1
1	4	61	3	471120.50	8	10	BRJA	1	0.0	.17	1

1	4	61	3	471120.50	8	10	SPCO	1	0.0	.01	1
1	4	61	3	471120.50	8	10	ERAS	21	0.0	.29	1
1	4	61	3	471120.50	8	10	MIOT	1	0.0	2.13	1
1	4	61	3	471120.50	9	10	AGSM	1	0.0	.55	1
1	4	61	3	471120.50	9	10	AGSM	2	0.0	44.76	1
1	4	61	3	471120.50	9	10	BOBU	+2	0.0	6.30	1
1	4	61	3	471120.50	9	10	CAEL	21	0.0	.15	1
1	4	61	3	471120.50	9	10	BRJA	1	0.0	.16	1
1	4	61	3	471120.50	9	10	ERAS	21	0.0	.39	1
1	4	61	3	471120.50	9	10	MIOT	1	0.0	3.46	1
1	4	61	3	471120.50	10	10	AGSM	1	0.0	.30	1
1	4	61	3	471120.50	10	10	AGSM	2	0.0	13.26	1
1	4	61	3	471120.50	10	10	BOBU	+2	0.0	41.73	1
1	4	61	3	471120.50	10	10	CAEL	21	0.0	.24	1
1	4	61	3	471120.50	10	10	BRJA	1	0.0	.23	1
1	4	61	3	471120.50	10	10	MIOT	1	0.0	1.77	1
1	4	62	1	471610.50	1	10	AGSM	2	0.0	.46	1
1	4	62	1	471610.50	1	10	BUDA	1	0.0	.65	1
1	4	62	1	471610.50	1	10	BOGR	21	0.0	.68	1
1	4	62	1	471610.50	1	10	BOBU	+2	0.0	22.94	1
1	4	62	1	471610.50	1	10	CAEL	21	0.0	.69	1
1	4	62	1	471610.50	1	10	BRJA	1	0.0	1.81	1
1	4	62	1	471610.50	1	10	FEOC	21	0.0	.27	1
1	4	62	1	471610.50	1	10	LOOR	1	0.0	.22	1
1	4	62	1	471610.50	1	10	SPCO	1	0.0	.21	1
1	4	62	1	471610.50	2	10	AGSM	1	0.0	.04	1
1	4	62	1	471610.50	2	10	AGSM	2	0.0	.96	1
1	4	62	1	471610.50	2	10	BUDA	1	0.0	.39	1
1	4	62	1	471610.50	2	10	BOGR	21	0.0	.39	1
1	4	62	1	471610.50	2	10	BOBU	+2	0.0	5.10	1
1	4	62	1	471610.50	2	10	CAEL	21	0.0	.46	1
1	4	62	1	471610.50	2	10	BRJA	1	0.0	1.30	1
1	4	62	1	471610.50	2	10	FEOC	21	0.0	.19	1
1	4	62	1	471610.50	2	10	LOOR	1	0.0	.07	1
1	4	62	1	471610.50	2	10	SPCO	1	0.0	.23	1
1	4	62	1	471610.50	3	10	BUDA	1	0.0	.50	1
1	4	62	1	471610.50	3	10	BOGR	21	0.0	.53	1
1	4	62	1	471610.50	3	10	BOBU	+2	0.0	22.42	1
1	4	62	1	471610.50	3	10	CAEL	21	0.0	.74	1
1	4	62	1	471610.50	3	10	BRJA	1	0.0	1.65	1
1	4	62	1	471610.50	3	10	FEOC	21	0.0	.22	1
1	4	62	1	471610.50	3	10	LOOR	1	0.0	.20	1
1	4	62	1	471610.50	3	10	SPCO	1	0.0	.05	1
1	4	62	1	471610.50	4	10	BUDA	1	0.0	.44	1
1	4	62	1	471610.50	4	10	BOGR	21	0.0	.48	1
1	4	62	1	471610.50	4	10	BOBU	+2	0.0	18.13	1
1	4	62	1	471610.50	4	10	CAEL	21	0.0	.44	1
1	4	62	1	471610.50	4	10	BRJA	1	0.0	1.16	1
1	4	62	1	471610.50	4	10	FEOC	21	0.0	.17	1
1	4	62	1	471610.50	4	10	LOOR	1	0.0	.07	1
1	4	62	1	471610.50	5	10	BUDA	1	0.0	1.63	1
1	4	62	1	471610.50	5	10	CAEL	21	0.0	1.78	1
1	4	62	1	471610.50	5	10	BRJA	1	0.0	4.94	1
1	4	62	1	471610.50	5	10	FEOC	21	0.0	.75	1
1	4	62	1	471610.50	5	10	LOOR	1	0.0	1.16	1
1	4	62	1	471610.50	5	10	SPCO	1	0.0	.05	1
1	4	62	1	471610.50	5	10	OPUN	T1	0.0	3.50	1
1	4	62	1	471610.50	5	10	LICHEN	1	0.0	18.27	1
1	4	62	1	471610.50	6	10	BUDA	1	0.0	.39	1
1	4	62	1	471610.50	6	10	BOGR	21	0.0	.42	1

1	4	62	1	471610.50	6	10	BOBU +2	0.0	18.74	1
1	4	62	1	471610.50	6	10	CAEL 21	0.0	.49	1
1	4	62	1	471610.50	6	10	BRJA 1	0.0	1.17	1
1	4	62	1	471610.50	6	10	FEOC 21	0.0	.18	1
1	4	62	1	471610.50	6	10	LOOR 1	0.0	.15	1
1	4	62	1	471610.50	6	10	OPUN T1	0.0	37.47	1
1	4	62	1	471610.50	6	10	LICHEN1	0.0	.90	1
1	4	62	1	471610.50	7	10	BUDA 1	0.0	.34	1
1	4	62	1	471610.50	7	10	BOGR 21	0.0	.36	1
1	4	62	1	471610.50	7	10	BOBU +2	0.0	10.70	1
1	4	62	1	471610.50	7	10	CAEL 21	0.0	.37	1
1	4	62	1	471610.50	7	10	BRJA 1	0.0	.47	1
1	4	62	1	471610.50	7	10	FEOC 21	0.0	.15	1
1	4	62	1	471610.50	7	10	LOOR 1	0.0	.02	1
1	4	62	1	471610.50	7	10	SPCO 1	0.0	.18	1
1	4	62	1	471610.50	7	10	OPUN T1	0.0	3.53	1
1	4	62	1	471610.50	7	10	LICHEN1	0.0	.71	1
1	4	62	1	471610.50	8	10	BUDA 1	0.0	.35	1
1	4	62	1	471610.50	8	10	BOGR 21	0.0	.40	1
1	4	62	1	471610.50	8	10	BOBU +2	0.0	11.62	1
1	4	62	1	471610.50	8	10	CAEL 21	0.0	.41	1
1	4	62	1	471610.50	8	10	BRJA 1	0.0	1.09	1
1	4	62	1	471610.50	8	10	FEOC 21	0.0	.16	1
1	4	62	1	471610.50	8	10	LOOR 1	0.0	.12	1
1	4	62	1	471610.50	8	10	LICHEN1	0.0	.04	1
1	4	62	1	471610.50	9	10	BUDA 1	0.0	.26	1
1	4	62	1	471610.50	9	10	BOGR 21	0.0	.30	1
1	4	62	1	471610.50	9	10	BOBU +2	0.0	5.41	1
1	4	62	1	471610.50	9	10	CAEL 21	0.0	.19	1
1	4	62	1	471610.50	9	10	BRJA 1	0.0	.07	1
1	4	62	1	471610.50	9	10	FEOC 21	0.0	.14	1
1	4	62	1	471610.50	9	10	SPCO 1	0.0	.01	1
1	4	62	1	471610.50	9	10	OPUN T1	0.0	.03	1
1	4	62	1	471610.50	9	10	LICHEN1	0.0	.15	1
1	4	62	1	471610.50	10	10	BUDA 1	0.0	.29	1
1	4	62	1	471610.50	10	10	BOGR 21	0.0	.33	1
1	4	62	1	471610.50	10	10	BOBU +2	0.0	10.67	1
1	4	62	1	471610.50	10	10	CAEL 21	0.0	.27	1
1	4	62	1	471610.50	10	10	BRJA 1	0.0	.25	1
1	4	62	1	471610.50	10	10	FEOC 21	0.0	.18	1
1	4	62	1	471610.50	10	10	LICHEN1	0.0	.17	1
1	4	62	1	471620.50	1	10	AGSM 2	0.0	1.58	1
1	4	62	1	471620.50	1	10	BUDA 1	0.0	.25	1
1	4	62	1	471620.50	1	10	BOGR 21	0.0	.29	1
1	4	62	1	471620.50	1	10	BOBU +2	0.0	7.69	1
1	4	62	1	471620.50	1	10	CAEL 21	0.0	.22	1
1	4	62	1	471620.50	1	10	BRJA 1	0.0	.50	1
1	4	62	1	471620.50	1	10	FEOC 21	0.0	.14	1
1	4	62	1	471620.50	1	10	LOOR 1	0.0	.03	1
1	4	62	1	471620.50	1	10	SPCO 1	0.0	.02	1
1	4	62	1	471620.50	1	10	LICHEN1	0.0	.15	1
1	4	62	1	471620.50	2	10	AGSM 2	0.0	1.79	1
1	4	62	1	471620.50	2	10	BUDA 1	0.0	.25	1
1	4	62	1	471620.50	2	10	BOGR 21	0.0	.28	1
1	4	62	1	471620.50	2	10	BOBU +2	0.0	5.91	1
1	4	62	1	471620.50	2	10	CAEL 21	0.0	.22	1
1	4	62	1	471620.50	2	10	BRJA 1	0.0	1.26	1
1	4	62	1	471620.50	2	10	FEOC 21	0.0	.12	1
1	4	62	1	471620.50	2	10	LOOR 1	0.0	.04	1
1	4	62	1	471620.50	3	10	AGSM 1	0.0	.04	1

The aboveground herbage data (A2U0114) are not collected or recorded in the Standard Comprehensive Site format. To make these data as comparable as possible, each set is run through a series of regression proceedures. The resultant file is structured exactly like the standard format data, and looks as if it had been collected on Form NREL-01 (Appendix B1). The information content differs in that what is recorded as a clipped ovendry weight is actually the result of a two-step regression proceedure. The converted data are Grassland Biome data set A2U00C4; a sample listing follows.

*** EXAMPLE OF DATA ***

```
         1         2         3         4         5         6
123456789012345678901234567890123456789012345678901234567890

070104010204711101612930199.6AGSM 1  3.50
070104010204711101612930199.6BOGR 1   .40
070104010204711101612930199.6AGSM 2 40.00
070104010204711101612930199.6SHRT 2 21.00
070104010204711101612930199.6FMUL   95.60
070104010204711101612930199.6HMUL    3.10
070104010204711101612930199.6CAEL 1   .30
070104010204711101612930199.6BRJA 1   .35
070104010204711101612930199.6LCAS   18.00
070104010204711101612930199.6DCAS   11.00
070104010204711101612930199.6SOIL    2.00
070104010204711101612930199.6ARFR 1   .35
070104010204711101612930199.6MISC 1  4.00
070104010204711102611930144.6AGSM 1  1.50
070104010204711102611930144.6AGSM 2 30.00
070104010204711102611930144.6SHRT 2 24.00
070104010204711102611930144.6FMUL   55.70
070104010204711102611930144.6HMUL    3.20
070104010204711102611930144.6CAEL 1   .25
070104010204711102611930144.6BRJA 1   .15
070104010204711102611930144.6LCAS   16.00
070104010204711102611930144.6DCAS    8.70
070104010204711102611930144.6SOIL    1.20
070104010204711103611930253.3AGSM 1  1.20
070104010204711103611930253.3AGSM 2 90.00
070104010204711102611930144.6MISC 1  3.90
070104010204711103611930253.3SHRT 2  9.00
070104010204711103611930253.3FMUL  119.75
070104010204711103611930253.3HMUL    2.00
070104010204711103611930253.3CAEL 1   .15
070104010204711103611930253.3BRJA 1   .10
070104010204711103611930253.3LCAS    6.00
070104010204711103611930253.3DCAS    4.00
070104010204711103611930253.3SOIL   20.00
070104010204711103611930253.3MISC 1  1.10
070104010204711104612930186.0AGSM 1  1.00
070104010204711104612930186.0AGSM 2 70.00
070104010204711104612930186.0SHRT 2  7.00
070104010204711104612930186.0FMUL   70.55
070104010204711104612930186.0HMUL    3.00
070104010204711104612930186.0CAEL 1   .20
070104010204711104612930186.0BRJA 1   .15
070104010204711104612930186.0LCAS    9.00
070104010204711104612930186.0DCAS    5.00
070104010204711104612930186.0SOIL   18.00
070104010204711104612930186.0MISC 1  2.10
070104010204711105611930099.9AGSM 1   .40
070104010204711105611930099.9AGSM 2  5.50
070104010204711105611930099.9SHRT 2 35.00
070104010204711105611930099.9FMUL   43.25
070104010204711105611930099.9HMUL    1.10
070104010204711105611930099.9BRJA 1   .15
070104010204711105611930099.9LCAS    7.00
070104010204711105611930099.9DCAS    4.00
```

```
070104010204711105611930099.9SOIL     3.00
070104010204711105611930099.9MISC 1    .50
070104010204711106611930222.0AGSM 1   1.90
070104010204711106611930222.0AGSM 2  75.00
070104010204711106611930222.0SHRT 2   8.00
070104010204711106611930222.0FMUL   114.65
070104010204711106611930222.0HMUL     2.00
070104010204711106611930222.0CAEL 1    .25
070104010204711106611930222.0BRJA 1    .30
070104010204711106611930222.0LCAS     9.00
070104010204711106611930222.0DCAS     4.00
070104010204711106611930222.0SOIL     6.00
070104010204711106611930222.0MISC 1    .90
070104010204711107611930192.4AGSM 1   1.10
070104010204711107611930192.4AGSM 2  75.00
070104010204711107611930192.4SHRT 2  11.00
070104010204711107611930192.4FMUL    84.05
070104010204711107611930192.4HMUL     1.50
070104010204711107611930192.4CAEL 1    .30
070104010204711107611930192.4BRJA 1    .35
070104010204711107611930192.4LCAS    11.00
070104010204711107611930192.4DCAS     3.50
070104010204711107611930192.4SOIL     3.50
070104010204711107611930192.4MISC 1   1.10
070104010204711108611930155.8AGSM 1   1.20
070104010204711108611930155.8AGSM 2  43.00
070104010204711108611930155.8SHRT 2  15.00
070104010204711108611930155.8FMUL    74.04
070104010204711108611930155.8HMUL      .95
070104010204711108611930155.8CAEL 1    .15
070104010204711108611930155.8BRJA 1    .18
070104010204711108611930155.8LCAS    15.00
070104010204711108611930155.8DCAS     3.70
070104010204711108611930155.8SOIL     1.90
070104010204711108611930155.8MISC 1    .60
070104010204711108611930155.8SPCO 1    .02
070104010204711108611930155.8LOOR 1    .06
070104010204711109611930184.6AGSM 1   1.40
070104010204711109611930184.6AGSM 2  66.00
070104010204711109611930184.6SHRT 2   8.00
070104010204711109611930184.6FMUL    85.20
070104010204711109611930184.6HMUL     2.50
070104010204711109611930184.6CAEL 1    .25
070104010204711109611930184.6BRJA 1    .15
070104010204711109611930184.6LCAS    12.00
070104010204711109611930184.6DCAS     4.00
070104010204711109611930184.6SOIL     2.10
070104010204711109611930184.6MISC 1   3.00
070104010204711110611930146.4AGSM 1   1.00
070104010204711110611930146.4AGSM 2  40.00
070104010204711110611930146.4SHRT 2   5.10
070104010204711110611930146.4FMUL    59.55
070104010204711110611930146.4HMUL     3.70
070104010204711110611930146.4CAEL 1    .20
070104010204711110611930146.4BRJA 1    .15
070104010204711110611930146.4LCAS    11.00
070104010204711110611930146.4DCAS     7.00
070104010204711110611930146.4SOIL    15.00
070104010204711110611930146.4MISC 1   3.70
07010401020471110161301016.05AGSM 1    .10
07010401020471110161301016.05AGSM 2   3.00
07010401020471110161301016.05BOGR 1    .03
07010401020471110161301016.05SHRT 2   1.70
07010401020471110161301016.05FMUL     8.00
07010401020471110161301016.05HMUL      .11
07010401020471110161301016.05CAEL 1    .01
```

07010401020471110161301016.05BRJA	1	.03
07010401020471110161301016.05LCAS		1.95
07010401020471110161301016.05DCAS		.70
07010401020471110161301016.05SOIL		.10
07010401020471110161301016.05MISC	1	.30
07010401020471110161301016.05ARFR	1	.02
07010401020471110161302018.95AGSM	1	.13
07010401020471110161302018.95AGSM	2	3.75
07010401020471110161302018.95BUGR	1	.02
07010401020471110161302018.95SHRT	2	1.95
07010401020471110161302018.95FMUL		10.22
07010401020471110161302018.95HMUL		.21
07010401020471110161302018.95CAEL	1	.01
07010401020471110161302018.95BRJA	1	.01
07010401020471110161302018.95LCAS		1.00
07010401020471110161302018.95DCAS		.95
07010401020471110161302018.95SOIL		.08
07010401020471110161302018.95MISC	1	.30
07010401020471110161302018.95ARFR	1	.32
07010401020471110161303022.10AGSM	1	.20
07010401020471110161303022.10AGSM	2	4.30
07010401020471110161303022.10BUGR	1	.03
07010401020471110161303022.10SHRT	2	2.10
07010401020471110161303022.10FMUL		11.78
07010401020471110161303022.10HMUL		.27
07010401020471110161303022.10CAEL	1	.02
07010401020471110161303022.10BRJA	1	.04
07010401020471110161303022.10LCAS		1.85
07010401020471110161303022.10DCAS		1.00
07010401020471110161303022.10SOIL		.11
07010401020471110161303022.10MISC	1	.40
07010401020471110161304027.84AGSM	1	.45
07010401020471110161304027.84AGSM	2	5.30
07010401020471110161304027.84BUGR	1	.10
07010401020471110161304027.84SHRT	2	2.70
07010401020471110161304027.84FMUL		14.18
07010401020471110161304027.84HMUL		40.00
07010401020471110161304027.84CAEL	1	.04
07010401020471110161304027.84BRJA	1	.05
07010401020471110161304027.84LCAS		2.40
07010401020471110161304027.84DCAS		1.35
07010401020471110161304027.84SOIL		.20
07010401020471110161304027.84MISC	1	.55
07010401020471110161304027.84ARFR	1	.12
07010401020471110161305030.75AGSM	1	.50
07010401020471110161305030.75AGSM	2	6.00
07010401020471110161305030.75BOGR	1	.10
07010401020471110161305030.75SHRT	2	3.00
07010401020471110161305030.75FMUL		15.30
07010401020471110161305030.75HMUL		.60
07010401020471110161305030.75CAEL	1	.06
07010401020471110161305030.75BRJA	1	.09
07010401020471110161305030.75LCAS		2.75
07010401020471110161305030.75DCAS		1.40
07010401020471110161305030.75SOIL		.25
07010401020471110161305030.75MISC	1	.70
07010401020471110161306027.50AGSM	1	.47
07010401020471110161306027.50AGSM	2	5.80
07010401020471110161306027.50BUGR	1	.05
07010401020471110161306027.50SHRT	2	2.90
07010401020471110161306027.50FMUL		13.40
07010401020471110161306027.50HMUL		.39
07010401020471110161306027.50CAEL	1	.04
07010401020471110161306027.50BRJA	1	.05
07010401020471110161306027.50LCAS		2.35
07010401020471110161306027.50DCAS		1.35

07010401020471110161306027.50SOIL		.20	
07010401020471110161306027.50MISC	1	.50	
07010401020471110161307024.69AGSM	1	.43	
07010401020471110161307024.69AGSM	2	5.00	
07010401020471110161307024.69HUGR	1	.04	
07010401020471110161307024.69SHRT	2	2.62	
07010401020471110161307024.69FMUL		11.97	
07010401020471110161307024.69HMUL		.38	
07010401020471110161307024.69CAEL	1	.03	
07010401020471110161307024.69BRJA	1	.05	
07010401020471110161307024.69LCAS		2.25	
07010401020471110161307024.69DCAS		1.27	
07010401020471110161307024.69SOIL		.15	
07010401020471110161307024.69MISC	1	.50	
07010401020471110161408024.99AGSM	1	.36	.16
07010401020471110161408024.99AGSM	2	4.65	4.18
07010401020471110161408024.99HUGR	1.	.05	.05
07010401020471110161408024.99SHRT	2	3.75	3.10
07010401020471110161408024.99FMUL		11.56	11.63
07010401020471110161408024.99HMUL		1.20	1.16
07010401020471110161408024.99CAEL	1	.03	.02
07010401020471110161408024.99BRJA	1	.05	.04
07010401020471110161408024.99LCAS		1.30	1.10
07010401020471110161408024.99DCAS		1.30	1.35
07010401020471110161408024.99SOIL		.26	.24
07010401020471110161408024.99MISC	1	.48	.39
07010401020471110461401016.70AGSM	1	.09	.11
07010401020471110461401016.70AGSM	2	6.45	6.67
07010401020471110461401016.70SHRT	2	.40	.43
07010401020471110461401016.70FMUL		8.89	8.61
07010401020471110461401016.70HMUL		.20	.24
07010401020471110461401016.70CAEL	1	.01	.01
07010401020471110461401016.70BRJA	1	.01	.02
07010401020471110461401016.70LCAS		.40	.42
07010401020471110461401016.70DCAS		.15	.24
07010401020471110461401016.70MISC	1	.10	.15
07010401020471110461302017.74AGSM	1	.05	
07010401020471110461302017.74AGSM	2	7.00	
07010401020471110461302017.74SHRT	2	.70	
07010401020471110461302017.74FMUL		6.32	
07010401020471110461302017.74HMUL		.10	
07010401020471110461302017.74CAEL	1	.01	
07010401020471110461302017.74BRJA	1	.01	
07010401020471110461302017.74LCAS		.85	
07010401020471110461302017.74DCAS		.40	
07010401020471110461302017.74SOIL		2.00	
07010401020471110461302017.74MISC	1	.30	
07010401020471110461303023.32AGSM	1	.15	
07010401020471110461303023.32AGSM	2	8.60	
07010401020471110461303023.32SHRT	2	.85	
07010401020471110461303023.32FMUL		8.74	
07010401020471110461303023.32HMUL		.39	
07010401020471110461303023.32CAEL	1	.02	
07010401020471110461303023.32BRJA	1	.02	
07010401020471110461303023.32LCAS		1.15	
07010401020471110461303023.32DCAS		.65	
07010401020471110461303023.32SOIL		2.50	
07010401020471110461303023.32MISC	1	.25	
07010401020471110461304025.99AGSM	1	.20	
07010401020471110461304025.99AGSM	2	8.95	
07010401020471110461304025.99SHRT	2	1.00	
07010401020471110461304025.99FMUL		10.96	
07010401020471110461304025.99HMUL		.38	
07010401020471110461304025.99CAEL	1	.02	
07010401020471110461304025.99BRJA	1	.02	
07010401020471110461304025.99LCAS		1.15	

```
07010401020471110461304025.99DCAS      .67
07010401020471110461304025.99SOIL     2.35
07010401020471110461304025.99MISC 1    .29
07010401020471110461305031.82AGSM 1    .25
07010401020471110461305031.82AGSM 2  10.00
07010401020471110461305031.82SHRT 2   1.15
07010401020471110461305031.82FMUL    15.01
07010401020471110461305031.82HMUL      .45
07010401020471110461305031.82CAEL 1    .03
07010401020471110461305031.82BRJA 1    .03
07010401020471110461305031.82LCAS     1.25
07010401020471110461305031.82DCAS      .90
07010401020471110461305031.82SOIL     2.40
07010401020471110461305031.82MISC 1    .35
07010401020471110461306025.42AGSM 1    .20
07010401020471110461306025.42AGSM 2   9.00
07010401020471110461306025.42SHRT 2   1.10
07010401020471110461306025.42FMUL     9.66
07010401020471110461306025.42HMUL      .40
07010401020471110461306025.42CAEL 1    .03
07010401020471110461306025.42BRJA 1    .03
07010401020471110461306025.42LCAS     1.30
07010401020471110461306025.42DCAS      .80
07010401020471110461306025.42SOIL     2.60
07010401020471110461306025.42MISC 1    .30
07010401020471110461307018.32AGSM 1    .05
07010401020471110461307018.32AGSM 2   7.50
07010401020471110461307018.32SHRT 2    .80
07010401020471110461307018.32FMUL     5.68
07010401020471110461307018.32HMUL      .35
07010401020471110461307018.32CAEL 1    .02
07010401020471110461307018.32BRJA 1    .02
07010401020471110461307018.32LCAS     1.00
07010401020471110461307018.32DCAS      .35
07010401020471110461307018.32SOIL     2.30
07010401020471110461307018.32MISC 1    .25
07010401020471110461308022.05AGSM 1    .10
07010401020471110461308022.05AGSM 2   8.50
07010401020471110461308022.05SHRT 2    .85
07010401020471110461308022.05FMUL     7.49
07010401020471110461308022.05HMUL      .37
07010401020471110461308022.05CAEL 1    .02
07010401020471110461308022.05BRJA 1    .02
07010401020471110461308022.05LCAS     1.15
07010401020471110461308022.05DCAS      .65
07010401020471110461308022.05SOIL     2.65
07010401020471110461308022.05MISC 1    .25
07010401030471120161195014 5.0AGSM 1    .90
070104010304711201611950145.0AGSM 2  15.00
070104010304711201611950145.0SHRT 2  35.00
070104010304711201611950145.0FMUL    56.00
070104010304711201611950145.0HMUL     3.00
070104010304711201611950145.0CAEL 1   1.10
070104010304711201611950145.0LCAS    17.00
070104010304711201611950145.0DCAS     9.00
070104010304711201611950145.0SOIL     3.00
070104010304711201611950145.0MISC 1   5.00
070104010304711202611950119.5AGSM 1   1.00
070104010304711202611950119.5AGSM 2  40.00
070104010304711202611950119.5SHRT 2   9.00
070104010304711202611950119.5FMUL    52.00
070104010304711202611950119.5HMUL     1.50
070104010304711202611950119.5CAEL 1    .90
070104010304711202611950119.5BRJA 1    .10
070104010304711202611950119.5LCAS     8.00
070104010304711202611950119.5DCAS     2.50
```

070104010304711202611950119.5SOIL		1.00	
070104010304711202611950119.5MISC	1	3.00	
070104010304711203611950173.3AGSM	1	1.30	
070104010304711203611950173.3AGSM	2	55.00	
070104010304711203611950173.3SHRT	2	12.00	
070104010304711203611950173.3FMUL		79.96	
070104010304711203611950173.3HMUL		2.00	
070104010304711203611950173.3CAEL	1	.40	
070104010304711203611950173.3BRJA	1	.20	
070104010304711203611950173.3LCAS		14.00	
070104010304711203611950173.3DCAS		3.40	
070104010304711203611950173.3SOIL		1.10	
070104010304711203611950173.3MISC	1	3.90	
070104010304711203611950173.3ACIA	1	.04	
070104010304711204611950088.6AGSM	1	.30	
070104010304711204611950088.6AGSM	2	25.00	
070104010304711204611950088.6SHRT	2	17.00	
070104010304711204611950088.6FMUL		35.65	
070104010304711204611950088.6HMUL		.65	
070104010304711204611950088.6CAEL	1	.15	
070104010304711204611950088.6BRJA	1	.05	
070104010304711204611950088.6LCAS		6.00	
070104010304711204611950088.6DCAS		2.00	
070104010304711204611950088.6SOIL		.80	
070104010304711204611950088.6MISC	1	1.00	
070104010304711205611920210.3AGSM	1	1.90	
070104010304711205611920210.3AGSM	2	75.00	
070104010304711205611920210.3SHRT	2	35.00	
070104010304711205611920210.3FMUL		71.45	
070104010304711205611920210.3HMUL		3.00	
070104010304711205611920210.3CAEL	1	.75	
070104010304711205611920210.3BRJA	1	.60	
070104010304711205611920210.3LCAS		11.00	
070104010304711205611920210.3DCAS		6.00	
070104010304711205611920210.3SOIL		1.60	
070104010304711205611920210.3MISC	1	4.00	
070104010304711206611920178.3AGSM	1	.80	
070104010304711206611920178.3AGSM	2	60.00	
070104010304711206611920178.3SHRT	2	20.00	
070104010304711206611920178.3FMUL		73.75	
070104010304711206611920178.3HMUL		2.00	
070104010304711206611920178.3CAEL	1	.45	
070104010304711206611920178.3BRJA	1	.30	
070104010304711206611920178.3LCAS		12.00	
070104010304711206611920178.3DCAS		5.00	
070104010304711206611920178.3SOIL		1.00	
070104010304711206611920178.3MISC	1	3.00	
070104010304711207612920151.3AGSM	1	.30	.21
070104010304711207612920151.3AGSM	2	40.00	40.10
070104010304711207612920151.3SHRT	2	15.00	14.05
070104010304711207612920151.3FMUL		70.85	69.14
070104010304711207612920151.3HMUL		1.00	1.04
070104010304711207612920151.3CAEL	1	.10	.09
070104010304711207612920151.3BRJA	1	.05	.05
070104010304711207612920151.3LCAS		11.00	9.85
070104010304711207612920151.3DCAS		6.00	5.73
070104010304711207612920151.3SOIL		3.00	2.63
070104010304711207612920151.3MISC	1	4.00	3.85
070104010304711208611920184.3AGSM	1	1.90	
070104010304711208611920184.3AGSM	2	78.00	
070104010304711208611920184.3SHRT	2	4.00	
070104010304711208611920184.3FMUL		81.23	
070104010304711208611920184.3HMUL		4.00	
070104010304711208611920184.3CAEL	1	.30	
070104010304711208611920184.3BRJA	1	.05	
070104010304711208611920184.3LCAS		6.00	

```
070104010304711208611920184.30CAS      2.50
070104010304711208611920184.3SOIL      4.00
070104010304711208611920184.3MISC 1    2.00
070104010304711208611920184.3SPCO 1     .01
070104010304711208611920184.3ERAS 1     .30
070104010304711209611920149.0AGSM 1     .40
070104010304711209611920149.0AGSM 2   50.00
070104010304711209611920149.0SHRT 2    7.00
070104010304711209611920149.0FMUL     70.94
070104010304711209611920149.0HMUL      2.00
070104010304711209611920149.0CAEL 1     .20
070104010304711209611920149.0BRJA 1     .04
070104010304711209611920149.0LCAS      9.00
070104010304711209611920149.0DCAS      3.00
070104010304711209611920149.0SOIL      2.00
070104010304711209611920149.0MISC 1    4.00
070104010304711209611920149.0ERAS 1     .42
070104010304711210611920174.8AGSM 1     .10
070104010304711210611920174.8AGSM 2    6.00
070104010304711210611920174.8SHRT 2   55.00
070104010304711210611920174.8FMUL     67.65
070104010304711210611920174.8HMUL      5.00
070104010304711210611920174.8CAEL 1     .35
070104010304711210611920174.8BRJA 1     .20
070104010304711210611920174.8LCAS     25.00
070104010304711210611920174.8DCAS     11.00
070104010304711210611920174.8SOIL      3.00
070104010304711210611920174.8MISC 1    1.50
07010401030471120761301014.11AGSM 2    4.00
07010401030471120761301014.11SHRT 2    1.50
07010401030471120761301014.11FMUL      5.91
07010401030471120761301014.11HMUL       .05
07010401030471120761301014.11LCAS      1.20
07010401030471120761301014.11DCAS       .70
07010401030471120761301014.11SOIL       .35
07010401030471120761301014.11MISC 1     .40
07010401030471120761302018.16AGSM 1     .02
07010401030471120761302018.16AGSM 2    5.00
07010401030471120761302018.16SHRT 2    1.85
07010401030471120761302018.16FMUL      8.31
07010401030471120761302018.16HMUL       .10
07010401030471120761302018.16CAEL 1     .01
07010401030471120761302018.16LCAS      1.27
07010401030471120761302018.16DCAS       .75
07010401030471120761302018.16SOIL       .35
07010401030471120761302018.16MISC 1     .50
07010401030471120761303019.97AGSM 1     .03
07010401030471120761303019.97AGSM 2    5.10
07010401030471120761303019.97SHRT 2    1.90
07010401030471120761303019.97FMUL      9.77
07010401030471120761303019.97HMUL       .15
07010401030471120761303019.97CAEL 1     .01
07010401030471120761303019.97BRJA 1     .01
07010401030471120761303019.97LCAS      1.30
07010401030471120761303019.97DCAS       .75
07010401030471120761303019.97SOIL       .40
07010401030471120761303019.97MISC 1     .55
07010401030471120761304017.57AGSM 1     .01
07010401030471120761304017.57AGSM 2    4.70
07010401030471120761304017.57SHRT 2    1.70
07010401030471120761304017.57FMUL      8.38
07010401030471120761304017.57HMUL       .10
07010401030471120761304017.57LCAS      1.20
07010401030471120761304017.57DCAS       .73
07010401030471120761304017.57SOIL       .30
07010401030471120761304017.57MISC 1     .45
```

07010401030471120761405018.89AGSM	1	.04	.04
07010401030471120761405018.89AGSM	2	5.30	5.35
07010401030471120761405018.89SHRT	2	1.20	1.21
07010401030471120761405018.89FMUL		9.72	10.02
07010401030471120761405018.89HMUL		.30	.29
07010401030471120761405018.89CAEL	1	.02	.03
07010401030471120761405018.89BRJA	1	.01	.04
07010401030471120761405018.89LCAS		1.05	1.06
07010401030471120761405018.89DCAS		.40	.42
07010401030471120761405018.89SOIL		.25	.30
07010401030471120761405018.89MISC	1	.60	.64
07010401030471120761306022.50AGSM	1	.05	
07010401030471120761306022.50AGSM	2	6.00	
07010401030471120761306022.50SHRT	2	2.00	
07010401030471120761306022.50FMUL		11.01	
07010401030471120761306022.50HMUL		.12	
07010401030471120761306022.50CAEL	1	.03	
07010401030471120761306022.50BRJA	1	.03	
07010401030471120761306022.50LCAS		1.30	
07010401030471120761306022.50DCAS		.90	
07010401030471120761306022.50SOIL		.41	
07010401030471120761306022.50MISC	1	.65	
07010401030471120761307020.87AGSM	1	.03	
07010401030471120761307020.87AGSM	2	5.10	
07010401030471120761307020.87SHRT	2	2.10	
07010401030471120761307020.87FMUL		10.42	
07010401030471120761307020.87HMUL		.12	
07010401030471120761307020.87CAEL	1	.01	
07010401030471120761307020.87LCAS		1.29	
07010401030471120761307020.87DCAS		.80	
07010401030471120761307020.87SOIL		.40	
07010401030471120761307020.87MISC	1	.60	
07010401030471120761308014.87AGSM	1	.03	
07010401030471120761308014.87AGSM	2	4.90	
07010401030471120761308014.87SHRT	2	1.80	
07010401030471120761308014.87FMUL		5.62	
07010401030471120761308014.87HMUL		.10	
07010401030471120761308014.87CAEL	1	.01	
07010401030471120761308014.87LCAS		1.24	
07010401030471120761308014.87DCAS		.70	
07010401030471120761308014.87SOIL		.37	
07010401030471120761308014.87MISC	1	.10	

Belowground Biomass

The belowground biomass data were collected at the Cottonwood Site on Form NREL-03. Crown data were extracted form the aboveground biomass data for Cottonwood and added to the belowground data. The combined data have the Grassland Biome designation of A2U0024. Examples of the data and data form follow.

IBP

GRASSLAND BIOME

U.S. INTERNATIONAL BIOLOGICAL PROGRAM

FIELD DATA SHEET - BELOWGROUND BIOMASS

DATA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	QUADRAT	CORE DIAM.	HORIZON	TOP DEPTH	BOTTOM DEP.	LENGTH	WASH WT.	DRY WT.	ASH WT.	CROWN DRY WT.
			Day	Mo	Yr													
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	21-23	25-27	29	31-33	35-37	39-41	43-47	49-54	56-61	63-68

DATA TYPE
- 01 Aboveground Biomass
- 02 Litter
- 03 Belowground Biomass
- 10 Vertebrate - Live Trapping
- 11 Vertebrate - Snap Trapping
- 12 Vertebrate - Collection
- 20 Avian Flush Census
- 21 Avian Road Count
- 22 Avian Road Count Summary
- 23 Avian Collection - Internal
- 24 Avian Collection - External
- 25 Avian Collection - Plumage
- 30 Invertebrate
- 40 Microbiology - Decomposition
- 41 Microbiology - Nitrogen
- 42 Microbiology - Biomass
- 43 Microbiology - Root Decomposition
- 44 Microbiology - Respiration

SITE
- 01 Ale
- 02 Bison
- 03 Bridger
- 04 Cottonwood
- 05 Dickinson
- 06 Hays
- 07 Hopland
- 08 Jornada
- 09 Osage
- 10 Pantex
- 11 Pawnee

TREATMENT
- 1 Ungrazed
- 2 Lightly grazed
- 3 Moderately grazed
- 4 Heavily grazed
- 5 Grazed 1969, ungrazed 1970
- 6
- 7
- 8
- 9

HORIZON
- 1 AO
- 2 A
- 3 B
- 4 C

EXAMPLE OF DATA

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

0304      2 471110.50000179.8    0    0    0     1.   23.78   -0.00          1
0304JAW01047111   .50001 4.2    00   10   10     3.   29.00   28.19          1
0304JAW01047111   .50001 4.2    10   20   10     3.    7.73    7.49          1
0304JAW01047111   .50001 4.2    20   30   10     3.    7.58    7.41          1
0304JAW01047111   .50001 4.2    30   40   10     3.    7.70    7.51          1
0304JAW01047111   .50001 4.2    40   50   10     3.    7.27    7.18          1
0304JAW01047111   .50001 4.2    50   60   10     3.    7.40    7.31          1
0304      2 471110.50000279.8    0    0    0     1.   18.77   -0.00          1
0304JAW01047111   .50002 4.2    00   10   10     3.   28.14   26.67          1
0304JAW01047111   .50002 4.2    10   20   10     3.    7.54    7.26          1
0304JAW01047111   .50002 4.2    20   30   10     3.    7.37    7.22          1
0304JAW01047111   .50002 4.2    30   40   10     3.    7.45    7.34          1
0304JAW01047111   .50002 4.2    40   50   10     3.    7.62    7.54          1
0304JAW01047111   .50002 4.2    50   60   10     3.    7.40    7.30          1
0304      2 471110.50000379.8    0    0    0     1.   10.07   -0.00          1
0304JAW01047111   .50003 4.2    00   10   10     3.   28.36   27.14          1
0304JAW01047111   .50003 4.2    10   20   10     3.    7.33    7.16          1
0304JAW01047111   .50003 4.2    20   30   10     3.    7.36    7.19          1
0304JAW01047111   .50003 4.2    30   40   10     3.    7.40    7.21          1
0304JAW01047111   .50003 4.2    40   50   10     3.    7.56    7.45          1
0304JAW01047111   .50003 4.2    50   60   10     3.    7.24    7.14          1
0304      2 471110.50000479.8    0    0    0     1.   12.09   -0.00          1
0304JAW01047111   .50004 4.2    00   10   10     3.   30.00   27.90          1
0304JAW01047111   .50004 4.2    10   20   10     3.    7.90    7.47          1
0304JAW01047111   .50004 4.2    20   30   10     3.    7.82    7.47          1
0304JAW01047111   .50004 4.2    30   40   10     3.    7.96    7.76          1
0304JAW01047111   .50004 4.2    40   50   10     3.    7.76    7.60          1
0304JAW01047111   .50004 4.2    50   60   10     3.    7.52    7.39          1
0304      2 471110.50000579.8    0    0    0     1.    8.52   -0.00          1
0304JAW01047111   .50005 4.2    00   10   10     3.   33.52   31.65          1
0304JAW01047111   .50005 4.2    10   20   10     3.    7.98    7.51          1
0304JAW01047111   .50005 4.2    20   30   10     3.    7.74    7.50          1
0304JAW01047111   .50005 4.2    30   40   10     3.    7.77    7.60          1
0304JAW01047111   .50005 4.2    40   50   10     3.    7.46    7.30          1
0304JAW01047111   .50005 4.2    50   60   10     3.    7.47    7.38          1
0304      2 471110.50000679.8    0    0    0     1.   12.09   -0.00          1
0304JAW01047111   .50006 4.2    00   10   10     3.   28.23   27.60          1
0304JAW01047111   .50006 4.2    10   20   10     3.    7.58    7.38          1
0304JAW01047111   .50006 4.2    20   30   10     3.    7.58    7.38          1
0304JAW01047111   .50006 4.2    30   40   10     3.    7.57    7.45          1
0304JAW01047111   .50006 4.2    40   50   10     3.    7.59    7.49          1
0304JAW01047111   .50006 4.2    50   60   10     3.    7.34    7.28          1
0304      2 471110.50000779.8    0    0    0     1.   12.58   -0.00          1
0304JAW01047111   .50007 4.2    00   10   10     3.   27.40   25.69          1
0304JAW01047111   .50007 4.2    10   20   10     3.    7.98    7.61          1
0304JAW01047111   .50007 4.2    20   30   10     3.    7.81    7.54          1
0304JAW01047111   .50007 4.2    30   40   10     3.    7.63    7.42          1
0304JAW01047111   .50007 4.2    40   50   10     3.    7.30    7.18          1
0304JAW01047111   .50007 4.2    50   60   10     3.    7.40    7.30          1
0304      2 471110.50000879.8    0    0    0     1.   14.83   -0.00          1
0304JAW01047111   .50008 4.2    00   10   10     3.   25.92   25.20          1
0304JAW01047111   .50008 4.2    10   20   10     3.    7.49    7.36          1
0304JAW01047111   .50008 4.2    20   30   10     3.    7.37    7.28          1
0304JAW01047111   .50008 4.2    30   40   10     3.    7.31    7.24          1
0304JAW01047111   .50008 4.2    40   50   10     3.    7.32    7.24          1
0304JAW01047111   .50008 4.2    50   60   10     3.    7.31    7.25          1
0304      2 471110.50000979.8    0    0    0     1.   13.60   -0.00          1
0304JAW01047111   .50009 4.2    00   10   10     3.   29.20   28.15          1
```

0304JAW01047111	.50009 4.2	10	20	10	3.	7.60	7.43	1
0304JAW01047111	.50009 4.2	20	30	10	3.	7.33	7.23	1
0304JAW01047111	.50009 4.2	30	40	10	3.	7.31	7.23	1
0304JAW01047111	.50009 4.2	40	50	10	3.	7.44	7.39	1
0304JAW01047111	.50009 4.2	50	60	10	3.	7.27	7.23	1
0304 2 47111	0.50001079.8	0	0	0	1.	14.17	-0.00	1
0304JAW01047111	.50010 4.2	00	10	10	3.	27.93	26.99	1
0304JAW01047111	.50010 4.2	10	20	10	3.	7.47	7.34	1
0304JAW01047111	.50010 4.2	20	30	10	3.	7.48	7.34	1
0304JAW01047111	.50010 4.2	30	40	10	3.	7.52	7.35	1
0304JAW01047111	.50010 4.2	40	50	10	3.	7.90	7.71	1
0304JAW01047111	.50010 4.2	50	60	10	3.	7.28	7.20	1
0304 3 47112	0.50000179.8	0	0	0	1.	20.17	-0.00	2
0304JAW01047112	.50001 4.2	00	10	10	3.	29.12	27.98	2
0304JAW01047112	.50001 4.2	10	20	10	3.	7.75	7.43	2
0304JAW01047112	.50001 4.2	20	30	10	3.	7.46	7.29	2
0304JAW01047112	.50001 4.2	30	40	10	3.	7.41	7.28	2
0304JAW01047112	.50001 4.2	40	50	10	3.	7.47	7.37	2
0304JAW01047112	.50001 4.2	50	60	10	3.	7.47	7.36	2
0304 3 47112	0.50000279.8	0	0	0	1.	8.78	-0.00	2
0304JAW01047112	.50002 4.2	00	10	10	3.	28.28	26.62	2
0304JAW01047112	.50002 4.2	10	20	10	3.	7.65	7.39	2
0304JAW01047112	.50002 4.2	20	30	10	3.	7.54	7.36	2
0304JAW01047112	.50002 4.2	30	40	10	3.	7.43	7.35	2
0304JAW01047112	.50002 4.2	40	50	10	3.	7.40	7.33	2
0304JAW01047112	.50002 4.2	50	60	10	3.	7.44	7.34	2
0304 3 47112	0.50000379.8	0	0	0	1.	14.62	-0.00	2
0304JAW01047112	.50003 4.2	00	10	10	3.	26.38	25.19	2
0304JAW01047112	.50003 4.2	10	20	10	3.	7.65	7.45	2
0304JAW01047112	.50003 4.2	20	30	10	3.	7.46	7.26	2
0304JAW01047112	.50003 4.2	30	40	10	3.	7.42	7.29	2
0304JAW01047112	.50003 4.2	40	50	10	3.	7.33	7.24	2
0304JAW01047112	.50003 4.2	50	60	10	3.	7.50	7.46	2
0304 3 47112	0.50000479.8	0	0	0	1.	6.42	-0.00	2
0304JAW01047112	.50004 4.2	00	10	10	3.	26.92	25.46	2
0304JAW01047112	.50004 4.2	10	20	10	3.	7.41	7.20	2
0304JAW01047112	.50004 4.2	20	30	10	3.	7.72	7.54	2
0304JAW01047112	.50004 4.2	30	40	10	3.	7.50	7.41	2
0304JAW01047112	.50004 4.2	40	50	10	3.	7.69	7.60	2
0304JAW01047112	.50004 4.2	50	60	10	3.	7.41	7.35	2
0304 3 47112	0.50000579.8	0	0	0	1.	14.58	-0.00	2
0304JAW01047112	.50005 4.2	00	10	10	3.	28.94	27.91	2
0304JAW01047112	.50005 4.2	10	20	10	3.	8.10	7.71	2
0304JAW01047112	.50005 4.2	20	30	10	3.	7.59	7.40	2
0304JAW01047112	.50005 4.2	30	40	10	3.	7.76	7.54	2
0304JAW01047112	.50005 4.2	40	50	10	3.	7.77	7.60	2
0304JAW01047112	.50005 4.2	50	60	10	3.	7.61	7.51	2
0304 3 47112	0.50000679.8	0	0	0	1.	14.08	-0.00	2
0304JAW01047112	.50006 4.2	00	10	10	3.	32.42	31.32	2
0304JAW01047112	.50006 4.2	10	20	10	3.	7.90	7.62	2
0304JAW01047112	.50006 4.2	20	30	10	3.	7.77	7.53	2
0304JAW01047112	.50006 4.2	30	40	10	3.	7.59	7.39	2
0304JAW01047112	.50006 4.2	40	50	10	3.	7.59	7.43	2
0304JAW01047112	.50006 4.2	50	60	10	3.	7.46	7.36	2
0304 3 47112	0.50000779.8	0	0	0	1.	13.67	-0.00	2
0304JAW01047112	.50007 4.2	00	10	10	3.	30.66	29.90	2
0304JAW01047112	.50007 4.2	10	20	10	3.	8.16	7.95	2
0304JAW01047112	.50007 4.2	20	30	10	3.	7.32	7.16	2
0304JAW01047112	.50007 4.2	30	40	10	3.	7.68	7.51	2
0304JAW01047112	.50007 4.2	40	50	10	3.	7.37	7.27	2
0304JAW01047112	.50007 4.2	50	60	10	3.	7.16	7.07	2
0304 3 47112	0.50000879.8	0	0	0	1.	8.18	-0.00	2
0304JAW01047112	.50008 4.2	00	10	10	3.	29.58	28.79	2
0304JAW01047112	.50008 4.2	10	20	10	3.	7.28	7.12	2
0304JAW01047112	.50008 4.2	20	30	10	3.	7.57	7.41	2
0304JAW01047112	.50008 4.2	30	40	10	3.	7.21	7.10	2

0304JAW01047112 .50008 4.2	40	50	10	3.	8.21	8.13		2
0304JAW01047112 .50008 4.2	50	60	10	3.	7.61	7.53		2
0304 3 471120.50000979.8	0	0	0	1.	10.09	-0.00		2
0304JAW01047112 .50009 4.2	00	10	10	3.	29.47	28.60		2
0304JAW01047112 .50009 4.2	10	20	10	3.	7.47	7.32		2
0304JAW01047112 .50009 4.2	20	30	10	3.	7.53	7.40		2
0304JAW01047112 .50009 4.2	30	40	10	3.	7.49	7.40		2
0304JAW01047112 .50009 4.2	40	50	10	3.	7.38	7.28		2
0304JAW01047112 .50009 4.2	50	60	10	3.	7.30	7.26		2
0304 3 471120.50001079.8	0	0	0	1.	27.55	-0.00		2
0304JAW01047112 .50010 4.2	00	10	10	3.	28.93	28.06		2
0304JAW01047112 .50010 4.2	10	20	10	3.	7.39	7.28		2
0304JAW01047112 .50010 4.2	20	30	10	3.	7.59	7.43		2
0304JAW01047112 .50010 4.2	30	40	10	3.	7.53	7.41		2
0304JAW01047112 .50010 4.2	40	50	10	3.	7.23	7.11		2
0304JAW01047112 .50010 4.2	50	60	10	3.	7.28	7.22		2