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1978 HERBACEOUS PRODUCTION STUDY FOR GEOKINETICS INC.

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GEOKINETICS INC.

shale oil development and production

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1978 HERBACEOUS PRODUCTION STUDY

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INTRODUCTION

Herbaceous productivity studies on the Geokinetics Oil Shale Project Research site on Section 2, T14S, R22E, Uintah County, Utah were begun during the summer of 1978. These studies were designed to assess the amount of biomass produced by herbaceous vegetation in each of the vegetation types occurring on the site. Measurements were made in each of the control and treatment plots established for these types.

The results given in this report are those obtained from the analysis of data collected during 1978. The herbacous productivity studies are on going and will be reported again after the 1979 sampling is completed.

OBJECTIVES

The chief objective of the herbaceous productivity study is to determine the amount of herbaceous biomass that is potentially available for use by herbivores on the LOFRECO site. As such, these studies are an intergral part of determining the carrying capacity of the site. The data collected from the 1978 study will be used together with other ecological information to provide a functional description of the site. Of particular importance in this synthesis are the data obtained from shrub utilization studies, phytosociological data, and the quantitative descriptions of the physical environment derived from ecoclimatic measurements.

Herbaceous productivity will be monitored during the pre and post disturbance phases of the research site development. Monitoring will produce two types of information:

- o A record of natural trends in herbaceous productivity to be used in accounting for disturbances resulting from oil shale development versus natural perturbations due to climate or herbivore use;
- o A data base that can be employed in determining the sucess of revegetation programs on disturbed and retort sites.

A further initial objective of this program is part of the site "calibration" process used to determine the degree of difference between monitoring and development sites.

DESIGN

Herbaceous productivity sampling grids were established in each of

the control and development vegetation study plots (Figure 1). Each sampling grid consists of 100 sampling points identified by ten transects staked and labeled at each end-point. The transects are 27 meters in length. Circular quadrats measuring $0.25m^2$ were located at three meter intervals along the transects.

Herbaceous productivity measurements were made using a double sampling technique. This technique, described in detail below, consists of two segments: 1) an occular estimate and 2) a clip sample. The occular estimate is the larger sample consisting of 100 quadrats. The clip sample consists of 10 quadrats. The clip sample is adjusted in terms of the occular estimate to give a value for the entire plot.

Two samples are taken each growing season. One during approximate peak season and the other at the end of the season. The two samples were compared to show season cycling in the productivity of the herb layer.

METHODS

Prior to sampling in each grid, ten plots were selected for clipping using a random number generator. The ten quadrats selected were located along the appropriate transects, staked, and labeled. During the entire sampling program no clip quadrat is sampled more than once.

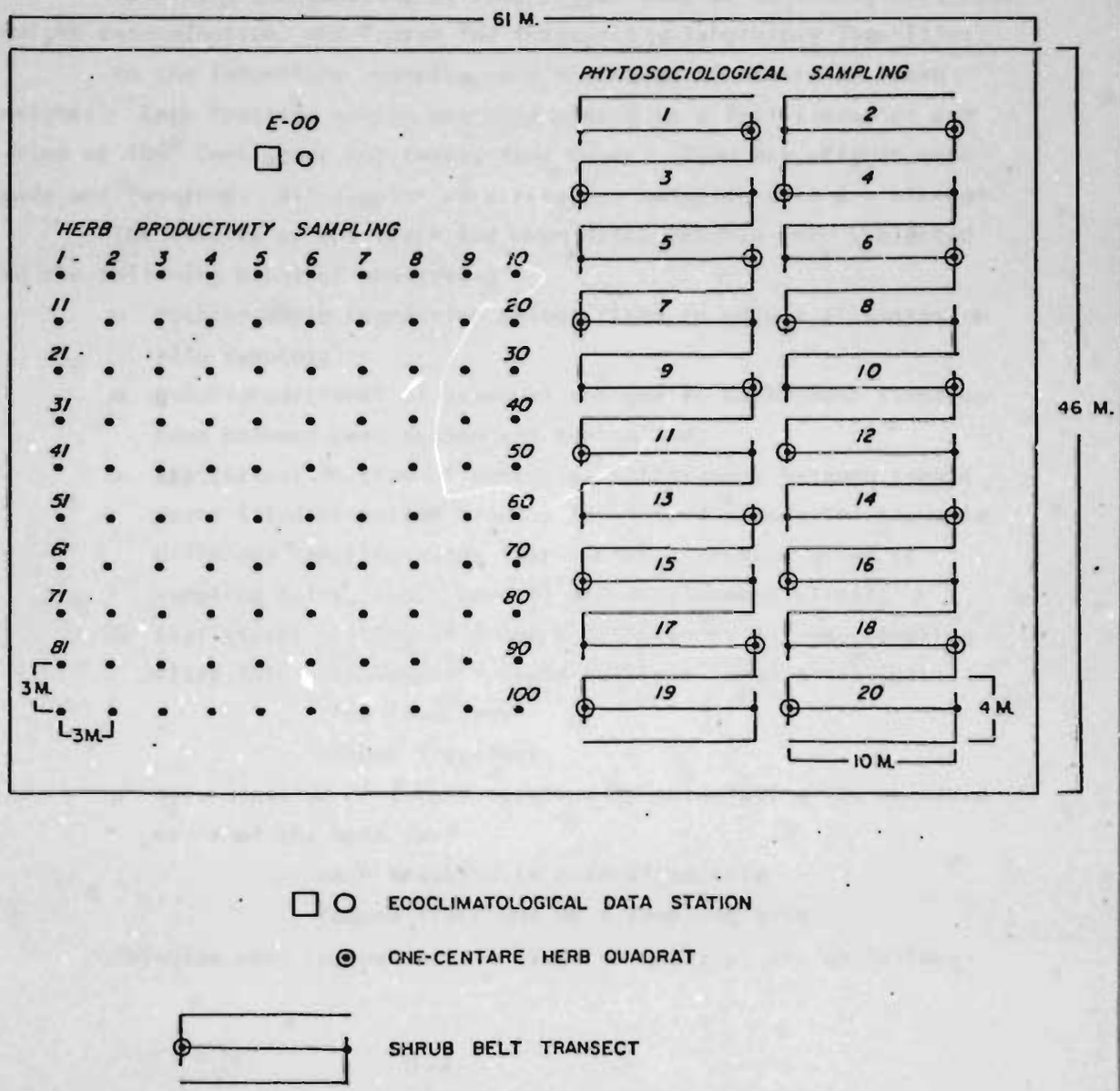
The remaining ninety plots, plus the ten clip plots were estimated occularly during the sampling. Before the occular estimate is started the estimator performs a calibration process consisting of educating himself as to the approximate weight of various fractions to be clipped. This procedure is accomplished by selecting an area outside the sample grid,estimating the various fractions occuring in the 0.25m quadrat, clipping the fractions estimated, and weighing each fraction. This procedure may be repeated as often as is necessary for the estimator to gain accuracy in occularly determining the weights of samples.

Seven fractions were clipped and estimated during the sampling:

- Annual Forbs
- Annual Grasses
- Perennial Forbs
- Perennial Grasses
- Half-Shrubs
- *Agropyron smithii*
- *Bouteloua gracilis*

FIGURE 1

VEGETATION PLOT DESIGN



Clipping was restricted to the standing-live portion of each of these fractions, except in the case of Bromus tectorum where all material was estimated and/or clipped.

During clipping each fraction was bagged and labeled. Each zip lock bag was marked with the vegetation plot number, clip quadrat number, fraction abbreviation (AF, AG, PF, PG, HS, AGSM, or BOGR), and sample date.

Occular estimations were begun with the quadrats selected for clipping Occular estimates were made by the same person throughout the sampling to ensure consistency.

Following the sampling period, bagged samples were weighed (fresh weight determination) and frozen for transport to laboratory facilities.

In the laboratory, samples were reweighed to determine fresh weights. Each fraction sample was then placed in a foil container and dried at 105° Centigrade for twenty-four hours. Oven dry weights were made and recorded. All samples were rebagged and placed in dry storage.

The results of the fresh and oven dried weights were subjected to the following kinds of analyses:

- o double-sample regression calculations to adjust estimates to clip samples;
- o graphic portrayal of seasonal changes in herbaceous standing crop between peak season and season end;
- o statistical testing of potential differences between sample means (student paired t-test) for lumped sample fractions in different sampling sites (particular attention given to sampling pairs, i.e., control and development sites);
- o statistical testing of grouped differences between sampling sites (Student- Newman - Keuls multiple range test) for:
  - . like fractions
  - . lumped fractions
- o determination of sample adequacy by calculating the standard error of the mean for:
  - . each fraction in a sampling site
  - . lumped fractions in a sampling site

Formulas used in the various types of analyses are as follows:

Double-Sample Adjustments Using Regression

$\overline{Y}_e = \overline{Y}_r + b_o (\overline{X}_e - \overline{X}_r)$; where $\overline{Y}_e$ = mean estimated plot weight weight (n=100)

$\overline{Y}_r$ = mean fresh weight of the clipped sample (n=10)

b_o = slope of the regression of y on x

$\overline{X}_e$ = mean fresh weight of the estimates (n=100)

$\overline{X}_r$ = mean fresh weight of the estimates of clipped samples (n=10)

$\overline{Y}$ as adjusted for the regression of y on x is refined according to the differences between fresh weights and dry weights as follows:

(1) G_{fw} / G_{dw} = Ratio fw:dw; where G_{fw} = fresh weight of the clipped sample (n=10)

G_{dw} = oven dry weight of the clipped sample (n=10)

(2) $\overline{Y}_e$ / fw:dw = $\overline{DW}_g$; where $\overline{DW}_g$ = mean adjusted weight of the sample

(3) $\overline{DW}_g \times 10 = \overline{DW}_{kg}$ per hectare (mean adjusted weight of the sample in kilograms per hectare)

Student Paired t-Test

$$t = \frac{n}{s}$$

Student-Newman-Keuls Multiple Range Test

$$\text{Nested } f = \frac{\text{Group Mean Squares}}{\text{Error Mean Squares}}$$

$$SE = \frac{s^2}{n}, \quad q = \frac{\overline{X}_B - \overline{X}_A}{SE}$$

Standard Error of the Mean

$$SE = \frac{s}{n}$$

where; s = standard deviation of the sample

n = sample size

$\overline{X}_{B,A}$ = mean of a sample group$_{B, A, \ldots\ldots N}$

SE = standard error

= the mean differences between paired values

s = standard deviation of the differences between paired values using N-1 weighting

RESULTS AND DISCUSSION

Oven dried weights of the fractions of each of the two samples collected during the summer of 1978 are summarized in Table 1. This table shows the results of the sample as it has been adjusted (i.e., the regression of the large sample on the small sample).

As illustrated by Table 1, the greatest amount of herbaceous biomass is found in the sagebrush-grass upland sites; the least in pinyon-juniper woodlands. These comparisons are also made graphically in Figure 2. The contribution of individual fractions to herbaceous biomass is well segregated between types. This will be discussed for each type in detail below. The major species in woodland sites is blue grama grass (Bouteloua gracilis); perennial forbs are also important in these sites. In sagebrush-saltbush lowlands, annual forbs show the most significant standing crop values. Blue grama grass and western wheatgrass (Agropyron smithii) are important species in the sagebrush-grass uplands, with half-shrubs contributing significantly also.

Figure 3 illustrates the seasonal changes that occurs in herbaceous standing crop between peak season and end of the growing season. The decrease in standing crop in the sage-brush-grass uplands, a sagebrush-saltbush lowland site, and a pinyon-juniper site is due to the decline in grass species biomass. The increases in other sites are the result of increasing amounts of annual forbs. This increase is the random result of the occurrence of these species in all sites.

Table 2 is a summary of herbaceous standing crop values constructed from the small sample (clipped plots). This table illustrates the mean oven dried biomass obtained from the actual clip samples for each plot. The table is presented as a comparison between oven dried and fresh weights. The ($\pm$) shown are the results of calculations to determine the

TABLE 1

SUMMARY OF HERBACEOUS STANDING CROP

OVEN DRY WEIGHTS
Kg/Ha

LOFRECO SITE
1978

VEGETATION PLOTS	ANNUAL FORBS	ANNUAL GRASSES	PERENNIAL FORBS	PERENNIAL GRASSES	HALF-SHRUBS	*Agropyron smithii*	*Bouteloua gracilis*	TOTAL WEIGHT PER PLOT Kg/Ha
V-10: July	0.02	--	0.71	0.001	0.31	--	5.14	6.18
September	--	--	0.66	0.001	0.06	0.001	3.27	3.99
V-11: July	1.84	--	5.84	0.15	0.001	--	0.24	8.07
September	8.54	--	3.09	0.001	0.22	--	0.22	11.85
V-20: July	0.02	--	0.38	0.39	--	--	0.02	0.81
September	0.001	--	0.59	2.00	0.02	--	0.001	2.61
V-21: July	2.90	--	3.10	1.47	0.001	0.001	1.88	9.35
September	6.05	0.01	1.19	2.64	0.41	0.03	0.89	11.22
V-30: July	69.90	--	--	0.05	0.13	--	--	70.08
September	52.80	--	--	--	0.02	--	--	52.82
V-31: July	2.73	--	0.001	0.001	0.001	0.001	1.38	4.11
September	8.45	--	0.001	0.001	0.001	--	4.32	12.77
V-40: July	0.44	2.45	4.85	0.09	20.40	8.99	8.59	45.81
September	0.31	2.31	8.59	0.42	0.001	10.60	9.48	31.71
V-41: July	2.92	9.73	12.54	0.14	59.56	36.05	12.42	133.36
September	0.24	2.91	2.51	0.77	2.16	22.86	4.79	36.24

V-10 & 11 = south-facing pinyon-juniper woodlands
V-20 & 21 = north-facing pinyon-juniper woodlands
V-30 & 31 = sagebrush-saltbush lowlands
V-40 & 41 = sagebrush-grass uplands

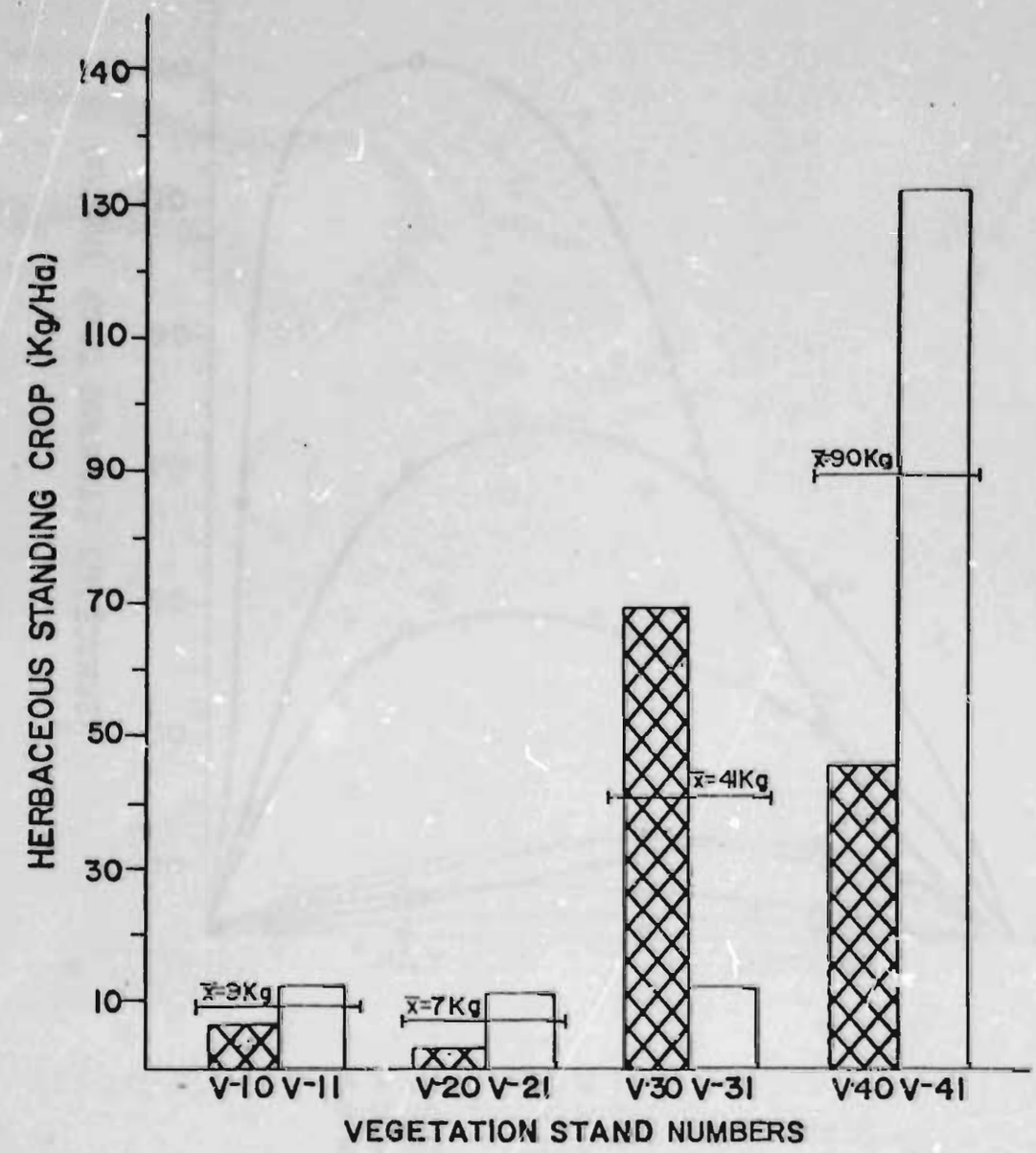


FIGURE 2

MEAN HERBACEOUS PRODUCTIVITY PER STAND
LOFRECO SITE
1978

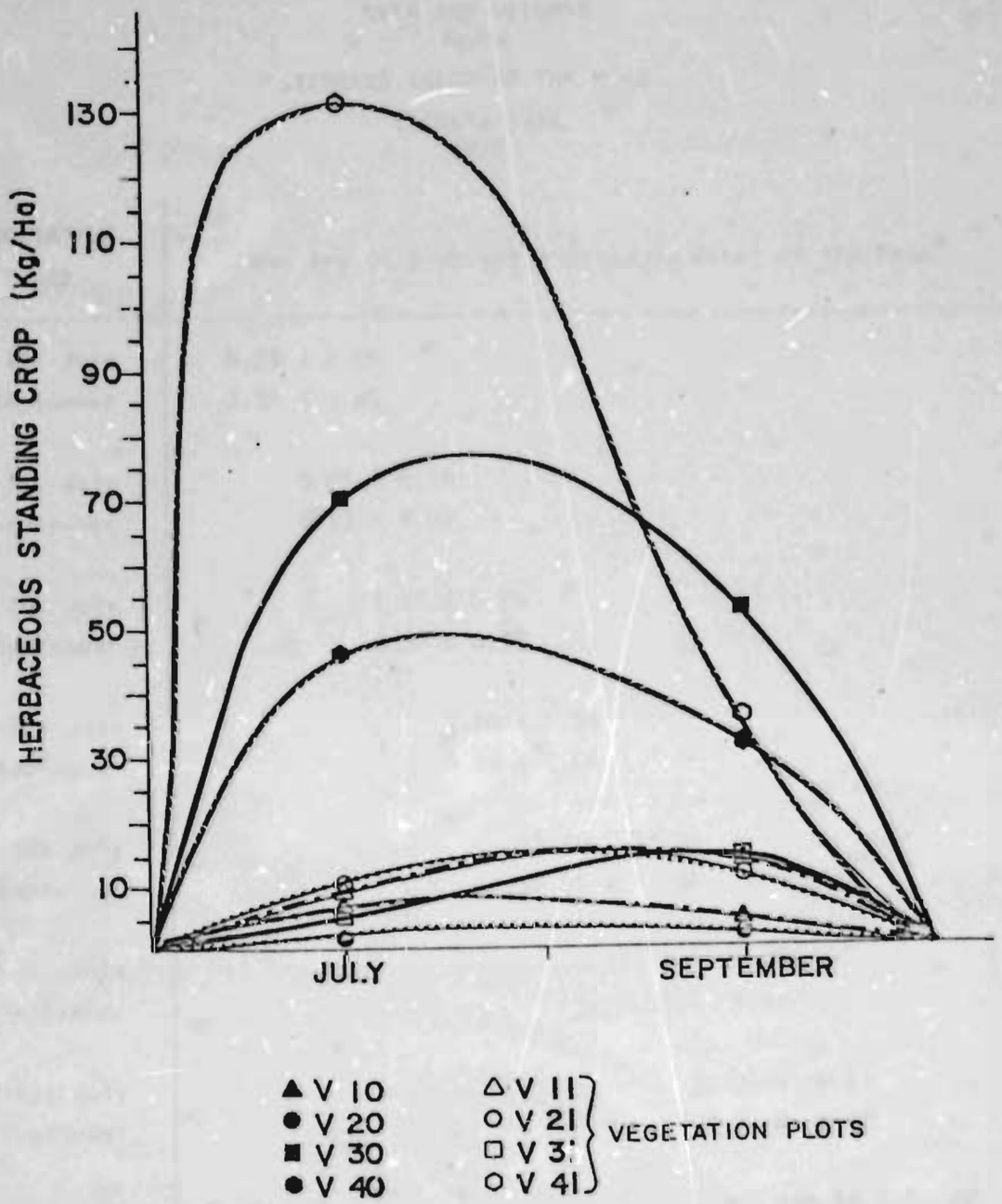


FIGURE 3

HERBACEOUS PRODUCTIVITY
LOFRECO SITE
1978

TABLE 2

SUMMARY OF HERBACEOUS STANDING CROP

SMALL SAMPLE*
OVEN DRY WEIGHTS
Kg/Ha

STANDARD ERROR OF THE MEAN

LOFRECO SITE
1978

VEGETATION PLOTS	Mean Dry Clip Weight ± Standard Error of the Mean+
V-10: July	4.93 ± 2.59
September	3.74 ± 3.35
V-11: July	9.05 ± 6.70
September	6.33 ± 4.67
V-20: July	1.12 ± 0.79
September	0.92 ± 0.79
V-21: July	8.05 ± 6.99
September	4.09 ± 3.06
V-30: July	63.89 ± 23.05
September	50.05 ± 17.36
V-31: July	17.27 ± 12.72
September	8.32 ± 8.23
V-40: July	39.94 ± 16.61
September	38.82 ± 16.58
V-41: July	105.85 ± 49.67
September	55.77 ± 17.99

*Small Sample = the actual clipped plots
+Standard Error of the Mean = standard deviation/square root of the sample size

V-10 & 11 = south-facing pinyon-juniper woodlands
V-20 & 21 = north facing pinypn-juniper woodlands
V-30 & 31 = sagebrush lowlands
V-40 & 41 = sagebrush uplands

standard error of the mean. This is a measure of the adequacy of a sample. Although this measure has been made only for the small sample and is, therefore, not a true reflection on the adequacy of the entire sample, it serves to show the effect of randomness of vegetation distribution on the herbaceous standing crop study results. This random effect is particularily true of the sample sites having a poorly-developed herbaceous understory, such as the woodland sites. The gradation in random effects is noticeable throughout the sample from the least to the most well-developed understory types: woodland -- sagebrush lowlands -- sagebrush uplands.

Standard error of the mean calculations were not performed on the large sample. The regression-based adjustments made as a part of the double-sample are not based on this type of sample adequacy measure. Sample adequacy in the double-sample is based on a ratio of total plots to clipped plots (Hilmon 1958). For other studies (Wilm, et al 1944, Hilmon 1958) this ratio varies from approxiamtely 6 estimates for each clip to 11 estimates for each clip. Our ratio of 10 estimates per each clip has been spot checked and has been shown to produce a reliable regression.

Pinyon-Juniper Woodlands

The woodland sites have the least herbaceous standing crop of all vegetation study areas on the LOFRECO site. The mean total herbaceous standing crop measured during peak season (July) was 7.15 Kg/Ha for south-facing woodland sites and 5.08 Kg/Ha for north-facing sites (Table 1). Mean total values for the growing season on these sites was 9 Kg/Ha for south-facing sites and 7 Kg/Ha for north-facing sites (Figure 2).

Standing crop on the south-facing sites is comprised chiefy of blue grama grass and perennial forb species---principally milkvetch (Astragalus spp.), fleabane daisy (Erigeron spp.), and dwarf goldenweed (Haplopappus acaulis). Annual forbs, such as stick seed (Lappula redowskii) and goosefoot (Chenopodium album) are also significant. The standing crop values on north-facing sites are contributed most by perennial grasses, predominately sedge (Carex filifolia) and perennial forbs.

The values obtained for annual forbs clipped and estimated

suggest some notable differences between the control and development sites in both the north-and south-facing types. In both cases the development sites show significantly higher values for annual forb standing crop biomass. The reasons for this difference are not directly determinable. The relationship is ostensibly one between soil factors and precipitation, but is added to by the random distribution of seed. The existence of pattern will be examined during the second year of sampling. The major importance of this difference is that it reflects dissimilarities between control and development sites that must be considered in monitoring.

Sagebrush-Saltbush Lowlands

The sagebrush-saltbush lowland sites are second in herbaceous standing crop values at means of 70.08 Kg/Ha and 4.11 Kg/Ha during the peak season sampling period (Table 1). The season mean for these sites is 41 Kg/Ha (Figure 2).

The majority of the herbaceous biomass in these sites is due to annual forbs. Predominant annual forbs include tansy mustard (*Descurainnia pinnata*) and spectacle pod (*Dithyrea wislizeni*) (Table 1). Blue grama grass is present at significant values in some samples, as are half-shrubs.

Sagebrush-Grass Uplands

The upland sites have the greatest herbaceous standing crop on the site. During peak season these sites show mean total values of 45.81 Kg/Ha and 133.36 Kg/Ha (Table 1). The seasonal mean values is 90 Kg/Ha for this type (Figure 2).

Herbaceous standing crop is made up principally of western wheatgrass (*Agropyron smithii*) and half-shrubs. Blue grama grass and perennial forbs are also important to the biomass in these sites. Cheat grass (*Bromus tectorm*) is also significant. Principal forbs include fleabane daisy,copper mallow (*Sphaeralcea coccinea*), and long-leafed phlox (*Phlox longifolia*). Indian ricegrass (*Oryzopsis hymenoides*) is the only perennial grass that contributes significantly to the herbaceous standing crop.

Site Similarities

The sites were statistically compared using a Student t-Test evaluation of differences between means. These tests were performed

using a lumped evaluation of the means determined from the various fractions. The hypothesis that all sites are equal in terms of herbaceous standing crop was accepted in all cases of site pair-wise comparisons, except plots V-20 and V-21. The null hypothesis was rejected in the case as a result of the t value being greater than ± 2.45 at the 95% confidence interval (Table 3). At lower confidence intervals --90% and 80% --- additional sample site separations occur as summarized in Table 3.

The results of the t-Test evaluation indicate a general lack of site differences based on total mean herbaceous standing crop. The results of the test at lower confidence intervals indicate some differences between types that apparently result from accounting for the sample randomness.

As a result of the similarities between means, a multiple range test was performed to elucidate those differences that are apparent from general data evaluations despite the t-Test results.

The results of the Newman-Keuls multiple range test (Table 4) illustrate the effect of ranking the means of the various herbaceous standing crop fractions and the total herbaceous standing crop for each site.

The hypothesis tested in this evaluation is that all sites are equal for all data treatments. The nested f-value generated for all data treatments is a further indication for accepting or rejecting the null hypothesis.

Comparing annual forb values by this method the null hypothesis was rejected. The multiple range evaluation shows that the differences between means are ranked as seen in Table 4. Grouped relationships are also shown in this ranking, illustrating, for example, that the greatest differences in annual forb standing crop exist between bottomland and woodland sites. In comparing annual grass values between sites the null hypothesis is accepted. This indication of similarity between sites in terms of annual grasses is further refined in the multiple range test ranking. The range shown in Table 4 indicates that upland sites are least like woodland sites. The remainder of the ranking shows a gradient between the south-facing woodlands and north-facing woodlands extending to bottomlands and to upland sites.

The analysis for perennial forbs separates bottomland sites from

TABLE 3

RESULTS OF t-TEST EVALUATION

HERBACEOUS STANDING CROP
OVEN DRY WEIGHTS
JULY
Kg/Ha

LOFRECO SITE
1978

	V-10	V-11	V-20	V-21	V-30	V-31	V-40	V-41
V-10	t=	-0.24	1.05	-0.58	-0.90	0.41	-2.14	-2.23
V-11			1.33	-0.33	-0.90	0.63	-1.81	-2.16
V-20				-2.51	-0.99	-1.09	-2.38	-2.34
V-21			R*/0.05		-0.89	1.70	-1.80	-2.12
V-30						0.98	0.31	-0.60
V-31							-2.12	-2.25
V-40	R/0.10		R/0.10			R/0.10		-2.25
V-41	R/0.10	R/0.10	R/0.10	R/0.10		R/0.10	R/0.10	

t = 0.05, (1), 6 = 2.45
0.10, (1), 6 = 1.94
0.20, (1), 6 = 1.44

H_o: $u_a = u_b$

SUMMARY OF SIGNIFICANT DIFFERENCES REJECTING H_o @ 0.05, 0.10, 0.20

10 ≠ 40 @ 0.10	20 ≠ 21 @ 0.05	31 ≠ 40 @ 0.10
10 ≠ 41 @ 0.10	20 ≠ 40 @ 0.10	31 ≠ 41 @ 0.10
---	20 ≠ 41 @ 0.10	---
11 ≠ 40 @ 0.20	---	40 ≠ 41 @ 0.10
11 ≠ 41 @ 0.10	21 ≠ 31 @ 0.20	
	21 ≠ 40 @ 0.20	
	21 ≠ 41 @ 0.10	

* R = Reject H_o
V-10 & 11 = south-facing pinyon-juniper woodlands
V-20 & 21 = north-facing pinyon-juniper woodlands
V-30 & 31 = sagebrush-saltbush lowlands
V-40 & 41 = sagebrush-grass uplands

TABLE 4

RESULTS OF STUDENT-NEWMAN-KEULS
MULTIPLE RANGE TEST

HERBACEOUS STANDING CROP
OVEN DRY WEIGHTS
JULY
Kg/Ha

LOFRECO SITE
1978

FRACTION	RANKING BY PLOT (highest mean-to-lowest mean)	NESTED F*
Annual Forbs	V-30 V-31 V-41 V-21 V-11 V-40 V-10 V-20	4.35[1] Reject H_o
Annual Grasses	V-41 V-40 V-31 V-30 V-21 V-20 V-11 V-10	1.18 Accept H_o
Perennial Forbs	V-41 V-11 V-40 V-21 V-10 V-20 V-30 V-31	1.74 Accept H_o
Perennial Grasses	V-21 V-11 V-20 V-41 V-40 V-30 V-31 V-10	0.063 Accept H_o
Half-Shrubs	V-41 V-40 V-10 V-30 V-11 V-20 V-21 V-31	1.57 Accept H_o
Agropyron smithii	V-41 V-40 V-10 V-11 V-20 V-21 V-30 V-31	6.27 Reject H_o
Bouteloua gracilis	V-41 V-40 V-10 V-21 V-11 V-31 V-20 V-30	4.66 Reject H_o
All Fractions	V-41 V-30 V-40 V-31 V-11 V-21 V-10 V-20	-9.20 Reject H_o

underlining indicates grouped similarity of means at q = q0.05,70,p
+underlining indicates grouped similarity of means at q = q0.05,49,p

*nested f=group mean squares/error mean squares
1critical f = 2.02
2critical f = 2.29
H_o = 10=11=20=21=30=31=40=41

V-10 & 11 = south-facing pinyon juniper woodlands
V-20 & 21 = north-facing pinyon-juniper woodlands
V-30 & 31 = sagebrush-saltbush lowlands
V-40 & 41 = sagebrush-grass uplands

the remaining types. Perennial grasses are indicated to be similar throughout the sites sampled. The ranking for perennial grasses reveals no strong trends among site types.

Half-shrubs are indicated to be similar throughout the sampling sites. Again in this parameter, the ranking shows random patterns among sites.

The multiple range test results for Agropyron smithii (western wheatgrass) reveal a ranking that clearly separates the two upland sites from all others. Further indications in the ranking are the internal grouping of like sites and the greatest dissmilarity (and lowest herbaceous standing crop values) of the bottomland sites.

The null hypothesis was also rejected for Bouteloua gracilis (blue grama grass) among sites. The results of the ranking for this fraction is similar to that of western wheatgrass.

The rejection of the null hypothesis for all fractions compared between sites shows a simple gradient type of range between sites. This ranking is significant because it essentially positions the sites in terms of their mean herbaceous standing crop. Upland and bottomland sites have the greatest standing crop mean values; south-and north-facing woodlands have the least mean biomass.

Several key factors important to the characterization of the herbaceous productivity of the LOFRECO site, as well as to the general description of vegetation types are apparent from the analyses presented:

1) The herbcaeous standing crop values obtained from the site are low in comparison with other available data (Table 5), although precipitation values vary.
2) Three of the fractions are the best apparent indicators of differences between vegetation types in terms of herbaceous standing crop:
    - annual forbs
    - Agropyron smithii (western wheatgrass)
    - Bouteloua gracilis (blue grama grass)

    The above three fractions are not only static indicators of type differences, but also reveal some important dynamics of these differences, particularily as this feature relates to carrying capacity relative to herbivores. For example,

TABLE 5

REGIONAL COMPARISONS

HERBACEOUS STANDING CROP
LOFRECO SITE
1978
Kg/Ha

VEGETATION TYPE	NORTHWESTERN+ COLORADO 1975	LOWER UINTAH' BASIN 1975	LOFRECO SITE 1978
Pinyon-Juiper Woodlands	219*	88	8
Sagebrush Uplands	520	510	90
Sagebrush Bottomlands	312	NO DATA	41

*measurements taken during June in each of sites are for standing live herbaceous biomass

+after C-b Shale Oil Venture, 1977

'after White River Shale Project, 1976

the higher standing crop values of the sagebrush uplands relate directly to biomass contributed by western wheatgrass, blue grama grass, and other perennial grasses, such as blue grass (Poa spp.) and needle and thread (Stipa spp.). The correspondingly low standing crop values of woodland sites relate to the absence of these fractions.

3) The differences between sites are most apparent from the analysis of the fractions that contribute to herbaceous standing crop on any given site. The fractions that are the best indicators of site differences or similarities are western wheatgrass, perennial grasses, and annual forbs. The site groupings that fall out using these fractions as a means of comparison are:

- sagebrush uplands have more similarities with woodland sites than with bottomland sites;
- bottomland sites that are dominated by annual forb biomass are well-separated from other sites on this basis.

SUMMARY AND CONCLUSIONS

Herbaceous standing crop, as determined in the eight sampling sites during the 1978 growing season, illustrates that the productivity of the herbaceous layer on the LOFRECO site is relatively low.

Among the types sampled, those sites that have the greatest importance to herbivores are those that have a substantial component of the following three fractions: (1) western wheatgrass, (2) perennial grasses, and (3) blue grama grass. It should be noted that the standing crop values obtained for blue grama grass would be expected to be substantially higher during a growing season having rainfall that more nearly approximates the mean values recorded for the area.

Annual forbs and annual grasses are an important component of the herbaceous standing crop. This is particularily true of the sagebrush bottomland sites.

Statistical tests of the mean herbaceous standing crop values for entire sites show that there is no significant difference between sites. This test is not considered to be valid because of the obvious

visual differences between the herbaceous layer in the various sites, and because of the dissimilarities in the fractions that contribute to standing crop among the sites. The failure of the t-Test in showing separations can be attributed to the sparseness and randomness of the herbaceous layer in most sites.

Further examination of the mean values by multiple range testing using fractions that predominate in various sites (annual forbs, western wheatgrass, and blue grama grass) revealed important site differences. These apparent differences were strengthened by testing sample means in groups. The combined result of both multiple range tests was generally that no two sites are significantly alike (i.e., some important differences exist between all sites). Testing also showed that sites can be grouped by differences or similarities: bottomland and upland sagebrush sites are the least alike; north and south-facing wooland sites are the most alike; and woodland and upland sagebrush sites share important similarities (such as the low importance of annual forbs).

The testing factors that tend to separate sites are also those that show site importance to herbivores for forage. Sites in which the contribution to herbaceous standing crop by the perennial grasses listed above is substantial are most important to grazing herbivores. Upland sagebrush sites are greatest in this type of importance. No inference should be made about overall habitat qualities as a direct result of herbaceous standing crop data. Other factors, such as cover and winter use, have not been considered in drawing conclusions relative to standing crop values of sites.

The low rainfall received during the summer of 1978 had a direct influence on the herbaceous growth measured. It is anticipated that all fractions sampled were decreased because of the sparseness of rainfall. It is also anticipated that measurements to be taken during the 1979 growing season will aid in the understanding between the relationship of precipitation and herbaceous standing crop. This type of comparison will also strengthen the understanding of the role of important fractions during periods of time that may be significantly influenced by natural trends.

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