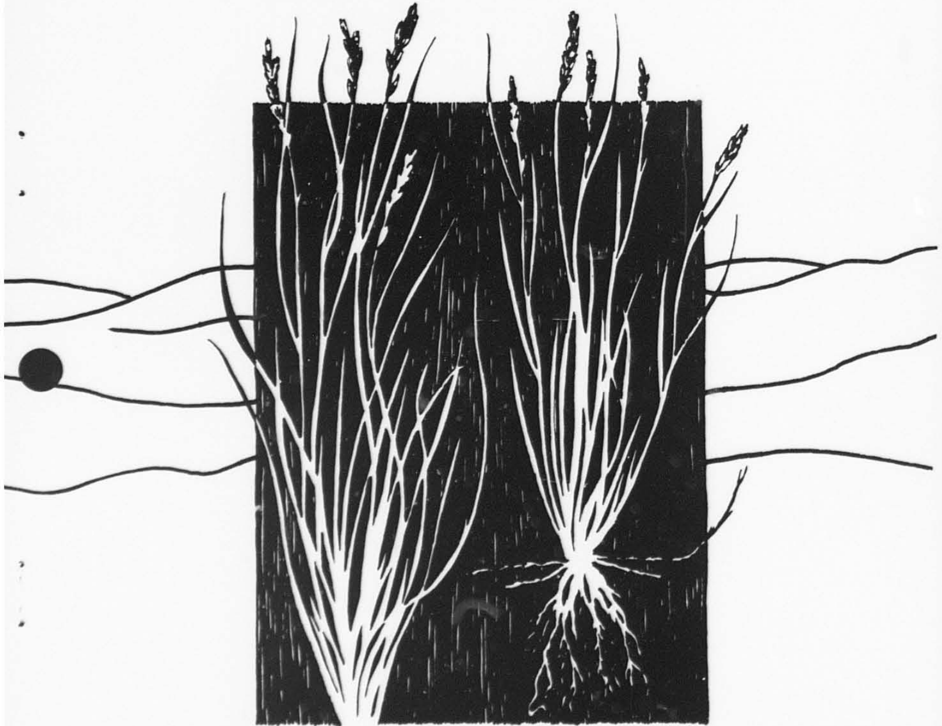
1993

Rangeland Monitoring: Analysis, Interpretation, and Evaluation

United States Bureau of Land Management

RANGELAND MONITORING



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Analysis, Interpretation, and Evaluation

TR 4400-7

1985

UNITED STATES

DEPARTMENT OF THE INTERIOR

BUREAU OF LAND MANAGEMENT

RANGELAND MONITORING

ANALYSIS, INTERPRETATION, AND EVALUATION

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1. INTRODUCTION.

The collection of monitoring data results in quantitative and qualitative information obtained from measurements or estimates of the natural resources. These data are most valuable when their meaning is defined and presented in understandable terms to the resource manager. This is the analysis, interpretation, and evaluation process. The result is the documentation of conclusions on the progress of management to accomplish specific management objectives. Such conclusions are used for management and planning purposes, and in particular, for determining management actions and establishing new or revised management objectives.

The analysis of biological information should be logical and well documented. Interpretation and evaluation are thought processes that deal with unique biological situations rather than more restrictive cookbook processes. There is no simple formula that can be used to analyze, interpret, and evaluate grazing use and its effects on the public rangeland.

2. GENERAL CONSIDERATIONS.

2.1 Frequency of Evaluations. As stated in BLM Manual 4400, schedules for analysis, interpretation, and evaluation should be based on land use decisions, grazing cycle length, allotment priorities developed through categorization, and funding levels. Schedules must also be coordinated with the renewal schedule of long-term (10-year) permits and leases.

In general, the following should guide the development of analysis, interpretation, and evaluation schedules:

2.11 Category I Allotments

a. Evaluate, prior to the third or fifth year implementation phase of grazing use decisions; thereafter to coincide with the end of the grazing cycle.

b. Evaluate at longer intervals where progress toward meeting management objectives is documented.

2.12 Category M Allotments

a. Evaluate prior to the renewal date of the term permit or lease.

b. Evaluate whenever use supervision indicates deteriorating resource conditions.

c. Evaluate as scheduled in the AMP or other management document.

2.13 Category C Allotments

Evaluate prior to the renewal date of the term permit or lease.

2.2 Intensity of Evaluation. The level of evaluation will depend upon the number of uses being monitored, the kinds and amounts of monitoring data available, the nature of the management actions being evaluated, the nature of the decisions required, and the potential for controversy. The manager must ensure that the monitoring and evaluation processes are carried out to the appropriate extent and intensity. It should be kept in mind that the success of a monitoring effort may depend upon the quality of analysis, interpretation, and evaluation that follows data collection. The best of field data are no better than the quality of the process.

2.3 Special Evaluations. Special evaluations may be warranted where monitoring data or use supervision detect a significant change in resource conditions prior to a scheduled evaluation. The analysis, interpretation, and evaluation process is the same for special evaluations as it is for scheduled evaluations.

2.4 Additional Criteria. Section 5, Evaluation, discusses important considerations and criteria pertinent to the evaluation process. Unique biological situations may require that unique criteria be applied during an evaluation.

3. ANALYSIS.

Analysis is (1) a detailed examination of anything complex in order to understand its nature or determine its essential features; or (2) a separating or breaking up of any whole into its component parts for the purpose of examining their nature, function, relationship, and so forth.

3.1 Format for Analysis. Because of the variety of monitoring data collected throughout the BLM, no single format for analysis is feasible or recommended. To facilitate the analysis of specific data, the format must be designed on a case-by-case basis. Complete documentation of the analysis is essential. The analysis may be as basic as visually comparing cover values from successive readings of trend or as complex as conducting a computer-aided analysis of variance of large amounts of data. Illustrations 1 and 2 present two formats that have proven useful for analysis. Appendix 1 describes an analytical technique for analyzing spatial data using a weighted average, and Appendix 2 describes how to analyze stocking rates.

3.2 Statistical Analysis. The proper use of statistical procedures allows probabilistic statements to be made about the data collected. Statistical tests aid the evaluator in objectively presenting and analyzing data. Any statistical procedures used should be compatible with the methods and detail required for each study. Suggested statistical references are

MONITORING DATA SUMMARY

STATE ____________

DISTRICT ____________

ALLOTMENT ____________ PASTURE ____________ RESOURCE AREA ____________

ACTUAL USE (AUMS)

19

UTILIZATION (%)

100
90
80
70
60
50
40
30
20
10

19

PRECIPITATION

19

TREND

19

19

19

MONITORING DATA SUMMARY AND INTERPRETATION

STATE ______________________
DISTRICT ______________________
RESOURCE AREA ______________________

ALLOTMENT ____________ PASTURE ____________

YEAR										
ACTUAL USE (AUMS)										
UTILIZATION										
KEY SPECIES										
WEATHER DEPARTURE FROM NORMAL/YIELD INDEX										

TREND

STUDY#	SPP	ATTRIBUTE										

MONITORING DATA SUMMARY AND INTERPRETATION – PART 2

INTERPRETATIONS : ______________________________________

EVALUATION : ______________________________________

RECOMMENDATIONS : ______________________________________

PREPARED BY : ____________________ DATE : __________
REVIEWED BY : ____________________ DATE : __________
APPROVED BY : ____________________ DATE : __________

Barrett and Nutt (1979), Freese (1962, 1967), Steel and Torrie (1960), and Zar (1974). Persons with little statistical experience should request assistance from a statistician prior to designing the sampling scheme and prior to undertaking statistical applications. A self-study statistical training package titled "The Lighter Side of Statistics" (United States Department Of The Interior, Bureau Of Land Management 1985) is available from the Service Center (D-470). The training package covers the principles of confidence, precision, confidence intervals, required sample size, and change detection.

3.3 Analysis with Computers or Programmable Calculators. Many computer programs that perform a variety of computations and statistical analysis procedures are available. For more information, contact the Denver Service Center, Division of Resource Systems (D-470). Several statistical packages that use the Statistical Package for the Social Sciences (SPSSX) (Nie et al. 1975), STATPACK, and the Biomedical Computer Programs P-Series (BMDP) (Dixon 1977) are available in the Denver Service Center. Illustration 3 describes the advantages, disadvantages, and characteristics of each statistical package.

4. INTERPRETATION.

To interpret is to explain or tell the meaning of something and present it in understandable terms. This includes interpreting individual data sets and examining their interrelationships. For example, cover and precipitation data must be interpreted individually, followed by an examination of the influence of precipitation on cover.

4.1 Interpreting Study Data. Five basic types of monitoring data are collected: actual use, estimated use, utilization, weather, and trend. Actual use, estimated use, utilization, and weather data are collected annually (or more frequently for weather data) to monitor short-term situations.

For instance, these short-term data may form the basis for a decision to implement new management practices if utilization mapping indicates that an area is receiving an unacceptable level of livestock use. New management practices may include a change in livestock distribution, a revised grazing system, range improvements, or adjustments in stocking rates. (For an example of interpreting short-term monitoring data, see Appendix 3.)

Trend studies indicate long-term trend. As trend data become available, the long-term trend effects of management actions may be more clearly assessed. Examples of local interpretations, interrelationships among long-term monitoring data, and management actions are found in Illustrations 4 and 5. Although the following discussions are by no means exhaustive, they are meant to encourage thorough, well-founded interpretations.

4.11 Actual Use Data. Interpretation of actual use data involving the number, kind and class of animal, and the period of use is fairly straight forward. Because of the general nature of actual use data, a certain amount of caution should be exercised when using these data.

COMPARISON OF THREE STATISTICAL PACKAGES - STATPACK, SPSSX, AND BMDP - AVAILABLE ON THE HONEYWELL DPS/8

CHARACTERISTIC	STATPACK	SPSSX	BMDP
Interactive	Yes	No	No
How to Access	Type "STPK"	(e.g.,) A363/SPSSXCC	(e.g.,)A363/BMDPCC
Quality of Manual	Poor	Good	Fair
Best Use of Package	Small, uncomplicated analyses	Most analyses, except the unusual	Unusual,complicated analyses
Type of Data Input	Interactive file with fixed or free format Free must have , or / as separators	File-fixed or 3 types of free format	File-fixed or 3 types of free format or FORTRAN subroutines
Will it accept non-numeric input?	No	Yes	No
Will it transform data?	Yes	Yes	Yes
Will it accept missing values or select only a subset of cases?	No	Yes	Yes
Maximum number of cases	250	Unlimited	Unlimited
Maximum number of variables	15	500	500

AN AID TO INTERPRETING LONG-TERM MONITORING DATA--AN EXAMPLE

Trend	% Utilization	Precipitation % of Normal	Possible Cause of Trend	Further Analyze	Management Changes	Comments
Up	< 40	>125	a, d	2, 3, 4	#, d	
Up	< 40	Normal	a, g	2, 3, 4	#, d	
Up	< 40	< 75	a	2, 3, 4	#, d	
Up	40 - 60	>125	a, d, g, i	4	n	primary obj.
Up	40 - 60	Normal	b, g, i	4	n	primary obj.
Up	40 - 60	< 75	b, g, i	4	n	primary obj.
Up	> 60	>125	d, g	2, 3, 4	#, d	
Up	> 60	Normal	g	1, 2, 3, 4	#, d	
Up	> 60	< 75	l	1, 2, 3, 4	#, d	
NA*	< 40	>125	h, l	1, 2, 3, 4	#, d	
NA	< 40	Normal	h	2, 3, 4	#, d	
NA	< 40	< 75	b, f, g	2, 3, 4	n	acceptable
NA	40 - 60	>125	c, h	4	n	trend should be up
NA	40 - 60	Normal	k	2, 4	n	acceptable
NA	40 - 60	< 75	b, f, g, i	2, 4	n	acceptable
NA	> 60	>125	c, h, j	2, 3, 4	#, d, s	
NA	> 60	Normal	k	2, 3, 4	#, d, s	
NA	> 60	< 75	g, l	2, 3, 4	#, d, s	
Down	< 40	>125	h, j, l	1, 2, 3, 4	s, d, k	
Down	< 40	Normal	h, j, l	1, 2, 3, 4	s, d, k	
Down	< 40	< 75	f, h, j	2, 3, 4	n	
Down	40 - 60	>125	h, j	1, 2, 4	s, d, k	
Down	40 - 60	Normal	h, j	2, 4	s, d, k	
Down	40 - 60	< 75	f, h	2, 4	s, d	
Down	> 60	>125	c, h, j	2, 3, 4	#, s, d	
Down	> 60	Normal	c, h, j	2, 3, 4	#, s, d	
Down	> 60	< 75	c, f, h, j	2, 3, 4	#, s, d	

*Not apparent

LEGEND

Possible Cause in Trend		Further Analyze	Management Changes
a. Low stocking rate	g. Good season of use mgt.	1. Key area location	# #s of livestock - uniform distribution
b. Proper stocking rate	h. Poor season of use mgt.	2. Utilization patterns	s season of use
c. High stocking rate	i. Good distribution	3. Stocking rate	d distribution
d. Favorable weather	j. Poor distribution	4. Season of use	k kind/class
e. Normal weather	k. Not apparent		n no adjustments
f. Unfavorable weather	l. Contradiction in logic		

AN AID TO INTERPRETING MONITORING DATA--AN EXAMPLE
(SINGLE PASTURE BASIS)

Evaluation Period	Livestock Distribution	Climate	Utilization Objectives	Trend Objectives	Condition Objectives	Management Actions
Interim	Good	Favorable	< AUL*	N/A	N/A	May indicate understocking. Adjust livestock numbers or period-of-use.
	Poor	Favorable	< AUL	N/A	N/A	Indicates poor distribution. Change distribution patterns through range improvements, salting, etc.
	Good	Unfavorable	> AUL	N/A	N/A	Indicates unfavorable climatic conditions. If conditions exist for more than 2 years, adjust livestock numbers or periods-of-use until climatic conditions and utilization are favorable.
	Good	Favorable	> AUL	N/A	N/A	May indicate overstocking. Adjust livestock numbers or periods-of-use.
Short-term and Long-term	Good	Favorable	< AUL	Met	Met	Indicates understocking. Adjust livestock numbers or period-of-use.
	Poor	Favorable	> AUL	Met	Met	Indicates poor distribution. Change distribution patterns through range improvements, salting, etc.
	Poor	Favorable	< AUL	Met	Met	Indicates poor distribution. Change distribution patterns.
	Good	Unfavorable	> AUL	Not Met	Not Met	Indicates unfavorable climatic conditions. If conditions exist for more than two years, adjust livestock numbers or periods-of-use until monitoring indicates conditions are more favorable.
	Good	Favorable	> AUL	Not Met	Not Met	May indicate overstocking. Adjust livestock numbers or periods-of-use.
	Good	Favorable	< AUL	Not Met	Not Met	Trend and condition objectives not being met, but for unknown reasons. Reevaluate monitoring procedures and/or intensify monitoring.

* ALLOWABLE UTILIZATION LEVEL

4.12 Utilization Data. Utilization is an important factor influencing changes in the soil, water, animal, and vegetation resources. The impact a specific intensity of use has on a plant species is highly variable depending on past and present use, period of use, duration of use, interspecific competition, weather, availablility of soil moisture for regrowth, and how these factors interact. Utilization data can be used alone to determine when livestock should be moved within an allotment and to identify livestock distribution problems. In combination with actual use and climatic data, utilization measurements on key areas and utilization pattern mapping are useful for estimating proper stocking levels under current management. Utilization studies are helpful in identifying key and problem areas, and in identifying range improvements needed to improve livestock distribution.

a. Weather Factors. Weather conditions (amount, type, and distribution of precipitation, soil and air temperature, etc.) that affect production must be considered when evaluating utilization data. Similar stocking rates on the same pasture during the same season but in different years often yield vastly different utilization levels when large fluctuations in forage production occur. Forage production estimates can be used to adjust key species utilization figures to reflect more accurately the level of utilization that could be expected in a "normal" production year at the same stocking rate (Sneva and Hyder 1962a and b, Sneva 1977). (See Appendices 3 and 4.)

The type and amount of precipitation may influence perceptions of utilization. For example, hail may cause a severely grazed appearance, or deep snow may cause unusual utilization levels on taller species.

Climatic adjustment factors should be developed on a species-by-species basis. Application of adjustment factors to species other than those for which they were originally developed must be done judiciously. Different species may not produce similarly in response to the same climatic variations.

b. Utilization Study Location. Assess utilization data to ensure that study locations are/were located in key areas, reflect utilization in the grazing area, and preferably overlay any trend and weather studies.

c. Utilization Methods Analyze methods of acquiring utilization data for accuracy, consistency, and appropriateness to the vegetation type. Utilization data acquired from utilization methods using cages should be checked to ensure that cages were moved at appropriate periods.

d. Stage of Growth/Regrowth. The phenological stage and amount of growth at the time of a utilization study affects utilization levels. Amounts of forage available early in the growing season will be less than the amount available late in the growing season. Therefore, a given stocking

level applied in the spring will produce higher utilization than in the fall. Interpretation should include a thorough assessment of season/growth/use relationships.

e. Species Utilized. Livestock often use species other than the key species. Assess utilization data for appropriateness of key species and non-key species.

f. Period of Use. The time livestock, wildlife, wild horses, or wild burros use the range affects where and what species are utilized. Forage preference of livestock changes in relationship to the animals' physiological needs, available forage, palatability of forage species, and even weather patterns. Consider the interrelationships of these factors before determining stocking levels.

g. Kind/Class of Animal. Consider the kind and class of animal when interpreting utilization patterns and levels. Generally speaking, grazing habits of kinds and classes of animals will differ in:

- distances traveled to and from water
- terrain traversed and grazed
- forage preference
- herding techniques (sheep/goats)

Consider utilization levels and patterns of wildlife also.

h. Physical and Biological Features. Physical and biological features should be included in the interpretation of utilization data. The following physical features influence the intensity and patterns of vegetation utilization:

- slope
- aspect
- topography
- soil texture
- density of brush/trees
- absence of vegetation
- height of vegetation
- amount and distribution of water

4.13 Weather Data. Normally in the monitoring program weather variables are sampled. Weather may be defined as the state of the atmosphere at a definite time and place with respect to precipitation, wind, temperature, relative humidity, evaporation, etc. Climate, on the other hand, is the average weather conditions of a place over a long period of time. Weather influences the daily fluctuation of resource production whereas climate establishes limiting factors for many plants and animals. Weather exerts a strong influence on vegetation growth, and in turn, there is a feedback influence of vegetation on microclimate. This feedback mechanism and the high variation of weather (i.e., temperature and precipitation) make interpreting vegetation/weather/climate associations difficult. Take extreme care when examining these associations to avoid confusion as to which climatic or weather elements are exerting the strongest influence on vegetation growth. Those interested in a more detailed examination of the bioclimate aspects of an ecosystem should consult Rosenberg (1974) and Oke (1978).

a. Extrapolation of Climate Studies. Because of the variability of climatic zones and plant tolerances, extrapolation of climatic data collected at one site should be applied to other sites only after careful comparison of site conditions. Comparisons should include, but are not limited to, short- and long-term precipitation and temperature patterns, vegetation composition and characteristics, and soil characteristics.

b. Climate Diagrams. Climate diagrams developed by Heinrich Walter (Walter 1979) can be used to represent climate stations graphically. These diagrams should be used for single-year and long-term average climate data. They are helpful aids in the evaluation of bioclimate controls.

(1) Climate Diagram Construction. Illustration 6 provides an example on how to construct climate diagrams.

(2) Climate Map. Placement of small climatic diagrams on a map for each climate station can be used to develop a general conception of the climatic types of the region. This map can be used to identify similar climatic sites or homoclimes.

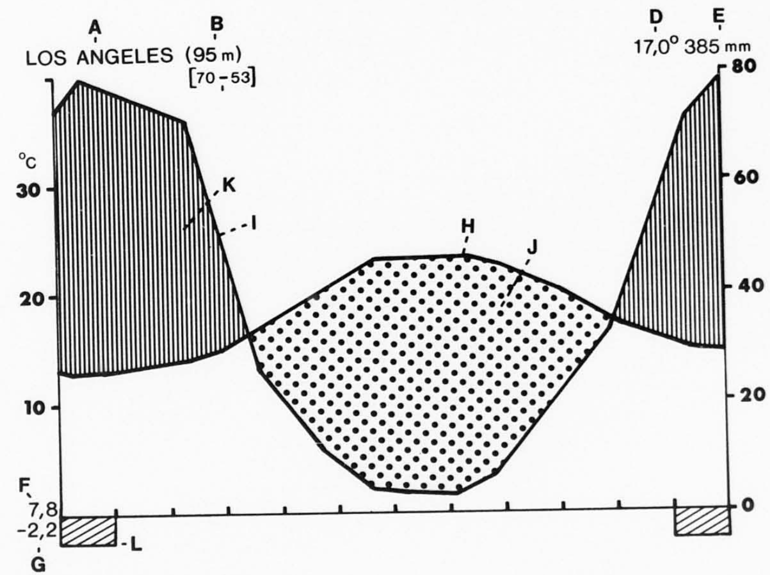
(3) Climate Diagram Interpretation. Climatic diagrams can be used to identify relative arid or humid periods, duration and severity of a cold winter, and frost-free periods (Walter 1979). Periods of drought (precipitation curve less than temperature curve) or humidity (precipitation curve greater than temperature curve) indicate only relative periods in relation to the two variables and may not represent absolute conditions.

c. Precipitation. Throughout the Western United States, precipitation will generally be the limiting factor to plant growth. Local topography and microclimate conditions can mollify or exaggerate the role of precipitation as a limiting factor to growth. Close examination of site conditions is needed to confirm the precipitation aspects of an ecosystem.

(1) Precipitation Mapping or Averaging. Precipitation seldom falls uniformly over an area. In general, precipitation increases as elevation increases. Data derived from a precipitation station may be highly variable because of the station location and its relationship to storm paths, topographic features, or other regional anomalies. Several methods are available to estimate precipitation on areas where no data were collected (Wisler and Brater 1959).

(a) Arithmetic Mean. The simplest method is to compute the mean of the precipitation recorded at the gauges surrounding the area. If stations and rainfall are uniformly distributed over an area, the results of the arithmetic mean method are fairly accurate. Mountainous,

CLIMATE DIAGRAM



Key to the climate diagram: **A**, station; **B**, height above sea level; **C**, number of years of observation (where two figures are given, the first indicates temperature and the second precipitation); **D**, mean annual temperature (in degrees Centigrade); **E**, mean annual precipitation (in millimeters); **F**, mean daily temperature minimum of the coldest month; **G**, absolute minimum temperature (lowest recorded); **H**, curve of mean monthly temperature (1 division = 10° C); **I**, curve of mean monthly precipitation (1 division = 20 mm); **J**, period of relative drought (dotted); **K**, corresponding relatively humid season (vertical shading); **L**, months with absolute minimum below 0° C (diagonally shaded) i.e., with either late or early frosts.

semiarid regions, however, are usually typified by complex precipitation patterns. Consequently, sparse and sometimes unrepresentative locations of precipitation stations yield inaccurate results for the mountainous areas.

(b) Thiessen Method. In the Thiessen method, polygons are drawn around gauge locations by constructing perpendicular bisectors between each gauge location and its neighboring gauges. The area within a polygon is considered to have had precipitation similar to its gauge. (See Illustration 7.)

(c) Isohyetal Method. The Isohyetal method involves drawing contour lines of equal precipitation based on extrapolation of values between gauges, topographic features, and storm patterns. It is likely to be more accurate than other methods where elevation differences are more pronounced. (See Illustration 8.)

(2) Effective Precipitation. More important than total precipitation received at a site is the amount received during the effective period. Effective precipitation is dependent on soil factors, vegetation growth patterns, and recent climatic conditions (temperature, previous precipitation, etc.).

(3) Precipitation Type. The precipitation type may have considerable impact on the vegetation resource. Hail, for example, can cause severe impacts on herbaceous species and because of mechanical damage, can adversely impact woody species.

d. Ambient Air Temperature. Ambient air temperature will influence the rate at which photosynthesis proceeds, as well as the initiation and cessation of vegetation growth. Under certain conditions, topographic and edaphic features can cause temperature to replace precipitation as the limiting factor to plant growth.

(1) Measurement Considerations. The time and height of measurement must be considered when analyzing temperature data. Time of measurement may reflect diurnal or seasonal changes that can alter the importance of temperature as a limiting factor to vegetation growth. Height of measurement should be considered to interpret data adequately due to a wide vertical gradient in temperatures. Ambient air temperatures may appear to limit growth at a two-meter height but not at a two-centimeter height.

(2) Maximum, Minimum, and Average Daily Air Temperatures. Maximum, minimum, and average daily air temperatures can have a high association with plant growth. The importance of these temperatures generally extends over a short time period rather than having instantaneous significance, e.g., the initiation of plant growth when minimum daily temperature is above 4° C for 15 consecutive days.

THIESSEN POLYGONS

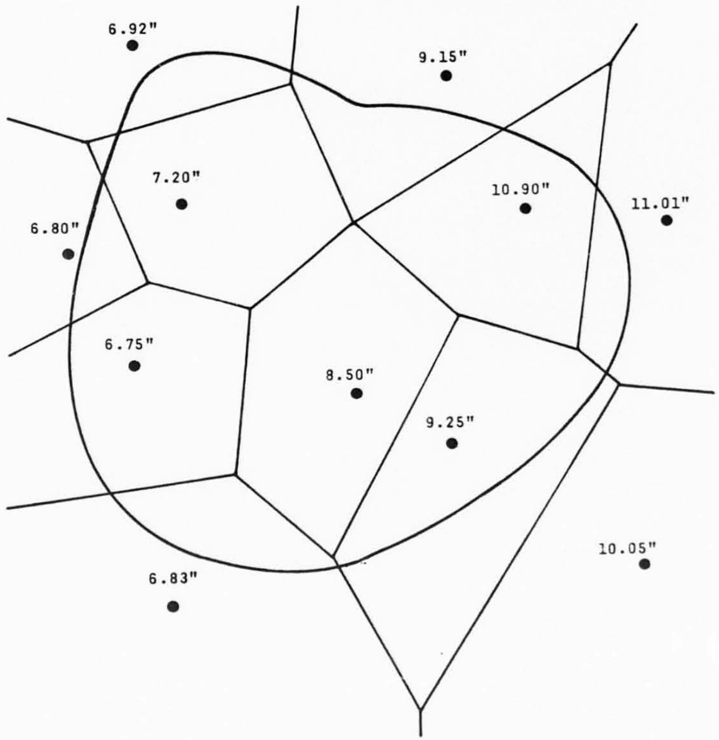
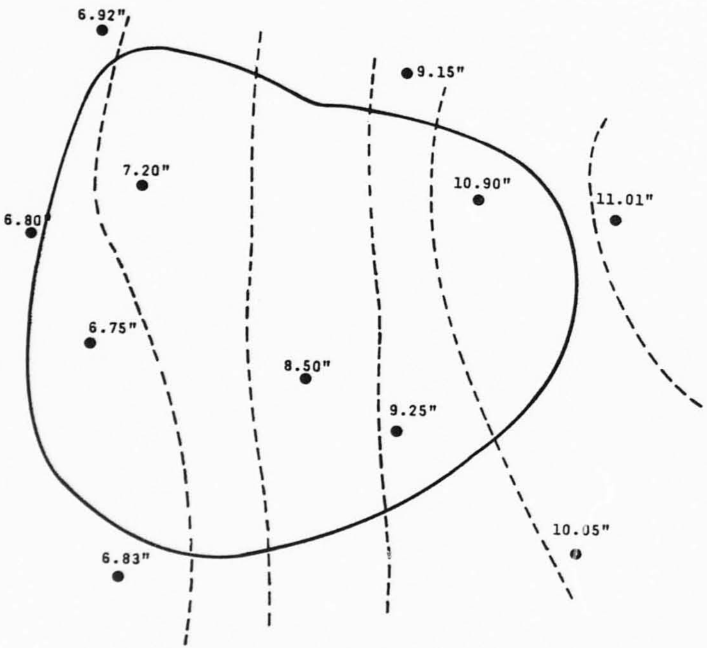


Illustration 8

ISOHYETS (CONTOURS OF EQUAL RAINFALL)



(a) Dual Interpretation. Temperature measurements may reflect energetic and/or hydrologic conditions; consequently, care must be taken to properly interpret temperature effects. (For example, temperature may be identified as the factor initiating summer dormancy, when in fact a lack of moisture resulting in higher air temperatures is the key factor.)

(3) Frost. The occurrence of frost can affect the total aboveground net primary production and species composition of a site. The effect of frost is species dependent; temperatures may only need to approach zero (°C) in some cases, whereas in other cases the temperatures may need to go well below zero (°C) to affect a plant. The consistent occurrence (several years in a row) of an abnormally late spring frost, or the lack of a late spring frost where one normally occurs, will affect trend by increasing or restricting the number of possible species and aboveground net primary production for a site.

e. Wind. Wind influences a number of biological and physical factors in an ecosystem including evapotranspiration, growth form, standing crop, and vegetation distribution patterns. Wind conditions should be considered when selecting key areas, analyzing utilization data, or estimating standing crop.

(1) Wind Lodging and Breakage. Lodging or breakage of vegetation will reduce the standing crop and may give the appearance of livestock utilization. The movement of litter or recent dead material onto or out of a site by wind movement can affect the trend and cover values depending on the measurement methods used.

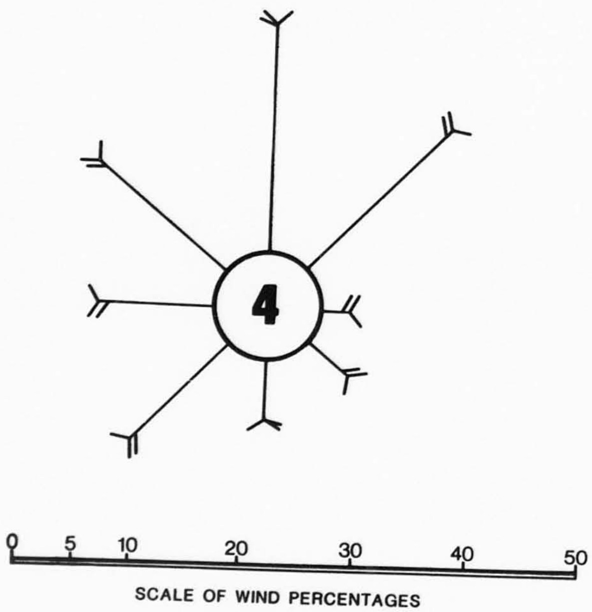
(2) Wind Patterns. High wind patterns will affect the distribution of livestock and wildlife, which in turn affects utilization patterns. The effects of wind patterns are seasonal and can influence animal distributions in opposite ways through the course of a year.

(a) Wind Rose. Wind patterns can be depicted and interpreted by constructing a wind rose for either daily, weekly, monthly, or annual wind patterns. A wind rose is constructed by placing arrows around a circle at the compass points from which the wind blew. The length of the arrow is proportional to the percent of time (for the specified time period) the wind blew from that direction. The value in the center of the circle is the percent of time the winds were calm. The number of compass points used is dependent on the user's needs. Generally, a minimum of eight compass points are used. (See Illustration 9.)

f. Soil Temperature. Soil temperatures play an important role in the germination and establishment of plant seedlings and the initiation of spring growth. As with air temperatures, soil temperatures must be analyzed in light of the time of measurement and the depth of measurement to interpret the data adequately.

Illustration 9

A WIND ROSE



(1) Plotting Soil Temperature. Due to seasonal and diurnal fluctuations, soil temperatures should be plotted over time with each curve labeled as to depth of measurement.

(2) Maximum, Minimum, and Average Daily Soil Temperatures. Maximum, minimum, and average daily soil temperatures have a strong association with seedling germination and breaking of winter dormancy. The importance of these temperatures generally extends over a short time period rather than having instantaneous significance.

g. Other Climatic Factors. Climatic elements such as soil moisture, evapotranspiration rate, relative humidity, dew point temperature, and others can each influence vegetation growth depending on the conditions. Because of the interdependence of climatic elements, it is important to critically evaluate the assumed importance of an element so that significance can be attributed to the initial element itself and is not just a reflection of other factors.

h. Limiting Factors. Limiting factors to vegetation growth should be determined whenever possible to gain a clear understanding of the microclimate and/or mesoclimate.

4.14 Trend Data. Interpret changes in the kind, proportion, or amount of plant species on a site as trend in ecological status or resource value rating. Determination of trend is evidence as to whether or not present management is resulting in changes toward or away from management objectives for vegetation and/or soils. This determination includes assessment of the direction and degree of change, as well as what caused the change.

Many different types and amounts of study data are collected to monitor trend. (See Technical Reference 4400-4 for information on trend study techniques.) Therefore, no single "step-by-step" procedure for analyzing and interpreting trend data is recommended. The following suggested references are examples of techniques employed to analyze and interpret changes in range vegetation: Grieg-Smith (1964), Harniss and Murray (1973), Tueller and Blackburn (1974), Schmutz and Smith (1976), Tausch and Tueller (1977), Miller et al. (1980), and Anderson and Holte (1981).

a. Density. Density is the number of individuals or stems per unit area. Density measurements are best suited to vegetation that occurs as discrete stems, rosettes, or clumps. The vegetation attribute of density is difficult to sample and interpret for vegetation with indiscrete units (e.g., sod grasses) and is particularly tedious where large numbers of small individuals occur. Density data are particularly valuable in studying population dynamics (the changes that take place during the life of a population) and in making intraspecific comparisons when density data are recorded by age class. When used in conjunction with other types of data, density also provides information on spatial relations between individuals, species, and vigor of species (USDA, Forest Service 1959, Daubenmire 1968).

(1) Density and Climatic Influence. Density of a perennial species is minimally affected by yearly climatic fluctuations; this feature gives particular value to the use of density to assess vegetation change and its relationship to management actions. Density of established plants provides one of the best measures of seedling establishment and survival. Density of annuals is strongly correlated with climatic conditions, particularly those that affect germination and seedling survival.

(2) Density and Vegetatively Reproducing Species. Density is difficult to assess on species that reproduce vegetatively because of the indistinctness of individual plants. For these species, density must be described as stems per unit area (e.g., 12,000 stems/acre).

b. Frequency. Frequency is the percentage of occurrence of a species in a series of samples of uniform size. Frequency is a spatial property strongly reflecting the distribution and relative abundance of a species in a community.

Analyzed differences in rooted frequencies of individual species may be interpreted as changes in the number of established individuals or as changes in the basal size of the individuals. Indications that individuals of the species did not significantly increase in size would signify that change in frequency is due to a variation in the number of established individuals, and vice versa. Frequency changes may also be due to species entering or leaving the sampling area. To be meaningful for interpretation of trend, the same plot size must have been utilized for successive readings, and frequency values should have fallen in a range of 20 to 80 percent for sampling sensitivity. Although a detected change in frequency may not be directly correlated to a specific change in density, cover, or yield, it may be used as a "Red Flag" to indicate that a real change has occurred. A limitation of frequency is that it cannot be interpreted to indicate a specific amount or the specific property of change in a species unless additional information is available (Society for Range Management 1983).

Frequency data may be compared by examining overlap of computed confidence intervals (See 3.2 [Lighter Side of Statistics]). Tables of confidence intervals for sample sizes of 100 and 200 are presented in Illustrations 10 and 11, respectively. These tables should only be used for gross interpretations. Statistically accurate confidence intervals must be calculated using specific values and confidence levels.

The size of the sampling unit (or frame) influences the probability that a species will be encountered in a frequency study. The smaller the sampling unit, the less chance of a species occurring in it. Likewise, the larger the sampling unit, the greater chance of a species occurring in it. Heterogeneous communities require more sampling than homogeneous ones and sparse cover more than dense. Changing plot size between readings invalidates direct data comparison . Some situations may require use of different sampling frame sizes on the same transect due to large differences in abundance and

CONFIDENCE INTERVALS FOR BINOMIAL POPULATIONS--100 QUADRATS

Approximate 95% and 80% confidence intervals for percentage frequency observed for 100 quadrats. Confidence intervals were calculated as:

$$\sqrt{\frac{pq}{100}}\ t_{\alpha(2)99}\ ;\ \text{where } t_{.95} = 1.98 \text{ and } t_{.80} = 1.29$$

Freq. %	Conf. P=.95 %	Inter. P=.80 %	Freq. %	Conf. P=.95 %	Inter. P=.80 %	Freq. %	Conf. P=.95 %	Inter. P=.80 %	Freq. %	Conf. P=.95 %	Inter. P=.80 %
0	0-4	0-2									
1	0-5	0-4	26	17-35	20-32	51	41-61	45-57	76	68-84	70-82
2	0-7	1-5	27	18-36	21-33	52	42-62	46-58	77	69-85	72-82
3	1-8	1-6	28	19-37	22-34	53	43-63	47-59	78	70-86	73-83
4	1-10	2-8	29	20-38	23-35	54	44-64	48-60	79	71-87	74-84
5	2-11	2-9	30	21-39	24-36	55	45-65	49-61	80	72-88	75-85
6	2-12	3-10	31	22-40	25-37	56	46-66	50-62	81	73-89	76-86
7	3-13	4-11	32	23-41	26-38	57	47-67	51-63	82	74-90	77-87
8	3-14	4-12	33	24-42	27-39	58	48-68	52-64	83	76-90	78-88
9	4-15	5-13	34	25-43	28-40	59	49-69	53-65	84	77-91	79-89
10	4-16	6-14	35	26-44	29-41	60	50-70	54-66	85	78-92	80-90
11	5-17	7-15	36	26-46	30-42	61	51-71	55-67	86	79-93	82-90
12	6-18	8-16	37	27-47	31-43	62	52-72	56-68	87	80-94	83-91
13	6-20	9-17	38	28-48	32-44	63	53-73	57-69	88	82-94	84-92
14	7-21	10-18	39	29-49	33-45	64	54-74	58-70	89	83-95	85-93
15	8-22	10-20	40	30-50	34-46	65	56-74	59-71	90	84-96	86-94
16	9-23	11-21	41	31-51	35-47	66	57-75	60-72	91	84-96	87-95
17	10-24	12-22	42	32-52	36-48	67	58-76	61-73	92	85-96	88-96
18	10-26	13-23	43	33-53	37-49	68	59-77	62-74	93	86-97	89-96
19	11-27	14-24	44	34-54	38-50	69	60-78	63-75	94	88-98	90-97
20	12-28	15-25	45	35-55	39-51	70	61-79	64-76	95	89-98	91-98
21	13-29	16-26	46	36-56	40-52	71	62-80	65-77	96	90-99	92-98
22	14-30	17-27	47	37-57	41-53	72	63-81	66-78	97	92-99	94-99
23	15-31	18-28	48	38-58	42-54	73	64-82	67-79	98	93-100	95-99
24	16-32	18-30	49	39-59	43-55	74	65-83	68-80	99	95-100	96-100
25	16-34	19-31	50	40-60	44-56	75	66-84	69-81	100	96-100	98-100

Values for frequencies 0-9% and 91-100% are "exact" binomials according to Owen (1962).

Illustration 11

CONFIDENCE INTERVALS FOR BINOMIAL POPULATIONS--200 QUADRATS

Approximate 95% and 80% confidence intervals for percentage frequency observed for 200 quadrats (binomial distribution). Confidence intervals were calculated as:

$$\sqrt{\frac{pq}{200}} \; t_{\alpha(2)199} \; ; \text{ where } t_{.95} = 1.97 \text{ and } t_{.80} = 1.29$$

Freq. %	Conf. P=.95 %	Inter. P=.80 %	Freq. %	Conf. P=.95 %	Inter. P=.80 %	Freq. %	Conf. P=.95 %	Inter. P=.80 %	Freq. %	Conf. P=.95 %	Inter. P=.80 %
0	0-3	0-2									
1	0-4	0-3	26	20-32	22-30	51	44-58	46-56	76	70-82	72-80
2	0-5	0-4	27	21-33	23-31	52	45-59	47-57	77	71-83	73-81
3	0-6	1-5	28	22-34	24-32	53	46-60	48-58	78	72-84	74-82
4	1-7	2-6	29	23-35	25-33	54	47-61	49-59	79	73-85	75-83
5	2-9	3-7	30	24-36	26-34	55	48-62	50-60	80	74-86	76-84
6	2-10	4-8	31	25-37	27-35	56	49-63	51-61	81	76-86	77-85
7	3-11	5-9	32	26-38	28-36	57	50-64	52-62	82	77-87	78-86
8	4-12	5-11	33	26-40	29-37	58	51-65	53-63	83	78-88	80-86
9	5-13	6-12	34	27-41	30-38	59	52-66	55-63	84	79-89	81-87
10	6-14	7-13	35	28-42	31-39	60	53-67	56-64	85	80-90	82-88
11	7-15	8-14	36	29-43	32-40	61	54-68	57-65	86	81-91	83-89
12	7-17	9-15	37	30-44	33-41	62	55-69	58-66	87	82-92	84-90
13	8-18	10-16	38	31-45	34-42	63	56-70	59-67	88	83-93	85-91
14	9-19	11-17	39	32-46	35-43	64	57-71	60-68	89	85-93	86-92
15	10-20	12-18	40	33-47	36-44	65	58-72	61-69	90	86-94	87-93
16	11-21	13-19	41	34-48	37-45	66	59-73	62-70	91	87-95	88-94
17	12-22	14-20	42	35-49	37-47	67	60-74	63-71	92	88-96	89-95
18	13-23	14-22	43	36-50	38-48	68	62-74	64-72	93	89-97	91-95
19	14-24	15-23	44	37-51	39-49	69	63-75	65-73	94	90-98	92-96
20	14-26	16-24	45	38-52	40-50	70	64-76	66-74	95	91-98	93-97
21	15-27	17-25	46	39-53	41-51	71	65-77	67-75	96	93-99	94-98
22	16-28	18-26	47	40-54	42-52	72	66-78	68-76	97	94-100	95-99
23	17-29	19-27	48	41-55	43-53	73	67-79	69-77	98	95-100	96-100
24	18-30	20-28	49	42-56	44-54	74	68-80	70-78	99	96-100	97-100
25	19-31	21-29	50	43-57	45-55	75	69-81	71-79	100	97-100	98-100

Values for frequencies 0-9% and 91-100% are "exact" binomials, and were calculated according to Steel and Torrie (1960).

distribution of species (Hyder et al. 1965, Tueller et al. 1972, and Mueller-Dombois 1974). Under these circumstances, the evaluator should be cautious of direct comparisons among species. An alternative is to redesign the trend technique and use different plot sizes in a nested configuration. The summed frequencies of the nested plots may be useful in detecting vegetation changes (Smith 1982).

c. Vegetation Cover. Cover is the percentage of ground surface covered by vegetation. The type of cover should be specified as canopy, foliar, basal area, or point cover. Informative discussions of cover are found in "Techniques and Methods of Measuring Understory Vegetation" (USDA, Forest Service 1959) and "Plant Communities" (Daubenmire 1968).

(1) Canopy Cover. Canopy cover reflects that part of two-dimensional space over which a plant exerts an influence and provides a relative index of a species' ecological dominance. It is the percentage of ground covered by a downward vertical projection of the outermost perimeter of the natural spread plant foliage. Canopy cover includes small openings in the canopy and should be higher than basal area cover and foliar cover.

(2) Foliar Cover. Foliar cover is the percentage of ground covered by a downward vertical projection of the aerial portion of plants; small openings in the canopy are excluded. Foliar cover may also be viewed as the sum of shadows that would be cast if a light source were placed directly over a plant. Foliar cover is a particularly useful value where interception of precipitation and other aspects regarding watershed are considered; it also allows for comparisons among all life forms.

(3) Basal Area Cover. Basal area is the area of ground surface occupied by the stem or stems of a plant, generally measured at 1 inch above soil level.

(4) Point Cover. Point cover (sometimes called point frequency) can be converted to an unbiased estimate of cover, provided that the point is very sharp, i.e., dimensionless. Use of a theoretically dimensionless point represents the ultimate reduction in quadrat size. The theory of point sampling is that if an infinite number of points were placed over an area, the cover of an object could be determined by computing the percentage of points covering the object (Evans and Love 1957, Pieper 1978). For sampling vegetation, point cover must use the principles discussed in basal, canopy, or foliar cover.

(5) Canopy or Foliar vs. Basal Area Cover. When monitoring shrub species, canopy or foliar cover data may be more meaningful than basal area cover data. The basal area or mainstem of a woody plant is subject to change in one direction only--to increase in size (or remain constant). The basal area/unit area of a woody species will decrease only when plants die. A decline will not be evident with basal area data until

mortality occurs and the stem disappears. While canopy or foliar cover is also an index of plant vigor, it periodically fluctuates because of variations in climatic conditions and foraging use. This is especially pronounced in herbaceous species where it is often preferable to use basal area cover. Basal cover is not noticeably affected by differences in phenological stage, current grazing use, and yearly fluctuations in production.

(6) Superimposed Canopies. Superimposed plant canopies are common in many communities; therefore, the sum of all cover values can theoretically exceed 100 percent. This sum can provide a comparative index of site productivity. The sum of basal area cover estimates cannot exceed 100 percent. Often combinations of canopy (or foliar) cover and basal area cover are used in sampling methods because plant communities rarely consist of only one plant form. Total cover in some communities tells very little about condition because increasers and invaders often replace decreasers. When determining trend, it is more informative to examine changes in cover and of composition of individual species (particularly key species) rather than total cover.

(7) Determining Bare Ground from Cover Data. Cover data are usually gathered with methods that estimate or measure superimposed vegetation layers. Merely subtracting total cover from 100 percent to determine percent bare ground underestimates the true amount of bare ground. It is more accurate to estimate or measure bare ground directly in the field if this type of data is desired.

d. Production. Production data are collected on a weight basis. Weight is a meaningful expression of productivity of a plant community or an individual species. Weight data have a direct relationship to feed units for grazing animals and thus are valuable in determining stocking rates (United States Department of Agriculture, Soil Conservation Service 1976). Because the total herbage yields do not necessarily reflect changes in condition, production of individual species should be examined when interpreting trend. Composition by weight is used in conjunction with Range Site Guides to determine condition.

Because of seasonal and annual variations in climatic conditions, annual herbage yields fluctuate considerably. Interpretation of the effect of climate on production is invaluable for trend analysis (Sneva and Hyder 1962a and b). Gradual changes (or no change) in range productivity may be obscured by seasonal and annual fluctuations.

e. Composition. Composition is the proportion or relative abundance of species in the community. Species composition is a primary means of describing successional stages, seral communities, or condition classes. It reflects the status of a species relative to the total community.

Composition is an interpretive item derived from absolute data. In fact, the terms "relative cover," "relative density," or "relative production" are preferred because they qualify or more aptly describe what was sampled and the relationship of one species to the group. Do not use the terms "relative frequency" or "composition by frequency."

Basing land use decisions on composition alone can be hazardous, especially in trend studies. Figure 1 hypothetically demonstrates a possible analytical error, associated with composition, that may occur in an inventory or monitoring effort.

Species Code	YEAR 1		YEAR 4	
	Lbs/acre	% Comp.	Lbs/acre	% Comp.
SPCR	100	25%	100	20%
BOER	100	25%	125	25%
SCBR	100	25%	100	20%
PPFF	100	25%	100	20%
XASA	0	0%	75	15%

Figure 1. Comparison of absolute and composition data for one site over time.

Absolute production data (lbs/ac) indicates no change over time for SPCR, SCBR or PPFF but shows an increase for BOER and XASA. However, composition shows a decrease for SPCR, SCBR, PPFF; an increase for XASA; and the same composition for BOER. A decision based solely on key species composition might be wrong. In this case the analysis should concentrate on the increase of XASA and BOER. This same problem may occur in an inventory effort when estimates of composition are not supplemented with absolute data (e.g., lbs/ac.).

f. Vigor. Vigor refers to the relative size and health of an individual. Criteria used to evaluate vigor include: plant height; presence or absence of dead portions of the plant; number of reproductive structures (buds, inflorescences, etc.); length of seedstalks or leaders; production; size of leaves; and color (Daubenmire 1968). Based on physiological requirements of forage plants (Blaisdell and Pechanec 1949, Pond 1960, Mueggler 1972 and 1975), monitoring plant vigor in response to various intensities of grazing and competition is beneficial to the development of grazing systems .

The tendency towards ecotypic specialization on different sites may complicate the evaluation of whether vigor ratings are an expression of genetic variability or direct environmental influences such as soil depth, soil chemistry, and available soil moisture. Species vigor commonly varies independently on the same site at different stages of succession--and herein lies the practical value of the concept of vigor in trend studies. Some ecologists believe that vigor as compared to other analytical techniques can provide the earliest indication of trend (Daubenmire 1968, Bjugstad and Whitman 1970).

g. Reproduction, Age Class, and Form Class. Analysis of reproduction, age class, and form class is useful in trend and succession studies. It is useful in determining whether and how the status of a species in a community is changing.

(1) Reproduction. Presence or absence of established seedlings is an indication of the degree of successful reproduction. For instance, absence of seedlings or young plants of a sexually reproducing species indicates poor reproduction success. (This condition would not be significant for those species that reproduce primarily by vegetative means.) Although production and cover estimates of a sexually reproducing species may be constant for many years, eventually the mature plants will grow old and die. If no replacement occurs, the species will begin to decline on that site.

The causes of successful reproduction or a lack of successful reproduction are complex. Nonbiotic factors, in particular climatic factors, strongly influence formation of viable seed, germination of seeds, and establishment of seedlings. Mortality among seedlings, particularly seedlings of perennial plants, is very high. At most, only a few individuals of each seed crop can be expected to reach reproductive age. The combination of prolific viable seed production and proper germination conditions can lead to an abundance of seedlings that may never reach maturity. It may be more appropriate to consider young established plants, rather than seedlings, as indicators of successful reproduction.

(2) Age Class. Population dynamics are complex; many variables interact to affect the balance between addition of new plants and mortality. The interpretation of the distribution of age classes (the proportions of various age groups present) can furnish evidence as to the dynamic successional status vegetation. If the rate of addition for a species exceeds mortality over a period of time, its density will increase and vice versa. An understanding of the autecology of the species is essential for critical interpretations of the data (Daubenmire 1968).

(3) Form Class. Form classes that reflect the degree of hedging (the effects of use during a previous year or a succession of previous years) and the availability of browse are particularly useful in vegetation analysis. The degree of hedging that will maintain browse plants in a productive condition will vary. Interpretation of these data requires considerable knowledge of the biology of the plant species and its response to browsing and other environmental factors (New Mexico Department of Game and Fish, USDA-Forest Service, USDI-Bureau of Land Management).

h. Litter. Litter influences the microclimate, vegetation, and soil of a site. For example, litter layers reduce evaporation, affect penetration of rain water, retard surface runoff, prevent raindrop splash erosion, modify soil temperature, and reduce the range of extremes of temperature and the rate of variation (Branson et al. 1981). The effect on temperature in turn affects viability and germination of seeds and survival of seedlings. Decay of litter also affects soil fertility and soil structure. Too much litter may stifle production. Whether or not increasing litter is an indication of trend is specific to the individual region and site.

(1) Factors Which Affect the Amount of Litter. The rate of litter accumulation is influenced by plant species, variations in production, levels of forage utilization, climatic factors, frequency of fires, and rate of litter decay (Williams and Gray 1974, Whitford et al. 1982).

(a) Variations in production from year to year can affect litter accumulation. For instance, voluminous production of annuals one year may create abundant nonpersistent litter, while the next year may be especially dry with very low herbage production, and therefore, low litter accumulation. These data considered alone would falsely indicate a negative trend.

(b) Different intensities of utilization directly affect the amount of material that becomes litter. Because utilization removes plant materials that would eventually become litter, data collection periods should be planned to occur at similar points in a grazing scheme. For instance, if a pasture received heavy utilization prior to data collection, litter estimates would probably be lower than had the data been collected after a rest period. The evaluator should consider trend indications from litter in conjunction with both actual use and utilization data.

(c) Abiotic events also affect the amount of litter present. The occurrence of fire on a study site will virtually remove all litter and may give an erroneous impression of negative trend to the casual observer. Evidence of events that affect litter accumulation, such as fire, intense thunderstorms, hail, and strong winds, should have been noted at the time of data collection.

(2) Recording Current Year's Growth. Data collection is often complicated by the presence of annuals that are live plants early in the season, only to become litter later in the season. Interpretation of litter data must assess whether observers consistently recorded such species as either plants or as litter within the span of one growing season. For example, recording cheatgrass as cheatgrass in June and recording the same plant as litter in August invalidates comparison of these two data sets. Data may be recorded for both as long as litter and species data are documented and recorded as separate entries.

4.2 Effects of Other Biological Agents (excluding big game and livestock). Concentrations of insects, rodents, smuts, rusts, etc., can have substantial influence on vegetation. Note abnormal concentrations of these agents during field examinations and subsequently consider during interpretation and evaluation. Their effects on trend and/or utilization may be either positive or negative depending on the resource value affected. For example, concentrations of the sagebrush defoliator, *Aroga websteri* Clarke, in sagebrush/bunchgrass communities may be harmful in terms of trend for wintering deer but may favor forage production for livestock. Histories of many of these agents indicate that outbreaks are relatively short-lived and that populations fluctuate rapidly depending on climate, food supply, and other habitat requirements. Absence of animals that act as seed disseminators, such as rodents and birds, is also important and should be noted.

County extension agents, Animal and Plant Health Inspection Service (APHIS), local universities, etc., may be consulted to ascertain impacts and relationships to other monitoring data.

4.3 Nonbiotic Factors Affecting Plant Communities. Nonbiotic factors that affect trend include fire, mechanical, or chemical factors. Each has a different kind and intensity of impact on the species affected. All three factors radically change the competitive interactions among species by selectively favoring some species and suppressing or eliminating others. Consider these impacts when interpreting trend data from communities affected by any of these factors.

5. EVALUATION.

An evaluation is the examination and judgment concerning the worth, quality, significance, amount, degree, or condition of something. The evaluation of monitoring data should provide an objective assessment of all available information concerning a specific area and its management. The goal is to determine whether satisfactory progress is being made toward meeting management objectives, and if not, what actions are necessary to correct the situation. Since the kinds of objectives and available monitoring methods vary from office to office, no standard set of criteria or format for the evaluation process is prescribed.

Sections 5.1 through 5.9 describe the general sequence of events that occur during a formal evaluation. As a preview, these events include:

- Assemble and review important documents (5.1).
- Establish coordination requirements (5.2).
- Display monitoring and other data (5.3).
- Analyze the data (5.4).
- Review management actions and other factors (5.5).
- Interpret the data (5.6).
- Evaluate the data (5.7).
- Review management objectives (5.8).
- Evaluate progress in meeting management objectives (5.9).

5.1 Assemble and Review Pertinent Documents. Prior to conducting an evaluation, assemble and review documents pertaining to the allotment (or geographic area) being evaluated. These documents provide information on objectives (general and specific), monitoring techniques, historical use, management actions, anticipated effects, etc. They will also be useful for determining coordination requirements. Illustration 12 provides a checklist of documents that should be reviewed prior to conducting an evaluation. The checklist should be supplemented as necessary to meet local needs.

5.2 Establish Coordination Requirements. A formal evaluation on any given management area must be designed to allow evaluation of the effects of consumptive uses present on the area (livestock grazing, wild horses, wildlife, etc.) This requires a high level of interdisciplinary coordination to ensure that multiple use principles are considered and to allow all interested and affected parties to participate in a meaningful manner. Documentation of participants is recommended. Illustration 13 describes some of the potential participants of an interdisciplinary evaluation and may be used as a checklist. Most evaluations will not involve this many participants.

5.3 Display Monitoring and Other Data. Summarize data collected from baseline inventories (ecological site), monitoring studies, supplemental studies, and other sources. Keep in mind the need to display the data in an understandable manner for easy reference by BLM personnel, permittees, lessees, other rangeland users, and affected interests.

5.4 Analyze the Data. Perform all necessary calculations of data and complete needed analysis of interrelationships.

5.5 Review Management Actions and Other Factors. Review grazing management actions that have been implemented to achieve specific management objectives. Specifically, what objectives were the actions expected to achieve, and how? What was the time frame? How were the actions expected to change the resources?

Determine if any changes in the management actions occurred after initiation of the monitoring studies or if new actions were implemented. Document how these changes affected utilization patterns, levels of grazing use, season-of-use, etc. Determine and document how changes in grazing management actions may have affected a change in the resources as detected by the monitoring studies.

Review and document factors other than the influences of management that caused a change in resource production and condition. These may include: climate, insects, rabbits, and other biological influences.

5.6 Interpret the Data. In some cases, the interpretation of data may be straightforward, while in others it may be complex, involving the consideration of numerous variables. In either case, the ultimate analyses, interpretation,

EVALUATION INFORMATION CHECKLIST

PLANS

- ☐ *Land Use Plan*
- ☐ *Monitoring Plan*
- ☐ *AMP*
- ☐ *CRMP*
- ☐ *HMP*
- ☐ *HMAP*
- ☐ *Watershed*
- ☐ *Other* ________
- ☐ *SCS/FS Cooperative Plan*

MONITORING FILES/DATA

- ☐ *Actual Use*
- *Estimated Utilization*
  - ☐ *Livestock*
  - ☐ *Wildlife*
  - ☐ *Wild Horses*
  - ☐ *Wild Burros*
  - ☐ *Other Biological Agents*
- ☐ *Weather/Climate*
- ☐ *Trend*
- ☐ *Photography*
- ☐ *Other* ________

- ☐ *Operator Case File*
- ☐ *Historical Case Files*
- ☐ *Project Files*

- ☐ *BLM Manuals/Handbooks*
- ☐ *BLM Technical References*
- ☐ *Field Notes*

- ☐ *ES/EIS*
- ☐ *EAs*
- ☐ *Range Program Summary (RPS)*

INVENTORY DATA/MAPS

- ☐ *Soils*
- ☐ *Vegetation*
- ☐ *Range Site Guides*

- ☐ *Special Studies*

OTHER MAPS

- ☐ *Historical*
- ☐ *GIS*

- ☐ *ADP*
- ☐ *Advisory Board/Council Minutes*

- ☐ *Textbooks (e.g. flora, range management)*

- ☐ ________
- ☐ ________

COORDINATION/CONSULTATION CHECKLIST

- ☐ **Range Conservationist**
- ☐ **Wildlife Biologist**
- ☐ **Soil Scientist/Watershed Specialist**
- ☐ **Wilderness Specialist**
- ☐ **Hydrologist**
- ☐ **Wild Horse & Burro Specialist**
- ☐ **Forester**
- ☐ **Geologist/Mining Engineer**
- ☐ **Planning Coordinator**
- ☐ **Environmental Coordinator**
- ☐ **Recreation Specialist**
- ☐ **Fire Management Officer/Ecologist**
- ☐ **Archeologist**

- ☐ **Previous Office Employee**
- ☐ **Allottee/Permittee/Leasee**
- ☐ **Lien Holders**
- ☐ **Advisory Board/Council Members**
- ☐ **Consultants/Attorneys**
- ☐ **State Land Office**
- ☐ **Other Federal**
  - _ SCS   _ BOR
  - _ USFS   _ BIA
  - _ FWS   _ DOD
- ☐ **State/Private Universities**
- ☐ **Extension Agents**
- ☐ **State Game & Fish**

and subsequent conclusions are often based on professional judgment. Consult the previous sections of this technical reference for ideas and factors to consider in the interpretation process.

Account for interrelationships between the factors that may have attributed to success or failure of grazing management actions in meeting the objectives. Document conclusions with supportive explanations.

5.7 Evaluate the Data. Evaluate monitoring data for consistency, reliability, strong points, weak points, completeness, and accuracy. If monitoring data are inadequate, the entire evaluation process becomes inadequate. Evaluators must document all inadequacies and recommend changes in monitoring techniques or procedures that will resolve the inadequacies.

5.8 Review Management Objectives. The following guidance on management objectives is included in this reference document to remind the reader of the importance of meaningful objectives in land-use planning, monitoring, evaluation of monitoring data, and subsequent decision making. Interdisciplinary input into the formulation or modification of objectives is essential. Appropriate input by the lessee, permittee, fish and game agency, and others is of equal importance.

In order for management actions to be monitored and progress to be evaluated, the objectives must address measurable attributes of vegetation. The objective to "increase ground cover" does not tell the manager specifically what is expected to be accomplished. Nor does it tell the attribute that needs to be monitored. Compare that objective with "to increase basal cover of bluebunch wheatgrass from 2 percent to at least 5 percent by 1990."

It is also important that management objectives be stated in terms that are reasonably attainable relative to the target itself and the time period over which it is to be attained. For instance, the objective "to increase basal cover of bluebunch wheatgrass from 16 percent to 30 percent by 1995 (in 10 years)," is not attainable because the site may not be capable of supporting a 30 percent basal cover of wheatgrass and unrealistic because of the amount of change expected in a relatively short time period. This objective should be restated in more practicable terms, such as "to increase basal cover of bluebunch wheatgrass from 16 percent to 20 percent by 1995 (in 10 years)."

In some cases, detection of a trend toward the desired value may be sufficient to justify continuation of the management practice being evaluated, especially on poor condition ranges where vegetation objectives will be attainable only in the long-term. In these cases, intermediate objectives may be useful in evaluating the progress.

An important step in any evaluation is to develop a complete and consistent summary of all the management objectives applicable to the management area being evaluated. Extract objectives from activity plans, land use plans, or

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monitoring plans. In cases where several consumptive uses are present in an area, the evaluation process must address them all, and criteria for adjusting or modifying the uses must be coordinated accordingly.

Regardless of the long-term goals and objectives for the management area, evaluation of grazing effects over the short term (5-year) is usually based on utilization data and their correlation with known or estimated grazing use levels. Some aspects of trend may be discernible over this short time span under ideal conditions. Trend data generally do not lend themselves to the quantification necessary to adjust stocking levels or other aspects of grazing use in the short term. Therefore, evaluate activity plans dealing with consumptive uses of vegetation on whether they contain objectives addressing target utilization levels for key forage and browse species.

5.9 Evaluate Progress in Meeting Management Objectives. Determine if management objectives have been met or if adequate progress toward achieving them has occurred.

5.91 Management Objectives Met. If a management objective has been met, a decision should be made as to whether present management may continue or new management should be implemented. It may be necessary to define a new objective.

Make recommendations on whether or not monitoring studies should be continued. When the evaluation shows that management objectives are being met and no immediate adjustments in grazing management appear necessary, it may be desirable to lengthen the interval between studies.

5.92 Adequate Progress Toward Objectives. If progress toward an objective is adequate, a decision may be made to continue present management. If so, a new objective does not need to be defined.

5.93 Inadequate Progress Toward Objectives. If a management objective has not been met and progress toward achieving it is not satisfactory, a change in management may be needed. Document the reasons why the desired change or direction toward the objective have not occurred. Recommend changes in management that are needed to meet the objectives. In some instances, biological or climatic situations may have contributed to the lack of progress. In other cases, additional studies and/or time may be needed to collect an adequate amount of data on the effectiveness of management. Conclusions on these situations should be well documented.

5.94 Management Objectives Need Redefining. Through the evaluation process, it may become apparent that management objectives need redefining, particularly if they are too general or are not reasonably attainable.

6. SUMMARIZE FINDINGS AND MAKE RECOMMENDATIONS.

Complete and thorough documentation of the findings of a formal analysis, interpretation, and evaluation process is critical, especially since monitoring data will be the basis for most management actions. Thorough documentation will also provide future range managers a historical account and rationale for many management actions that may be questioned in the future.

The formal evaluation must include concise management recommendations (if any) as well as recommendations on changing monitoring techniques, management objectives, key areas, or key species. The authorized officer is ultimately responsible for implementing any recommendations and, therefore, he/she requires thorough documentation for making sound decisions. Illustration 14 is an example of an outline that might be used for documenting an evaluation. Each Field Office should establish a basic outline for guiding an evaluation. Appendix 5 illustrates a completed evaluation following the outline shown in Illustration 14.

OUTLINE--EVALUATION SUMMARY

I. Name and Number of Allotment - user's name(s).

II. Livestock Use

A. Total preference, allowable use, suspended preference, voluntary nonuse by user.

B. Season(s) of use - list dates.

C. Kind and class of livestock use.

D. Percent public land and any appropriate statements on use of private or state lands in allotment.

E. Other - (changes in livestock use during period of evaluation) etc.

III. Allotment Profile (if needed by the area manager).

A. Briefly describe the allotment.

B. Acreage (Federal, State, Private).

C. Objectives (list numerically).

D. Key species (list by species).

E. Grazing system - describe number of pastures, type system, etc.)

1. When implemented.

2. Has it been followed - if not describe deviations, when they occurred and why.

IV. Management Evaluation

A. Give the purpose of the evaluation (determine stocking rate, evaluate operation of system, both, or ?).

B. Summary of Studies Data (use Illustration 1, TR4400-7) and other supplementary tables and charts as necessary).

1. Actual use - indicate if use was made by pairs, or yearlings etc. to indicate significant differences in forage consumption. List use by AUMs by season and total for each year.

2. Precipitation - indicate what and how many data sources are quoted. Show crop year, and if desired, growing season (April through October) precipitation for each year. It is important to also include the long term mean precipitation for the same periods to be able to assess the "normality" of the year or period. A simple table is preferred to a narrative.

3. Utilization - indicate the number of locations sampled, the total number of samples taken, and whether samples were taken at the same time and location in each pasture. Was utilization mapped? Are there areas of overuse or little use? If so, what are the sizes of these areas? What was the stage of plant growth when sampling was done? Is regrowth a consideration? Mention any data you have on other important forage plants which contribute to production but weren't sampled (i.e., percent comp. etc.). Indicate any significant presence and effect of other biological agents--insects, rodents, smut, rust, etc. It is important to indicate if utilization reflects total growing season use or not and to what extent big game use is a factor in total utilization figures.

V. Conclusions - List the number of each objective cited in III.C. and discuss each as appropriate. Are objectives reasonable and measurable? Are objectives met or being met? Summarize your conclusions based on your analysis of the studies data. Identify proposals for resolving problems identified. Include needed changes in key species, stocking rate, objectives, grazing system, studies, etc. Your conclusions and proposed recommendations should be discussed with the area manager for his input prior to consultation with the user and others. (Write out your proposed recommendation(s) including rationale for each and attach to this summary for the area manager's review and use during your discussion).

VI. Consultation - Describe consultation with the use, DOW and others to discuss the studies data and conclusions. Indicate the results of this consultation including any recommendations made by others.

VII. Recommendation - Give your final recommendation as to the alternative which should be adopted.

GLOSSARY OF TERMS

-A-

actual use: a report of actual livestock grazing use certified to be accurate by the permittee or lessee. (See 43 CFR 4100.0-5.) Actual use may be expressed in terms of animal unit months or animal months.

allotment: an area of land designated and managed for grazing of livestock. (See 43 CFR 4100.0-5.) Such an area may include intermingled private, State, or Federal lands used for grazing in conjunction with the public lands.

allotment management plan (AMP): a documented program which applies to livestock grazing on public lands, prepared in consultation, cooperation, and coordination with the permittee(s), lessee(s), or other involved affected interests.

analysis: (1) a detailed examination of anything complex in order to understand its nature or determine its essential features; or (2) a separating or breaking up of any whole into its component parts for the purpose of examining their nature, function, relationship, etc. (A rangeland analysis includes an examination of both biotic (plants, animals, etc.) and abiotic (soils, topography, etc.) attributes of the rangeland.

animal month: a month's tenure upon the rangeland by one animal. Animal month is not synonymous with animal unit month.

animal unit month (AUM): the amount of forage necessary for the sustenance of one cow or its equivalent for a period of one month. (See 43 CFR 4100.0-5.)

available forage: that portion of the forage production that is accessible for use by a specified kind or class of grazing animal.

-B-

bare ground: all land surface not covered by vegetation, rock fragment, bedrock, or litter.

basal area: the cross sectional area of the stems or stems of a plant or of all plants in a stand. Herbaceous and small woody plants are measured at or near ground level; large woody plants are measured at breast or other designated height. Basal area is synonomous with basal cover.

basal cover: (see basal area.)

boulder: descriptive term applied to rock fragment ground cover where the longest dimension measures over 24 inches.

browse: (1) the part of shrubs, half shrubs, woody vines, and trees available for animal consumption; or (2) to search for or consume browse.

browse plant or browse species: a shrub, half shrub, woody vine, or tree capable of producing shoot, twig, and leaf growth suitable for animal consumption.

-C-

canopy cover: the percentage of ground covered by a downward vertical projection of the outermost perimeter of the natural spread of plant foliage. Small openings within the canopy are included. Total canopy cover of all species may exceed 100 percent. Canopy cover is synonomous with crown cover.

classification: the assignment of items or concepts into classes or groups based on similarity of selected attributes.

class of livestock: the age and/or sex groups of a kind of livestock.

climate: the average weather conditions of a place over a period of years.

cobble: descriptive term applied to rock fragment ground cover where the longest dimension measures between 3 and 10 inches.

community: an assemblage of populations of plants and/or animals in a common spatial arrangement.

composition: the proportions (percentages) of various plant species in relation to the total on a given area. It may be expressed in terms of cover, density, production, etc.

confidence interval: a range of values computed from sample data. It is constructed such that one can state, with a predetermined degree of confidence, that the estimated parameter will be included in the range.

cover: (see basal cover, canopy cover, foliar cover, and ground cover.)

-D-

density: the number of individuals or stems per unit area. (Density does not necessarily equate to any kind of cover measurement.)

-E-

ecological site: a kind of rangeland with a specific potential natural community and specific physical site characteristics, differing from other kinds of rangeland in its ability to produce vegetation and to respond to management. Ecological site is synonomous with range site.

ecological status: the present state of vegetation of a range site in relation to the potential natural community for the site. Ecological status is use independent. It is an expression of the relative degree to which the kinds, proportions, and amounts of plants in a plant community resemble that of the potential natural community. The four ecological status classes correspond to 0-25, 26-50, 51-75, or 76-100 percent similarity to the potential natural community and are called early seral, mid seral, late seral, and potential natural community, respectively.

ecosystem: a complete, interacting system of organisms (i.e., community) considered together with their physical environment.

estimated use: the use made of forage on an area by wildlife, wild horses, wild burros, and/or livestock where actual use data are not available. Estimated use may be expressed in terms of animal unit months or animal months.

evaluation: (1) an examination and judgment concerning the worth, quality, significance, amount, degree, of condition or something; or (2) the systematic process for determining the effectiveness of on-the-ground management actions and assessing progress toward meeting management objectives.

-F-

foliar cover: the percentage of ground covered by a downward vertical projection of the aerial portion of plant foliage. Small openings in the canopy are excluded. Foliar cover is always less than canopy cover. Total foliar cover of all species may exceed 100 percent.

forage: (1) browse and herbage which is available and may provide food for animals or be harvested for feeding, or (2) to search for or consume forage.

forage production: the weight of forage that is produced within a designated period of time on a given area. Production may be expressed as green, air-dry, or oven-dry weight. The term may also be modified as to time of production such as annual, current year, or seasonal forage production.

forb: (1) any herbaceous plant other-than those in the Gramineae (Poaceae) (true grasses), Cyperaceae (sedges), and Juncaceae (rushes) families--i.e., any nongrass-like plant having little or no woody material on it, or (2) a broadleaved flowering plant whose stem, above ground, does not become woody and persistent.

frequency: a quantitative expression of the presence or absence of individuals of a species in a population. It is defined as the percentage of occurence of a species in a series of samples of uniform size.

-G-

goal: the desired state or condition that a resource management policy or program is designed to achieve. A goal is usually not quantifiable and may not have a specific date by which it is to be completed. Goals are the base from which objectives are developed. (See objective.)

grass: any plant of the family Gramineae (Poaceae).

grasslike plant: a plant of the Cyperaceae or Juncaceae families that vegetatively resembles a true grass of the Gramineae family.

gravel: descriptive term applied to rock fragment ground cover where the longest dimension measures between 2 millimeters (approximately 1/16 inch) and 3 inches.

grazing management: the manipulation of grazing and browsing animals to accomplish a desired result.

ground cover: the percentage of material, other than bare ground, covering the land surface. It may include live and standing dead vegetation, litter, gravel, cobble, stones, boulders, and bedrock. Ground cover plus bare ground would total 100 percent.

-H-

half shrub: a plant with a woody base whose annually produced stems die each year.

hedging: (1) the appearance of browse plants that have been browsed so as to appear artificially clipped, or (2) consistent browsing of terminal buds of browse species causing excessive lateral branching and a reduction in upward and outward growth.

herbage: the above-ground material of any herbaceous plant (grasses and forbs).

-I-

interpretation: explaining or telling the meaning of something and presenting it in understandable terms.

inventory: the systematic acquisition and analysis of information needed to describe, characterize, or quantify resources for land-use planning and management of the public lands.

-K-

key area: a relatively small portion of a rangeland selected because of its location, use, or grazing value as an area on which to monitor the effects of grazing use. It is assumed that key areas, if properly selected, will reflect the effects of current grazing management over all or a part of a pasture, allotment, or other grazing unit.

key management area: an area of land that influences or limits the management opportunities of the land surrounding it. Key management area may be synonymous with key area.

key species: (1) those species which must, because of their importance, be considered in a management program; or (2) forage species whose use serves as an indicator of the degree of use of associated species.

kind of livestock: species of domestic livestock--cattle, sheep, horses, burros, and goats.

-L-

litter: the uppermost layer of organic debris on the soil surface, essentially the freshly fallen or slightly decomposed vegetal material.

-M-

monitoring: the orderly collection, analysis, and interpretation of resource data to evaluate progress toward meeting management objectives.

-N-

nonpersistent litter: undecomposed organic debris on or near the soil surface with expected decomposition rates of two years or less. Composed primarily of herbaceous material.

-O-

objective: planned resulted to be achieved within a stated time period. Objectives are subordinate to goals, are narrower and shorter in range, and have increased possibility of attainment. Time periods for completion and outputs or achievements that are measurable and quantifiable are specified. (See goal.)

overstory: the upper canopy or canopies of plants. Usually refers to trees, tall shrubs, or vines.

-P-

pasture: grazing area enclosed and separated from other areas by fence or natural barrier.

persistent litter: undecomposed organic debris on or near the soil surface with expected decomposition rates exceeding two years. Composed of woody material and large mammal droppings.

phenology: relationship between climate and plant growth stages such as begin growth, peak of flowering , seed ripe, dormant, etc.

plant association: a kind of potential natural community consisting of stands with essentially the same dominant species in corresponding layers.

plant community: (See community.)

potential natural community (PNC): the biotic community which would become established if all successional sequences were completed without interference by man under the present environmental conditions. Natural disturbances are inherent in development. Includes naturalized non-native species.

production: (See forage production.)

productivity: the rate of production per unit area usually expressed in terms of weight or energy.

professional judgement: judgement tempered by knowledge gained through education and experience.

proper use: (1) a degree of utilization of current year's growth which, if continued, will achieve the management objectives and will maintain or improve the long term productivity of the site; or (2) the percentage a plant is utilized when the rangeland as a whole is properly utilized. Proper use varies with time and systems of grazing. Proper use is synonymous with proper utilization.

proper utilization: (See proper use.)

public lands: any land and interest in land outside of Alaska owned by the United States and administered by the Secretary of the Interior through the Bureau of Land Management. (See 43 CFR 4100.0-5)

-R-

range: embraces rangelands and also many forest lands which support an understory or periodic cover of herbaceous or woody vegetation amenable to certain range management principles or practices.

range condition: the present state of vegetation of an ecological site in relation to the potential natural community for that site. It may also be stated in terms of specific values. (See ecological status and resource value rating.)

rangeland: a kind of land which supports vegetation useful for grazing or browsing on which routine management of that vegetation is through manipulation of grazing rather cultural practices. (Rangelands include natural grasslands, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes, riparian zones, and wet meadows. Rangeland includes lands revegetated naturally or artificially to provide a plant cover which is managed like native vegetation.)

range site: (See ecological site.)

resource value rating (RVR): the value of vegetation present on a range site for a particular use or benefit. Resource value ratings may be established for each plant community capable of being produced on an ecological site, including exotic or cultivated species.

rock fragment: an individual fragment of solid mineral material which occurs naturally on the earth's crust and ranges in size from gravel to boulder.

-S-

seral community: one of a series of biotic communities that follow one another in time on any given area. Seral community is synonymous with successional community and may be synonymous with seral stage and successional stage.

seral stage: (See seral community.)

shrub: a plant which has persistent, woody stems and a relatively low growth habit, and which generally produces several basal shoots instead of a single bole. It differs from a tree by its low stature--less than 5 meters (16 feet)--and nonarborescent form.

shrubland: land on which the vegetation is dominated by shrubs. Lands not currently shrubland but were or could become shrubland through natural succession may be classified as potential natural shrubland.

standing crop: the total amount of living above-ground plant material per unit area at a specified point in time.

statistics: refers to the analysis and interpretation of data with a view toward objective evaluation of the reliability of the conclusions based on the data.

stocking rate: the number of specified kinds and classes of animals grazing (or utilizing) a unit of land for a specific period of time. May be expressed as animals per acre, hectare, or section, or the reciprocal (area of land per animal). Where dual use is practiced (e.g., cattle and deer) stocking rate is often expressed as animals units per unit of land or the reciprocal.

stone: a descriptive term applied to rock fragment ground cover where the longest dimension measures between 10 and 24 inches.

stratification: subdividing an area into units which are, more or less, internally homogeneous with respect to the (those) characteristic(s) of interest.

succession: the orderly process of community change; it is the sequence of communities which replace one another in a given area.

successional community: (See seral community.)

successional stage: (See seral community.)

-T-

tree: a woody perennial, usually single--stemmed plant that has a definite crown shape and reaches a mature height of at least 5 meters (16 feet). Some plants, such as oaks (*Quercus* spp.), may grow as either trees or shrubs.

trend: the direction of change in range condition (ecological status or resource value ratings) observed over time.

-U-

use: (See utilization.)

utilization: the proportion or degree of current year's forage production that is consumed or destroyed by animals (including insects). May refer either to a single plant species, a group of species, or to the vegetation as a whole. Utilization is synonymous with use.

-V-

vegetation: plants in general, or the sum total of the plant life above and below ground in an area.

vegetation type: a kind of existing plant community with distinguishable characteristics described in terms of the present vegetation that dominates the aspect or phsiognomy of the area.

vigor: relates to the relative robustness of a plant in comparison to other individuals of the same species.

-W-

weather: the state of the atmosphere at a definate time and place with respect to temperature, humidity, wind, etc.

-Y-

yield: (1) the quantity of a product in a given space, time, or both; or (2) the harvested portion of a product.

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RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

CALCULATING A WEIGHTED AVERAGE

A weighted average is a mathematical technique of calculating an average for a set of data that contains two related variables. In the resource management context the weighted average is most useful in averaging spatial data (e.g., acres, production) and their relationship to quantitative data (e.g., utilization, range condition scores, etc.). The formula for calculating a weighted average (based on a spatial unit) is:

$$\frac{(\text{Spatial Unit A} \times \text{Quantitative Unit A}) + (\text{Spatial Unit B} \times \text{Quantitative Unit B})\ldots}{\text{Total of Spatial Units}}$$

EXAMPLES OF USING A WEIGHTED AVERAGE:

Weighted Average Range Condition

The weighted average formula may be used to calculate the "average range condition" for an area. Weighted average range condition may be useful in the categorization of allotments during the selective management process or may be useful in interpreting a change in range condition.

Example: A pasture has 1,000 acres in poor condition (condition score of 20), 2,000 acres in fair condition (condition score of 39), and 3,000 acres in good condition (condition score of 70). To calculate the weighted average range condition, multiply the range condition spatial units (acres) times the condition score (e.g., 29) of the spatial unit; sum the result; then divide by the total number of spatial units (acres) in the pasture:

$$\frac{\overset{\text{Poor}}{(1000 \text{ ac} \times 20)} + \overset{\text{Fair}}{(2000 \text{ ac} \times 39)} + \overset{\text{Good}}{(3000 \text{ ac} \times 70)}}{6000\text{ac}} = 51.3$$

The pasture weighted average range condition is therefore low good (51.3).

Weighted Average Utilization (Variable Production Levels)

Where utilization patterns have been mapped and production data are available, weighted averages are useful for estimating a weighted average utilization level. This is especially true if production levels vary considerably (e.g., meadow/upland vegetation).

Example: A pasture has two zones (SWAs or range sites) of production, A and B. Zone A produces 500 AUMs on 2000 acres with a utilization level of 70 percent. Zone B produces 1000 AUMs on 10000 acres with a utilization level of 35 percent. Using the weighted average formula, AUMs is used as the spatial unit and utilization is the quantitative unit:

$$\frac{\overset{\text{Zone A}}{(500 \text{ AUMs} \times 70\%)} + \overset{\text{Zone B}}{(1000 \text{ AUMs} \times 35\%)}}{1500 \text{ AUMs}} = 46.6\%$$

The weighted average utilization for the pasture (based on production) is 46.6 percent, which infers that the pasture is probably properly stocked. However, the differences in utilization levels indicate the presence of distribution problems.

Weighted Average Utilization (Uniform Production Levels)

Where production levels are fairly uniform (or if production levels are unknown) and utilization patterns have been mapped, the weighted average utilization may be calculated on the basis of acreages found in each utilization zone.

Example: A pasture has three zones of utilization. Zone A is 2000 acres with 70 percent use, Zone B is 3000 acres with 50 percent use, and Zone C is 3000 acres with 30 percent use.

$$\frac{\overset{\text{Zone A}}{(2000 \text{ ac} \times 70\%)} + \overset{\text{Zone B}}{(3000 \text{ ac} \times 50\%)} + \overset{\text{Zone C}}{(3000 \text{ ac} \times 30\%)}}{8000 \text{ acres}} = 47.5\%$$

Therefore the weighted average utilization is 47.5 percent, inferring that the pasture is properly stocked. As in the previous example, distribution is a more serious problem than is the stocking rate.

Proportions

Proportion (expressed as a decimal) may be substituted for production or acreage data, as the spatial unit. The weighted average formula changes slightly because it is not necessary to divide by a total of the spatial units.

(Proportion Spatial Unit A x Quantitative Unit A) + (Proportion Spatial Unit B x Quantitative Unit B) + . . . = weighted average

RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

Example: Using proportion and utilization data as in the previous example:

$$\overset{\text{Zone A}}{(.25 \times 70\%)} + \overset{\text{Zone B}}{(.375 \times 50\%)} + \overset{\text{Zone C}}{(.375 \times 30\%)} = 47.5\%$$

Comparison of Techniques

It is highly recommended that weighted average analysis of spatial data be conducted in as many ways as possible, especially when analyzing utilization data. Using production or acreages as the spatial unit may produce different answers.

Example: A pasture has been stratified into three zones of production: A, B, C. Utilization patterns correspond to the production zones. Zone A produces 500 AUMs on 1000 acres with a utilization level of 70 percent, Zone B produces 500 AUMs on 4000 acres with a utilization level of 40 percent, and Zone C produces 500 AUMs on 10,000 acres with a utilization level of 10 percent.

Production as the spatial unit:

$$\frac{\overset{\text{Zone A}}{(500 \text{ AUMs} \times 70\%)} + \overset{\text{Zone B}}{(500 \text{ AUMs} \times 40\%)} + \overset{\text{Zone C}}{(500 \text{ AUMs} \times 10\%)}}{1500 \text{ AUMs}} = 40\% \text{ weighted average utilization}$$

Acreage as the spatial unit:

$$\frac{\overset{\text{Zone A}}{(1000 \text{ ac} \times 70\%)} + \overset{\text{Zone B}}{(4000 \text{ ac} \times 40\%)} + \overset{\text{Zone C}}{(10{,}000 \text{ ac} \times 10\%)}}{15{,}000 \text{ ac}} = 22\% \text{ weighted average utilization}$$

The weighted average utilization figures are obviously different. One formula indicates almost twice as much utilization as the other. Analysis of weighted average data must be performed on a case by case basis. In this example, production data and acreage figures indicate that production is variable; therefore, using acreage as the spatial unit is not the preferred alternative.

RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

CALCULATING DESIRED/POTENTIAL STOCKING LEVELS

The analysis, interpretation, and evaluation process must involve an assessment of proper stocking levels. The range manager must be able to calculate a desired level of stocking for a management unit assuming that management will not change. The range manager must also be able to calculate a potential stocking level for a management unit by estimating the effects of a change in management.

Desired Stocking Level

The calculation of a desired stocking level depends on the assumption that management, specifically utilization patterns, will not change following a change in the stocking level. The calculation of a desired stocking level also depends on the identification of a key management area. A key management area is an area of land that influences or limits the use of the land surrounding it. Examples of key management areas could be riparian, wetland, or meadow areas surrounded by uplands. Maintaining proper use on the meadow could cause low utilization on the uplands. A key management area is the key area that overrides the indicators of the other key areas within the management unit. Management actions are based on the key management area. In the meadow/upland example, the meadow and upland may each have a key area, yet at any given point in time there is only one key management area (KMA).

The following formula is used for calculating a desired stocking level:

$$\frac{\text{ACTUAL USE}}{\text{KMA UTILIZATION}} = \frac{\text{DESIRED ACTUAL USE}}{\text{DESIRED KMA UTILIZATION}}$$

ACTUAL USE is the actual use for the management unit (pasture), KMA UTILIZATION is the utilization for the KMA only (pasture averages or pasture weighted averages are not allowed), DESIRED KMA UTILIZATION is the percent utilization desired for the KMA, and DESIRED ACTUAL USE is the amount of use desired in the pasture to produce the desired KMA utilization.

Example:

$$\frac{\text{1000 AUMs}}{\text{70\%}} = \frac{\text{(x) DESIRED ACTUAL USE}}{\text{50\% DESIRED KMA UTILIZATION}}$$

$$\frac{\text{50\% x 1000 AUMs}}{\text{70\%}} = \text{714 AUMs DESIRED ACTUAL USE}$$

RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

For further information and comparisons of the stocking level formulas, please read the discussion on Stocking Level/Stratification Examples (below).

Potential Stocking Level

A Potential Stocking Level is the level of use that could be achieved on a management unit, at the desired utilization figure, assuming utilization patterns could be completely uniform. Potential stocking levels are most useful when assessing the benefits of improved distribution and changes in numbers of livestock. Calculations of potential stocking levels are dependent on pasture average or pasture weighted average utilization figures. Utilization data from one specific location cannot be used unless the utilization figure represents the entire pasture.

The following formula is used for calculating a potential stocking level:

$$\frac{\text{ACTUAL USE}}{\text{AVERAGE/WEIGHTED AVERAGE UTILIZATION}} = \frac{\text{POTENTIAL ACTUAL USE}}{\text{DESIRED AVERAGE UTILIZATION}}$$

ACTUAL USE is the actual use for the management unit (pasture), AVERAGE/WEIGHTED AVERAGE UTILIZATION is the average or weighted average utilization for the pasture, DESIRED AVERAGE UTILIZATION is the degree of utilization desired for the pasture assuming uniform utilization, and POTENTIAL ACTUAL USE is the level of use required to achieve the desired average utilization uniformly over the pasture.

Example:

$$\frac{\text{1000 AUMs}}{\text{70\% (Weighted Average)}} = \frac{\text{(x) POTENTIAL ACTUAL USE}}{\text{(60\% DESIRED AVERAGE UTILIZATION}}$$

or

$$\frac{\text{60\% x 1000 AUMs}}{\text{70\%}} = \text{857 AUMs POTENTIAL ACTUAL USE}$$

For further information and comparisons of the stocking level formulas, please read the following section.

Stocking Level/Stratification Examples

A management unit can be stratified in a number of ways; however, for determining stocking levels, two data elements (utilization patterns and production mapping) are the most important. These data elements can be combined to produce four unique examples (Figure 2-1) of stratification: (A) production uniform/utilization uniform, (B) production uniform/utilization not uniform, (C) production not uniform/utilization uniform, and (D) production not uniform/utilization not uniform. Each management unit in Figure 2-1 produces approximately 1000 AUMs; actual use is 1000 AUMs and each unit is 10,000 acres in size. The shaded area in examples C and D (Figure 2-1) is a meadow area producing one half the total production.

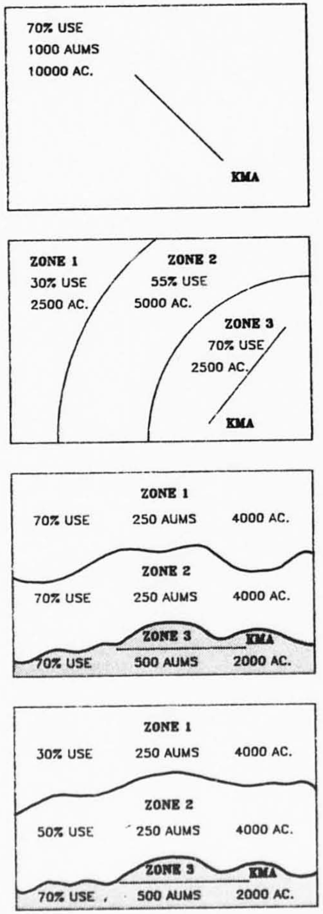
Example A (Figure 2-1) illustrates a management unit where production and utilization are uniform; however, utilization has been estimated to be 70 percent. The key management area has been determined to be the transect in the center of the management unit. The desired stocking level, using the KMA utilization figure, is 714 AUMs. The potential stocking level, using average utilization, is also 714 AUMs. The pasture average utilization is the same as the KMA utilization because utilization is uniform and the KMA is a key area representing the whole pasture.

Example B (Figure 2-1) illustrates a more typical example of a management unit where production is uniform but utilization is not. Zone 3 in this case is the KMA, and management of this zone affects the other zones. Using the KMA utilization level of 70 percent, the desired stocking level is 714 AUMs. If the allottee could change management style and achieve uniform distribution (utilization), the potential stocking level would be 952 AUMs. The allottee has a choice--stock at 714 AUMs and continue the same management or change management and potentially stock at 952 AUMs (33 percent higher than the 714 AUM figure).

Example C (Figure 2-1) illustrates a management unit where production is not uniform but where utilization is uniform. Zone 3, the meadow area, is the KMA. Calculating the desired stocking level indicates a desired stocking level of 714 AUMs. The potential stocking level, using a weighted average (production) utilization, also calculates to 714 AUMs. During the analysis of these particular data, the range manager must also consider what would realistically happen if the stocking level was reduced on the pasture. It is highly possible that livestock would continue to overgraze the meadow but undergraze the uplands. Further reductions in the stocking level might be necessary unless livestock distribution is improved.

Example D illustrates the most typical management unit, albeit much too simplistically. Again, the desired stocking level calculates to 714 AUMs, based on the KMA (the meadow) utilization level of 70 percent. The potential stocking level, assuming uniform utilization (pasture wide), calculates to 909 AUMs. The benefits (195 AUMs) to the allottee of improving distribution are easily calculated by computing the difference between the desired stocking level and the potential stocking level.

Figure 2-1



A. PRODUCTION–UNIFORM; UTILIZATION–UNIFORM

DESIRED STOCKING LEVEL (KMA):

$\frac{1000\ AUMS}{70\%} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{70\%} = 714\ AUMS$

POTENTIAL STOCKING LEVEL:

$\frac{1000\ AUMS}{70\%*} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{70\%} = 714\ AUMS$

* AVERAGE UTILIZATION

B. PRODUCTION–UNIFORM; UTILIZATION–NOT UNIFORM

DESIRED STOCKING LEVEL (KMA):

$\frac{1000\ AUMS}{70\%} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{70\%} = 714\ AUMS$

POTENTIAL STOCKING LEVEL

$\frac{1000\ AUMS}{52.5\%*} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{52.5\%} = 952\ AUMS$

* WEIGHTED AVERAGE (ACREAGE)

C. PRODUCTION–NOT UNIFORM; UTILIZATION–UNIFORM

DESIRED STOCKING LEVEL (KMA):

$\frac{1000\ AUMS}{70\%} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{70\%} = 714\ AUMS$

POTENTIAL STOCKING LEVEL

$\frac{1000\ AUMS}{70\%*} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{70\%} = 714\ AUMS$

* WEIGHTED AVERAGE (PRODUCTION)

D. PRODUCTION–NOT UNIFORM; UTILIZATION–NOT UNIFORM

DESIRED STOCKING LEVEL (KMA):

$\frac{1000\ AUMS}{70\%} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{70\%} = 714\ AUMS$

POTENTIAL STOCKING LEVEL

$\frac{1000\ AUMS}{55\%*} = \frac{(X)}{50\%}$ OR $\frac{50\% \times 1000\ AUMS}{55\%} = 909\ AUMS$

* WEIGHTED AVERAGE (PRODUCTION)

RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

DETERMINING STOCKING LEVELS WITH ACTUAL USE, UTILIZATION, AND CLIMATIC YIELD INDEX--AN EXAMPLE

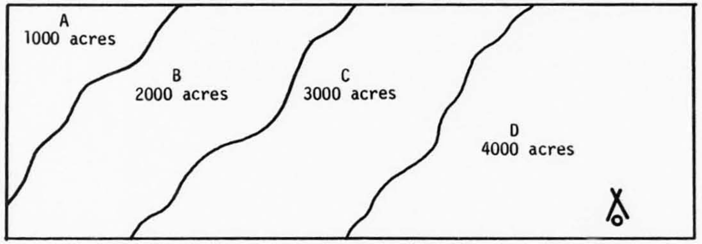
The following data were collected on the Spring Creek Pasture. The key forage species occur throughout most of the pasture. The maximum level of use on the key species is 60 percent. Utilization data were used to map utilization zones (see Appendix 2, page 2).

		Percent Utilization		
Zone	Proportion	1978	1979	1980
A	.10	25 (2.5)	20 (2.0)	25 (2.5)
B	.20	40 (8.0)	30 (6.0)	30 (6.0)
C	.30	65 (19.5)	55 (16.5)	60 (18.0)
D	.40	75 (30.0)	70 (28.0)	70 (28.0)
Prorated Pasture-Wide Utilization (%)		(60.0)	(52.5)	(55.0)
Yield Index*		.9	1.2	1.3
Pasture-Wide Utilization (%) Adjusted to "Normal" Production Year (Utilization x Yield Index)		(54.0)	(63.0)	(71.0)
Actual Use Data (AUMs)		255	300	360

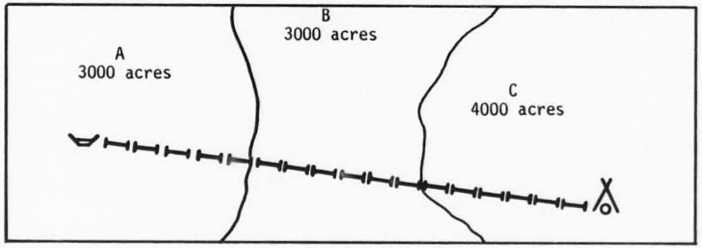
*The yield index is an estimate of production relative to production that occurs in a "normal" year. It is derived from establishing the relationship (regression equation) between herbage yield indices and their corresponding crop-year precipitation indices. The yield and precipitation indices are expressed in percentages of median amounts (Sneva and Hyder 1962a and b).

RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

The utilization zones and water are distributed as illustrated.



The mapping reveals an undesirably high level of use in zones C and D nearest the water source and too little use in zones A and B. A second water source is developed to promote better livestock distribution. Monitoring continues for the next two years and only three utilization zones are observed.



RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

Utilization data indicate the following:

Zone	Proportion	Percent Utilization 1981	Percent Utilization 1982
A	.30	60% (18.0)	65% (19.5)
B	.30	50% (15.0)	55% (16.5)
C	.40	55% (22.0)	60% (24.0)
Prorated Pasture-Wide Utilization (%)		(55.0)	(60.0)
Yield Index		1.1	.9
Pasture-Wide Utilization (%) Adjusted to "Normal" Production Year		(61.0)	(54.0)
Actual Use Data (AUMs)		312	300

The actual use data and adjusted utilization values can be used to determine the actual use needed to provide the potential level of use in the pasture in a normal production year (see Appendix 1).

$$\frac{\text{Actual Use}}{\text{Average Utilization}} = \frac{\text{Potential Actual Use}}{\text{Desired Average Utilization}}$$

(adapted from Schmutz, 1971)

The values determined are as follows:

YEAR	1978	1979	1980	1981	1982
AUMs	283	286	304	307	333

Therefore, the potential stocking level for obtaining approximately 60 percent utilization uniformly throughout the pasture is within the range of 283-333 AUMs and can probably be assumed to be towards the higher level. (The data collected after the second water source was developed support this assumption.)

RANGELAND MONITORING - ANALYSIS, INTERPRETATION, AND EVALUATION

RANGE PRODUCTION INDEX FOR UTAH[1]

A Utah State University research team has related the Palmer Drought Index, developed by the National Weather Service, to vegetation production on Utah's rangelands.

The Palmer Drought Index is the result of combining average monthly temperature and monthly accumulation of precipitation during the 1931-1960 period. If conditions are approaching this 30-year average, the value of the index is near zero. If conditions are wetter than the 30-year average, the index is positive. If conditions are below average, the index is negative. Negative indexes have been related to drought conditions in each climate division. If the index drops to -4 or lower, an extreme drought condition exists.

In order to relate the Palmer Drought Index to range production, it is necessary to make an estimate of what the average Palmer Drought Index will be for the growing season. Three different conditions are assumed:

1. Normal temperature and moisture conditions will persist during the remainder of the growing season from the time the last actual values were measured.

2. Precipitation will be only 50 percent of normal for the remainder of the growing season.

3. Precipitation will be 150 percent of normal during the remainder of the growing season.

The resulting Palmer Drought Indexes are used to calculate the Range Production Index[2] for the coming growing season. This index is updated at the end of each month and is distributed to interested parties by the Office of the State Climatologist.

Several weather conditions may override the index. Late spring frosts that kill early production and serious drought stress during previous years cause production estimates to vary considerably.

The following are sample production figures for the 1983 growing season as estimated at the end of March 1983:

1 Revised from E. Arlo Richardson's "The Range Condition Index" Report.
2 The Range Production Index is referred to by Richardson as "Range Condition Index."

Calculated Range Production in Utah's Climate Divisions
at the End of March 1983

	Range Production Assuming Selected % of Normal Precipitation		
Division	50% Normal	Normal	150% Normal
Western	94	111	114
Dixie	107	109	111
North Central	120	124	126
South Central	115	119	123
North Mountain	109	114	113
Uinta Basin	93	109	113
South East	97	108	109

These estimates would indicate in general very good production in most areas of the state even if the percent of normal precipitation should drop to 50 percent of normal for the period April through September. If a severe late spring frost should develop, however, these production values might be considerably less.

EVALUATION SUMMARY - AN EXAMPLE

I. Name and Number of Allotment

Blue Mesa Allotment (No. 6403) - User is Mile High Ranch

II. Livestock Use

A. Preference 1. Total - 690
2. Allowable use - 243 (by agreement)
3. Suspended preference - 394
4. Voluntary non-use - 53
B. Season of Use: 4-20 to 5-19 103 AUMs
12-2 to 1-1 140 AUMs
C. Kind and Class of Livestock: Cattle - Pairs
D. Percent Public Land: 100
E. Other: No changes were made in kind or season of livestock use during the evaluation period; however, the permittee may convert his operation to raise sheep.

III. Allotment Profile

A. The Blue Mesa allotment is located northwest of Poverty Knoll along the Red River. It is characterized by low country and draws dominated by annuals and perennial grasses, bitterbrush benches, and pinyon-juniper woodlands in its upper elevations. Almost all grazing use is made by cattle in the flat areas along the river and the draws. According to an agreement reached with the permittees in 1980, this allotment was studied from 1980 through 1983. At that time, licensed use was 296 active AUMs. The agreement set use at 243 AUMs with the rest of the AUMs to be taken as non-use pending the outcome of this evaluation.

B. Acreage: Fed - 6420

C. Objectives: 1. Reduce SSF from 74 to 64 in pasture 3 and from 55 to 45 in pasture 4 by the year 2000 by increasing vegetative density.
2. Improve mountain mahogany (CEMO) composition and condition for wildlife.
3. Improve 800 acres of bitterbrush (PUTR) benches for wildlife in 20 years by limiting utilization to 50 percent and achieving an age class of 70 percent mature, 10 percent young, 10 percent seedling, and 10 percent decadent; and form classes of 20 percent heavy hedging, 60 percent moderate hedging, and 20 percent light hedging.

4. Improve riparian habitat.
5. Increase livestock use from 243 to 296 AUMs by increasing ground cover by 10 percent.

D. Key Forage Species: Galleta grass (HIJA) and Indian rice grass (ORHY); however, only galleta, alkali sacaton (SPAI), and blue grama (BOGR) are found in any amount. Key species for deer are mountain mahogany and bitterbrush.

E. Grazing System: Two pasture deferred rotation alternating early use each year. The system was implemented 11/82, and has been followed until sale of cattle in summer 1983. This AMP was one of many written by a team of new employees in the six-month effort prior to preparation of the 1979 grazing ES.

IV. Management Evaluation

A. The purpose of this evaluation is to determine proper stocking rate per the monitoring policy and grazing ES schedule.

B. Summary of Studies Data: Refer to the attached analysis form

1 Actual Use - Made by pairs - mixed angus and herefords:

	1980	1981	1982	1983
Spring	126	83	78	62
Winter	170	170	170	0
	296	253	248	62

Agreement on nonuse was effective 3/1/81. Actual use exceeded permitted use in 1981 because of an error made in issuance of preference statement.

2. Climate

A. Precipitation: long term annual mean for Poverty Knoll is 11.01 inches

	1980	1981	1982	1983
Annual	14.47	13.67	15.45	15.56

These data are only for the Poverty Knoll NOAA Station. BLM rain gauge data correlate fairly closely with the above. From these data, 1980-83 should have been above average production years. However, looking at seasonal precipitation, the spring of 1982 as well as the summer of 1980 should have shown below usual production.

3. Utilization

Eighty-five (85) samples were taken in four different key areas (two in each pasture), at the same location both in the draws and in the flats next to the river. No samples were taken on the benches as there is little forage use up high. High utilization (50-70 percent) is found near the river and in the draws away from the river (ranging from 37-55 percent over the period 1981-83). Approximately 42 percent of the forage is produced in the flats near the river on 11 percent of the area. Utilization is usually only sampled during the spring so considerable regrowth occurs after utilization is sampled. In January, 1982, when winter utilization was sampled, the use approximated 70 percent. Species sampled most frequently were HIJA and SPAI; they comprise approximately one-third of the perennial plant community. Utilization represents livestock use. Other use is insignificant. Average utilization is as follows:

1981 = 51%, 1982 = 61%, 1983 = 42%

4. Trend

A. The trend index (percent key species, percent live perennial vegetation, number of seedlings and percent litter cover) and apparent trend are as follows (representing three key areas):

	Trend Index	Apparent Trend
1980	51.8	21.3
1981	44.6*	23.0
1982	91.5	29.0
1983	88.2	29.3

(*Data from one key area only due to access being flooded.)

Transect data show an improvement in trend as reflected in increase in percent perennial cover and key species. Trend index increased markedly in 1982 and 1983 due to increases mainly in number of seedlings of SPCR and BOGR. Apparent trend is also upward.

B. Hedging and form class studies were done on bitterbrush. No significant livestock use is made of this plant in the allotment due to inaccessibility. No SSF studies have been done. No monitoring or riparian habitat has been attempted because of an inability to find a suitable site for the studies.

V. Conclusions

A. Objectives

Referred to by number shown in III.C.

1. Trend in SSF is not being measured as this procedure is too subjective and since sampling the change in cover and litter objectively assesses change in soil surface protection in response to management

2 and 3. Objective 2 is not specific as to what and how much improvement is desired. Wildlife habitat and use are primarily restricted to the benches and upper slopes of the drainages. Cattle use in these same areas is negligible due to topography and not a significant factor in use of bitterbrush and mountain mahogany. At this time, therefore, cattle use cannot be used as a tool to reach objectives shown for these two species.

4. The riparian objective is not specific as to what and how much improvement is desired. There is a thick cover of willow, skunkbrush, and tanglebrush along most of the riverbank. With the fluctuating water levels, the riverbanks are as stable as can be expected. The overbrowsing of young cottonwood trees is the primary problem with grazing use by livestock in the riparian zone since this limits seedling and sapling growth. Monitoring (cover or frequency) is difficult if not impossible except by photo point in the riparian areas near the riverbank.

5. At this point the objective for increasing stocking rate has not been met. The following table summarizes spring grazing which is the most critical use:

	1981	1982	1983
AUMs Used	83	78	62
Ppt (Feb. thru May)*	3.6	2.1	6.5
Utilization (%)	51	61	42

(*3.6 = NOAA mean Ppt. for this period)

From the above, 50 percent utilization was realized during an average spring precipitation year when 83 AUMs use was made. The goal of 55 percent spring utilization would probably be realized by a stocking rate of 80-85 AUMs (this also recognizes that regrowth will occur).

VI. Consultation

O. G. Whiz, Wildlife Biologist; "Dusty" N. Windee, Soil, Air and Water Specialist; Bob N. Weave, Range Conservationist; and Ralph Rancher, Allottee.

VII. Recommendations

A. Objective 1 - Delete the former objective and replace it with the following:

Increase perennial ground cover in areas used by livestock (from 12 percent to 18 percent) and litter (from 18 percent to 24 percent) by the year 2000.

B. Objectives 2 and 3 - Delete both objectives until such time as the kind of livestock is changed to sheep. When and if this occurs, reinstitute these objectives if sheep will use the benches and upper slopes. Establish utilization limits on both species and consider propriety of winter sheep use in these areas. Assuming a change to sheep the objectives should be combined and reworded as follows:

"Improve deer habitat in the upper slopes of the drainages and on the benches by limiting total utilization on mountain mahogany and bitterbrush to 50-60 percent and manage both species to achieve and age class distribution of 50-70 percent mature, 15-25 percent young, and 15-25 percent decadent. Manage both species to attain 10-20 percent heavy hedging, 60-80 percent moderate hedging, and 10-20 percent light hedging.*"

C. Objective 4 - The riparian objective should be reworded to read: Limit livestock use on cottonwood seedlings and saplings to no more than 50 percent of plants browsed annually until the plants are 8 feet or more in height.

If a change to sheep occurs, the permittee should be instructed to water the sheep at no more than two points on the river in each pasture.

In addition to the percent of cottonwood seedlings/saplings browsed, the riparian area should be monitored by using the Riparian Habitat Scorecard which rates apparent trend (in lieu of cover or frequency studies). Also, at least two permanent photo plots should be established and read.

*Both age and form class objectives should have baseline figures confirmed and documented in these objectives.

D. Objective 5 - The period of time during which the AMP has been in operation is inadequate in terms of judging the allotments' response to management. Further, the allotment was not fully stocked in 1983. These factors make an assessment of proper stocking rate difficult. Based on the data available and our best judgment, it is recommended that the use be held to 243 AUMs with no more than 85 AUMs use allowed during the spring season pending the next evaluation.

In regard to the grazing system, a more rapid improvement of the allotment in general and a better chance to maintain and improve the riparian habitat and increase livestock use would be probable with a change in the present grazing system. Instead of alternating early use year by year which results in seedlings and young plants being grazed before they become established, a two-year schedule using the same pasture in the spring and deferring the other for fall use should result in greater improvement allotmentwide (including the riparian areas). It is recommended this change in the grazing system be made effective next spring.

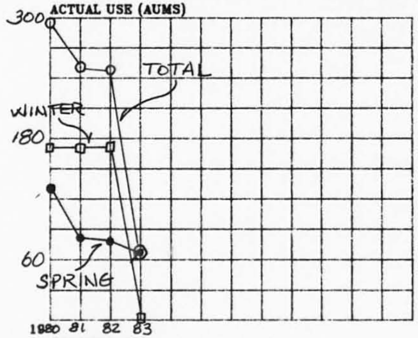
E. Key Species and Utilization - Based on species occurrence and use, key forage species should be changed to HIJA, SPAI, BOGR (and PUTR if sheep use is made on the benches). Utilization limits should be placed on key species which would provide for use of annual species in the spring but still consider physiological needs of the key species. To facilitate reaching cover objectives, utilization limits should also be established on key species in the winter pasture, and use in the winter season should be measured as well.

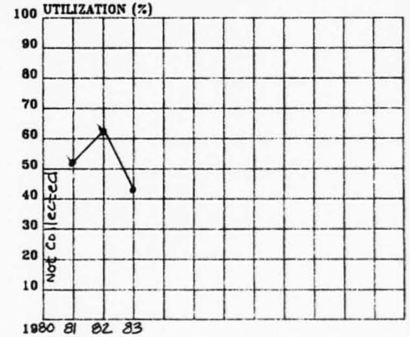
F. Next Evaluation - Schedule the next evaluation in four years after one cycle of the new grazing system is completed. The resource area range conservationist, wildlife biologist, district hydrologist, permittee, and Division of Wildlife should be included in the evaluation. If the results are controversial or consensus cannot be reached on changes to be made, the District Grazing Advisory Board and District Advisory Council should be consulted.

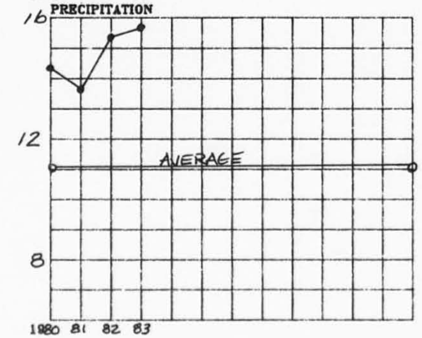
MONITORING DATA SUMMARY

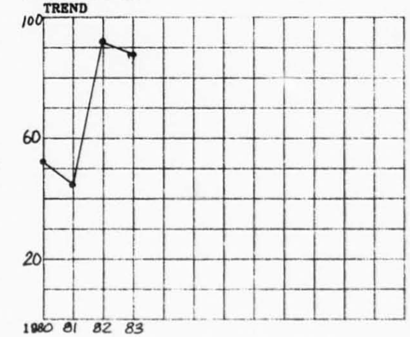
STATE YA
DISTRICT 04
RESOURCE AREA 0470

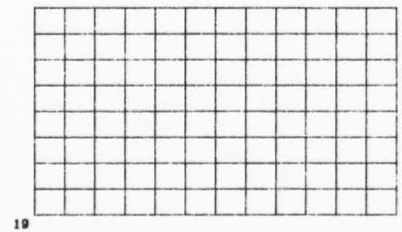
ALLOTMENT BLUE MESA
PASTURE ALLOTMENT SUMMARY

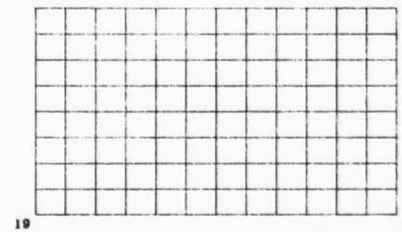












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