served by the climax approach than by proposed alternatives; (g) that the '49 approach has been applied with results obvious to, and appreciated by, ranchers from the 5–9 inch Avg. Annu. Precip. Zone to the 30-34 P.Z. and up on very shallow, claypan, and coastal marsh sites; and (h) that local Technician's Guides are required, and where not already available within the Soil Conservation Service, the Bureau of Indian Affairs, the Province of Alberta, or regionally in other agencies such as the Bureau of Land Management on the watershed of the Missouri River, they must first be developed.

Taking into account regulation of runoff and erosion, along with ecological findings of Sampson and many since, it seems improbable that site condition, based primarily on soil characteristics and productivity for various uses, will displace; (1) climax as a measure of site potential on rangelands, (2) broad range condition classes as indicators of amount of improvement possible on such sites, and (3) secondary succession as the measure of progress in range improvement.

Canopy Cover as a Method of Monitoring Trend in Ecological and Soil Status

E. William Anderson

Monitoring the trend of ecological and soil status on rangelands and grazed forests has long been considered a necessary field procedure. Historically, we have used a variety of procedures including pantograph and photograph quadrats, exclosures, fence-line photos, belt and line transects, and various randomized plot schemes and methods of measuring vegetation and soil factors. All have had good points at the time and much as been written on this subject (USDA Forest Service 1959).

Although intentions are good, the fact is that follow-through under practical field conditions is frequently neglected. Literally hundreds of plots and transects established over the years have been forgotten or abandoned. Monitoring, as a field technique, has been plagued by factors such as procedures involving too much precision for easy application by the nonresearch type people who were expected to use them; frequent transfers of personnel without continuity in the monitoring effort; and costs and workloads that led administrators to decide that other budgetary items took precedence over monitoring.

Monitoring is so important in contemporary resource management that special effort should be made to develop a simple, relatively inexpensive procedure that can meet the needs of practical resource management. Reliance on legislation to mandate monitoring is not enough to get the job done.

This article presents a simple procedure for documenting trend in ecological and soil status based on multiple factors and sensitivity to the dynamics of change, especially in early stages of trend. It is not intended as a substitute for more precise procedures where they are needed. This procedure consists of two phases, one conducted annually and one periodically over a span of years. The annual phase, already being used, consists of interpreting patterns of utilization that exist following the livestock grazing season (Anderson and Currier 1973). The periodic phase consists of interpreting data collected on permanent plots as described herein. Either of these two phases can be used alone advantageously. When used in conjunction with each other, the impact of livestock on trend is clarified in respect to the impact of weather and other herbivores, such as elk, deer, rabbits, mice and insects. Consequently, reasons for apparent trend are clearer and more realistic than if trend data, *per se*, are the only data for interpretation.

Causes of Change

Vegetational changes over time may result from factors that are not readily apparent nor well understood. Not all changes are attributable to grazing by herbivores. Long-time observations of the synecology of ecological sites indicate that many herbaceous species are naturally cyclic in respect to their abundance from year to year and some naturally disappear for a period of years. Although weather or changes in ecological status (condition) are commonly cited as causal factors, the specifics are often speculative.

Various kinds of shoddy techniques can induce artificial vegetational changes into the data. For example, a thorough listing of species on a plot during one data collection and an incomplete listing during the subsequent collection results in the data showing changes that may not have occurred. A subsequent collection of data on a plot during a different phenological stage than existed at the time of the first collection will produce similar results.

For reasons such as these, considerable prudence is required to develop the rationale upon which a viewpoint on trend in ecological and soil status can be based; it is not a cut-and-dried procedure (R.I.S.C. 1983).

Changes Measured

Diet selectivity by herbivores causes different effects on the plant community and the resulting changes usually occur in combinations rather than as single effects (Anderson 1977). Therefore, a single criterion is not adequate for predicting trend.

In this procedure, the following changes in the plant community were selected for measurement: floristic composition, canopy cover, litter, plant vigor, and forage production. Trend in soil status is measured by changes in bare ground and cover of litter, gravel/stones and mosses/lichens.

Floristic composition is measured by listing the names of

The author is Certified Range Management Consultant, 1509 Hemlock Street, Lake Oswego, Oregon 97034. (503) 636-8017.

all species that occur on the permanent plot. Canopy cover and dominance ratings of vegetation, species by species, and cover of litter, bare ground, gravel/stones, and mosses/lichens are measured by using the technique and guide for estimating cover explained by Anderson (1986). Special attention is given to the occurrence of seedlings of perennial/biennial species that might help predict trend, such as sagebrush and needlegrass, and these are rated as either ABUNDANT or SOME.

Plant vigor, based on the current growth form as compared to a perceived standard for the species on that particular ecological site, is expressed in one of three classes: HIGH MEDIUM LOW. Obviously, this is a judgmental factor with many weaknesses. Nevertheless, the three-class comparison does provide an experienced-judgment opinion by the observer which can be used as supplementary information for predicting trend, which is in keeping with the objectives of this practitioner-type procedure.

Forage production is not a factor for judging trend. A change in production of perennial/biennial species can be caused by a change in the vigor of these plants, especially during early changes in ecological status. Changes in production also can be caused by changes in plant density and composition. In both cases, changes in production that are obviously not related primarily to weather are supporting evidence of trend. Production is estimated in usable pounds per acre air dry, using clipped/weighed plots if desired, from perennial/biennial species and taking into account a residue

	ITEMS & SPECIES	DATE: 6/21/78		DATE: 6/26/84	
		DOMI-NANCE	CANOPY COVER	DOMI-NANCE	CANOPY COVER
	Bare Ground	XXX	45	XXX	35
	Gravel & Stones	XXX	10	XXX	10
	Litter & Mulch	XXX	20	XXX	30
	Mosses & Lichens	—	0	–	0
	Idaho fescue	3	5	- 3+	5
	Squirrel tail	2	1	- 3	1
	Bluebunch wheatgrass	2	1	- 3	1
	Prairie junegrass	1	T	- 2	T
Grass & Grass-like	Thurber needlegrass	3	2	- 3	2
	Needle-and-thread	1	T	0	0
	Western needlegrass	1	T	- 3	1
	* Basin wildrye			2	T
	Arabis	1	T	- 1	T
	Longleaf phlox	2	1	0	0
	Woollypod loco	1	T	- 2	1
	Sulphur flower buckwheat	2	1	- 2	1
	Willow weed	3	1	- 1	T
Forbs	Silky lupine	3+	7	- 3-	2
	Pearl everlasting	1	T	0	0
	* Specklepod loco			1	T
	* Madia			1	T
	* Lineleaf fleabane			1	T
	* Threadleaf fleabane			1	T
	* Butterweed groundsel			2	1
Shrubs					
	Granite gilia	1	T	- 1	T
	Gray horsebrush	1	T	- 1	T
	Lanceleaf green rabbitbrush	2	1	- 2	1
Trees	Mt big sagebrush	5	25	- 5	25
	Bitterbrush	3	3	- 4	5
	* Rubber rabbitbrush			1	T
	plus 1 for 10 Ts				1
	Total Cover:	XXX	48	XXX	47
	Perennial Cover:	XXX	47	XXX	47
	Growing season this year:	(AbAv) : AV : : BeAv		AbAv : : (Av) : BeAv	
	Est. lbs/acre air dry: Per. grass & forbs	100		300	
	Shrubs	—		—	
	Apparent vigor (key species):	H M L		H M L	
	Idaho fescue	L: X		H: X	
	Thurber needlegrass	L: X		H: X	
	Bitterbrush	M: X		H: X	
	Seedlings:	abun some		abun some	
	Western Ndlgrass & Bitterbrush			abun: X	
	Idaho fescue & Bluebunch whtgr			some: X	

Fig. 1 . *Format for recording monitoring data on a single plot over a span of time. Data shown are abbreviated from an actual plot study.*

conforming to safe degree of utilization (proper use).

Frequency of measuring changes in vegetation and soil on permanent plots can be at intervals of five or more years depending upon objectives and the size and distribution of workloads. If an objective is to learn about the dynamics of trend in ecological and soil status at early stages of seral change, the five-year interval produces such information.

Permanent Plots

In this procedure, each permanent plot consists of three components: a 3-foot square plot marked by steel pegs, which serves as a close-up photo point; a 25-foot line plot, suitably marked at both ends and encompassing the 3-foot plot, which serves as a photo point of the general aspect; and an unmarked plot approximately 50 feet in radius centered on the 3-foot plot which is the area on which all plant species and other measurements are recorded. The size of the plot (approximately 8,000 sq. ft.) is usually sufficient to encompass the species variability and clumpiness typical of native plant communities. Larger areas may be required in some vegetational types and smaller areas may be adequate to sample plant communities that are fairly uniform. The size of the plot used in the initial data collection should be recorded on the data sheet so that subsequent collection will represent approximately the same area.

Subsequent readings of an unmarked plot can only approximate the area previously read. A few species may be added or lost in the data. The dominance rating which accompanies the cover estimate for each species will flag the rare species which are too insignificant in the floristic composition to affect interpretation.

This procedure is not suitable for measuring the plant community on wet meadow sites because the dense, multi-layered vegetation makes estimating per cent cover of individual species virtually impossible. The occurrence and aspect dominance of wet-meadow species commonly changes markedly as the growing season progresses and different readings are obtained at different times due to phenological changes.

Number and location of plots is an important consideration in monitoring trend in ecological and soil status by this procedure. Since an objective is to simplify and reduce costs consistent with meeting the needs of practical resource management, the number of plots is minimal. No attempt is made to attain statistical adequacy. Rather, the philosophy of this procedure is "on the basis of the data *from these plots,* the predicted trend for this ecological site is...and for these reasons...." For those who have never tried this approach to interpreting data, experience has shown that it is a common-sense philosophy acceptable for practical resource management situations.

In order for a minimum number of plots to provide a reasonable basis for predicting trend, it is necessary to judiciously select the location of each plot. The value of the data from the plots is enhanced and made more acceptable for interpretation and extrapolation by locating each permanent plot on a representative example of each major ecological site in the pasture being monitored. In large pastures, several plots per ecological site are desirable. Thus, the ecological site becomes the means for stratifying the landscape into reasonably homogeneous units which require fewer plots to sample. The site becomes the basis for extrapolating to other areas of the same site within that pasture. Plots should not contain transition zones between sites so as to obtain as much homogeneity and extrapolation value as possible.

The objective of monitoring trend is to denote changes caused by herbivore grazing. It is essential that each permanent plot be located where it will be grazed. Plots on upland sites should be located at least one quarter mile from water and in easily accessible area to ensure being grazed. Plots located in the vicinity of roads help reduce travel time between plots, which constitutes a large proportion of the cost of monitoring.

Data Collection

The process of initially reading a plot is necessarily somewhat different than subsequent readings because the first reading establishes the plot and its basic data. Subsequent readings focus on changes that have taken place since the previous reading.

Step 1 is to select the location of the plot, establish the 3-foot square and 25-foot line plots and take a color photo of each using a standard lens to avoid distortion. Each photo should display a placard for identification of the plot. Preferably, two people, one acting as recorder, should be involved in data collection so as to save time and provide a cross-check on estimates made when measuring factors. Collection of data begins by listing the names of all species—annuals and perennials—occurring on the 50-foot-radius plot using common and/or scientific names. Symbols are not readily translated during interpretation when numerous species are involved. After both persons have searched the plot and all species have been recorded, the process of quantifying begins by estimating canopy cover and dominance ratings, species by species, then bare ground and other items. Both persons verbally concur on each estimate and rating before it is recorded using the scattergram and technique described by Anderson (1986) so as to maintain reasonable accuracy and consistency.

Seedlings of species that might help predict trend in ecological status are recorded and rated as to abundance—ABUNDANT or SOME. Estimates of usable forage and apparent vigor of key species provide supplemental information.

Subsequent plot readings are made to denote changes that have taken place during the interim. Starting with the data sheet from the initial reading, use a check mark to indicate the species currently on the plot that were there previously. Add those species that are currently on the plot but were not there previously and mark these with an asterisk for ready identification during interpretation of the data. Species that have disappeared from the plot since the previous reading should be marked by a zero in the current quantification (Fig. 1).[1] For species currently on the plot that were there previously, if no change has occurred, the previous percent cover and dominance rating for each of those

[1]A copy of a field data sheet which accommodates four readings of a plot can be obtained from the author by sending a self-addressed, stamped envelop. Figure 1 is a simplified version.

species is recorded as the current data. If change has occurred, estimating cover, rating dominance and other measurements are the same procedure as used in the initial reading.

Case History

This monitoring procedure was established on the 576,000-acre Sheldon National Wildlife Refuge in Nevada-Oregon in 1978 after the coordinated resource management plan for the refuge was developed. Selected management units that had been grazed by cattle and feral horses were examined annually to map zones of utilization and record other pertinent data. Fifty-three permanent plots were established initially representing 14 different ecological sites and all management units. Distribution was reasonably uniform over the entire refuge. Since the initial plots were established, a number of additional plots have been established in strategic locations.

The initial reading of the permanent plots involved 11 days between June 6 and June 22, 1978, and required 110 hours for each of two people, about 65 percent of which was locating and establishing plots and travel between plots. About 40 minutes were required to document a single plot. Plant communities on most ecological sites were fairly well developed phenologically.

The next reading of plots was originally planned for 1983; however, that was an exceptionally favorable year for vegetational growth which might have exaggerated actual changes that had occurred. Therefore, the readings were postponed to 1984, when it involved 9 days between June 25 and July 13 and required 102 hours for each of two people. Growing season temperatures were near normal. Crop-year (September through June) precipitation was above normal (121%). But precipitation during the critical spring growing season, April through June, was only 72% of normal. Phenologically, some species were slightly overmature on some sites. Two plots had been vandalized and could not be relocated.

Data collected by using this procedure provided a basis for the following kinds of interpretations regarding trend:

Canopy Cover: In 1984, plot readings showed a uniform reduction in the cover of perennial/biennial species on all ecological sites and in all management units. Only 10 of the 51 plots located during the second reading showed increased cover and one plot remained static. Decreased cover was likely due to the droughty spring growing season which adversely affected production. Had grazing management been a factor, some units would have differed from others because grazing varied from unit to unit and from year to year in a single unit. Mapped zones of utilization support this viewpoint.

Floristic Composition: Between 1978 and 1984, low sagebrush sites on Sheldon lost six perennial/biennial species but gained 23 new perennial/biennial species. The bitterbrush site lost 13 and gained 32 new; the mountain mahogany site lost six and gained two new; the juniper site lost five and gained four new; the big sagebrush sites lost 13 and gained 23 new; and the bottomland sites lost 15 and gained 20 new perennial/biennial species. This general increase of new perennial species on nearly all sites and in all management units over six years indicates an apparent favorable trend in ecological status toward the potential natural plant community (PNC) of the sites.

The desirable quality of these new species, as illustrated by species such as basin wildrye; big, Canby and Cusick bluegrasses; serrate balsamroot; lineleaf, threadleaf and Austin fleabanes; modoc hawksbeard; and cream and rock buckwheats, lend credance to this trend.

Diversity of vegetational types is often cited as a major management objective, especially in respect to wildlife management. Under natural conditions, diversity is usually associated with the pattern of vegetational types in the area, e.g., low sagebrush, big sagebrush, juniper. The addition of new perennial species to the plant community of an ecological site is also an important factor in achieving vegetational diversity, albeit generally overlooked.

Litter: The 1984 reading showed that litter had increased on 23 plots and remained static on 26 of the 51 plots read. Litter increased on eight major ecological sites, remained static on four and decreased on two relatively minor sites. Increased litter is related to the standing stubble left on forage plants at the end of the past five grazing seasons in conformance with the objective of obtaining safe degree of utilization. Mapped utilization zones support this viewpoint.

Increased cover of litter indicates the development of an improved microenvironment for establishment of seedlings of herbaceous species. This, in turn, represents an apparent trend toward eventual establishment of new species and an increased stand density.

Soil: No clearcut procedure for rating trend in soil status exists. Several factors related to soil stability, infiltration and evaporation were observed. On the average, bare ground decreased on five sites, remained static on seven and increased slightly on two minor ecological sites. Cover of gravel/stones decreased on three sites, remained static on nine and increased slightly on two minor sites. Cover of mosses/lichens increased on seven sites, remained static on five and decreased on two ecological sites. Cover of litter, which is a factor in both ecological and soil status, has been cited previously.

Summary: Based on the plots of this study, it was found there was an apparent overall trend in ecological status toward the potential natural plant communities of the ecological sites on the Sheldon Refuge. The rationale for this prediction is based on the significant increase in litter reflecting the standing residues associated with safe degree of utilization obtained annually, the increased number of perennial/biennial forbs, the abundance of new species, and the kinds of perennial/biennial species that have increased or are new in the plant communities as a result of mangement between 1978 and 1984. Futhermore, there is an apparent improvement in soil status on upland sites as indicated by reduction in bare ground and a significant increase in litter.

Summary

The monitoring procedure described herein is equally adapted to grassland, shrubby, savannah, woodland and forest sites. All species of grasses, grass-likes, forbs, shrubs and trees, as well as bare ground, gravel-stones, mosses/lichens, and litter are measured by the same method of quantification—estimated canopy cover. This enhances the value of the data for ecological interpretation, especially as related to watershed values and wildlife habitat.

The plot used is large enough to encompass the major variability of the native plant community being sampled. Percent cover and a dominance rating for each species on the plot clearly displays the kinds and rate of changes that occur in respect to floristic composition and canopy cover. Changes in bare ground, litter, mosses/lichens and gravel/-stones also are documented thereby providing a combination of factors upon which the rationale for predicting trend in ecological and soil status can be based.

Ecological sites provide the means for stratifying the landscape into relatively homogeneous units and each plot is located on a representative example of an ecological site. This enhances the value of the data for interpretation and extrapolation.

Predictions of trend are based on the data from a few carefully selected plots; location in relation to ecological sites and grazing patterns is emphasized. Fewer plots affect the cost and workload involved which can be important for perpetuating the monitoring program in competition with other activities.

This procedure requires the ability to identify all the plant species, which is a skill that some resource managers do not have or have not retained. However, people skilled in plant taxonomy are available and can use this procedure.

Because of the nature of the data obtained, the greatest value of this procedure may be its contribution to our knowledge of the autecology of species and the synecology of ecological sites upon which prudent resource management must be based.

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Accreditation of Professional Programs in Range Management Education

The responsibility for accreditation of professional programs in range management education has been accepted by the Society for Range Management (SRM) in furtherance of its stated constitutional objectives to "foster advancement in the science and art of grazing land management...and to encourage professional improvement of its members." Accreditation of professional programs is a proven and accepted approach successfully used in such professions as medicine, law, engineering, and forestry for several decades. In comparison, SRM's accreditation program is young and is patterned after the procedures developed by the Society of American Foresters. SRM has been accrediting universities' range management programs since 1980, during which time nine universities have been accredited (Table 1).

Table 1. Universities' professional range management programs that have been accredited by the Society for Range Management.

University	Date: Accredited	Date: Re-Accredited
Colorado State University	Feb. 1980	March 1985
Utah State University	Feb. 1980	March 1985
University of Arizona	Feb. 1981	Jan. 1986
Texas Tech University	July 1981	Jan. 1986
New Mexico State University	Feb. 1982	July 1987
University of Idaho	March 1985	—
Washington State University	March 1985	—
Oregon State University	Feb. 1987	—
Texas A&M University	Feb. 1987	—

The objectives of the SRM accreditation program are to: (1) support the universities' efforts to improve the quality of educational programs in range management; (2) establish recognized minimum standards for undergraduate range management education; and (3) identify schools having programs meeting or exceeding acceptable standards.

SRM has a standing accreditation panel that has been assigned by its Board of Directors the responsibility of developing and updating standards and procedures, and conducting the accreditation visit. The panel makes recommendation to the Board which is responsible in all final actions. Accreditation of university range management programs can only be successful if the process and procedures are carried out by recognized peers. For this reason the panel is made up primarily of university faculty from accredited programs. Five of the seven panel members are to be university faculty with the rank of associate professor or higher, with at least one member from a federal land management or federal research agency.

The Society's minimum standards for accreditation are strong but should be attainable by most range programs. SRM encourages all range management programs to seek accreditation. Eight standards are used to judge program quality: (1) program objectives; (2) curriculum; (3) faculty; (4) students; (5) program; (6) parent institution and supporting departments; (7) physical resources and facilities; and (8) research and extension. Universities wishing to be considered for accreditation need to request through SRM's executive vice president: (1) standards for accrediting institutions; (2) procedures for accrediting; (3) instructions for preparing the self-evaluation report; and (4) a program site visit and evaluation.