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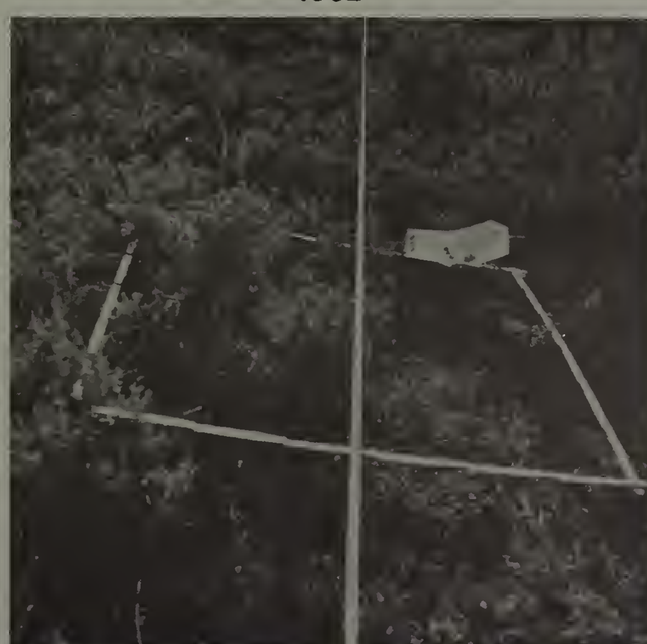
INTERPRETATION OF TREND IN RANGE CONDITION FROM 3-STEP DATA

By Jack N. Reppert
And Richard E. Francis

1952

1962



Abstract

The 5-phase procedural framework uses 3-step range trend data to identify important trends in vegetation and soil characteristics and assign cause. Fieldwork is executed under strict procedural rules (phase 1), and current condition and tentative trend are determined (phase 2). Office statistical tests of change in frequency of important species groups, species, and soil surface factors are related by photointerpretation to visible changes in other important indicators of range trend (phase 3). All characteristics that indicate change are grouped and related to trends judged in the field (phase 4), and all available supplemental information is considered and most probable cause(s) of trend assigned (phase 5).

KEYWORDS: Range management, indicator plants, ground-photointerpretation, range plant frequency, 3-step method.

Acknowledgments

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Contents

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Jack N. Reppert and Richard E. Francis

Background

Presently, there are 11,908 grazing allotments administered by the Forest Service which, among other important uses, furnish forage and browse for livestock, game, and other animals. Within these allotments are many complex range sites classed within broad vegetation types. These sites vary in range condition. One responsibility of range examiners is to know the current condition of these range sites and, over the years, to be aware of trends in condition. The objectives are to prevent deterioration of the range resource, and encourage application of appropriate management strategies to improve condition. This Paper describes how a skilled range examiner may use the 3-step method to interpret trend in range condition.

The 3-step method for measuring trend in range condition was developed by the USDA Forest Service for administrative use after 3 years of intensive study from 1948 through 1950 (Parker and Harris 1959). Under the direction of K. W. Parker, National Forest Systems range examiners from various Regions modified and adapted research contributions to help build a practical procedure. The Forest Service adopted the 3-step method as part of its range analysis program in 1956, and many other agencies since have adopted it.

Within the Forest Service, the method has been modified. However, the three fundamental steps remain intact: (1) Measure vegetation and soil stability on permanent transects grouped in clusters of one to three transects, (2) summarize data and classify current range condition and trend in the field, and (3) take two oblique ground photographs for permanent visual record. The procedural details for measurement are familiar to all who have used the method or have read Parker's 1951 and 1953 papers.

A cluster is permanently located on an area; periodic remeasurement (often at 5-year intervals of certain plant and soil characteristics along with ground photographs provide data to infer trend in range condition. Clusters are used as benchmarks on key areas, similar to listening posts on a battlefield. A key area is representative of a portion of primary range and, by location, is sensitive to changes in management practices. By 1967, over 16,500 permanent 3-step clusters had been established on 5,307 allotments within the six western Regions.

Difficulty in Interpretation of Trends

The 3-step method was designed so that trained range examiners could establish many clusters and collect data rapidly. The more difficult part came later when the range examiner had to explain changes in the data, visible changes in the photos, or changes in the condition scorecard values. This difficulty has long been recognized. In 1957, Parker wrote in a memo to the file, "At the onset of the trend study we recognized that interpretation of data would be the most difficult problem."

A range examiner expected to interpret range trend must be a highly trained ecological investigator, who is able to understand much about the situation as he currently examines it and compares it with previously collected data. It is seldom easy to determine range trend direction, state the cause, and recommend proper management action. Several reasons for this difficulty are:

1. Trend is evaluated over many years. During passage of time, transects may be destroyed, or moved, data lost, condition standards changed, and management objectives shifted.
2. The range examiner who remeasures a 3-step cluster is seldom the person who made the previous measurement and, except for photos, often has never seen the cluster before.
3. Many clusters measured on a 5-year interval are not visited the second, third, and fourth years so that a trend-causing agent (effects of weather, insects, or disease in intervening years) may go unnoticed and undocumented.
4. Highly skilled range examiners are not always available to remeasure and interpret the data.

Frequency — What It Is and How It Can Be Used

Three-quarter-inch loop-frequency is the most consistently used measurement in the 3-step method. Frequency is the chance of finding a plant species or nonplant factor within a sample area in any one trial (Greig-Smith 1964). When no plant occurs within the loop, the soil surface factor covering most of the loop area is recorded. Frequency is measured at 1-ft intervals along 100-ft transects which form a cluster (Parker 1951). In some cases, frequency data are supplemented by recording the nearest perennial plant if a plant does not occur in the ¾-inch plot (Parker 1954). These data are used to determine plant community composition.

Frequency is a nonabsolute measurement influenced by plant density, dispersion, shape, size, and size class distribution (Greig-Smith 1964, Hutchings and Holmgren 1959, Sharp 1954, Smith 1962). Any combination of these factors may affect frequency. Greig-Smith (1964) described frequency as "an uncertain assessment of several different characteristics." It is not possible, with reliability, to relate frequency mathematically to other single plant community characteristics such as basal cover, foliar cover, herbage production, or density (Francis et al. 1972). While frequency may be hard to relate mathematically to other attributes which reflect trend, it still has value when subjectively related to visible changes in photographed characteristics such as cover or density.

The range examiner should know the significance of change in frequency. Biologically, change in plant frequency means live members of a species have, over time, increased or decreased relative to their original presence. This change may have been caused by change in any one or a combination of other plant attributes. In addition, the occurrence of a plant does not necessarily mean that the plant is healthy.

Species recorded as present are often grouped into relative desirability classes for subjective range condition class scorecards. Scorecards, prepared to apply to a particular plant community, assess the current range condition. Changes in scorecard values, over time, imply trend in condition. But because scorecards presently in use depend heavily on frequency and subjective judgments, they cannot be confidently relied upon to indicate trend in condition. Also, condition scorecards have yet to be prepared for some plant communities. For others, scorecards may in some way be deficient because of lack of required ecological understanding.

There is a way, however, to determine more than changes in frequency or scorecard values from 3-step data. It involves identification and interpretation of photographed changes in other characteristics of the plant community. The photographs are thus a valuable part of the method when used to subjectively relate any visible plant community changes to frequency and scorecard changes. This procedure, details of which follow, brings into use all good features of the 3-step method — both subjective judgments and objective measurements.

Framework for Interpretation

A 5-phase procedure has been developed to interpret range trend from 3-step data. Phases 1 and 2 include the standard 3-step procedure for collecting data and tentatively interpreting trend in range condition in the field at the time of measurement. Phases 3 and 4 concern office statistical and photointerpretive procedures, which are then related to the tentative field interpretation. Phase 5 is assignment of cause of trend in condition.

Phase 1

The 3-step procedure should be executed exactly as prescribed, including improvements that enhance the basic method. The best phenological time for species identification and transect reading should be set with strict limits. Past data that do not meet these or other important standards usually should not be used.

Employ any devices that will increase the chance of correct measurement and interpretation. For example, cluster herbariums may be useful where species identification is difficult. Condition scorecards will have the most value if they are refined so they apply to community types within broad vegetation types. High quality photographs are vital for future interpretation. Color photos are preferable.

Phase 2

Next, make a tentative on-the-ground interpretation of short- and long-term trend and its cause. Short-term trend compares the current measurement to the previous measurement, while long-term trend compares the current measurement to all earlier measurements. If available, use valid subjective trend tables based on change in condition scores (Wood and Woolfolk 1960). Carefully compare the past photos to the scene at the time the current transect photos are taken. Any visible and describable evidence of change should be documented for final office interpretation. Look for changes in basal cover, shrub crown cover, density, plant dispersion, and other factors which may explain changes in frequency.

An on-the-ground judgment of whether short- and long-term trends are up, down, or static should be made primarily for general categories. Such categories as bare soil, total plant cover, forage plant cover, litter, and other characteristics are the most likely to be visible in the photographs. Any other important observable attributes such as density and dispersion should also be noted. Secondarily, trend direction should be judged for one or more important species, especially if they can be identified on the past photos.

While on the cluster area, study both written and visible supplemental information for clues to the cause of trend in condition and document them. Include livestock manipulation, cultural improvements, weather influences, plant diseases, influence of insects, wildlife use, and drastic impacts such as fire.

Phase 3

Gather all data and photos together in the office. Make statistical tests to determine if frequency has changed significantly for plant groups, important species, and nonplant factors. These tests can be made easily on a preprogramed desk calculator or on a computer. Relate statistical tests of frequency to visible photo changes.

Statistical tests for significant trends in frequency require that clusters have two or more transects and three or more years of measurement to meet the minimum requirement for degrees of freedom. Each transect is one sample unit. Therefore, at least two transects are required to get a measure of variance. Vegetation and soil condition scores are summarized for each transect and combined to obtain one condition score for each cluster. Therefore, statistical tests cannot be made for change in condition scores. One-transect clusters and clusters measured only twice are still useful for subjective interpretation. Except for statistical tests, they can be interpreted by most of this procedure, including photos.

For those clusters tested for trends in frequency of plant and soil factors, these tests are useful:

1. Analysis of variance (Cochran and Cox 1957) with orthogonal comparisons to find if:
   a. Differences in frequency between years of measurement are significant. This may indicate a short- or long-term trend.
   b. With repeated measurement over time, some equation best fits changing frequency data (linear, quadratic, cubic, quartic, and so forth). This can indicate the nature of the long-term trend, such as continuous increase, decrease, or a cyclic situation.
   c. Differences in frequency between transects in any one year are significant. This may indicate site confounding within the cluster.
2. Duncan's multiple range test to determine which years of frequency are different from or the same as other years (Duncan 1955). This test sorts years into homogeneous sets of frequency values. It indicates time intervals when short-term trends occurred, or intervals of no change.

Carefully interpret photos, simultaneously viewing photos from all transects and dates. Relate visible changes in important trend indicators (such as basal cover for plant and soil surface factors) to the changes in frequency. Photographic evidence of change, or lack of change, in cover may or may not be supported by results from frequency tests. These possibilities exist:

1. If the photographic evidence of change in some important item, such as cover, is convincing, it should be accepted. If change in cover is in the same direction as significant change in frequency, the two support each other, and change in cover is likely a factor affecting frequency. This is strong evidence of trend in condition.
2. If frequency change is not significant (static), and pictorial evidence of change in some factor, such as cover, is strong a conflict exists. Photointerpretation is accepted, and it is concluded that, while cover has changed, it has not significantly affected frequency. This is mild-to-strong evidence of trend.
3. If convincing photo evidence of change in cover is in opposition with significant change in frequency, a more serious conflict exists. Often it is best to accept changes visible on the photos. For example, when a plant is hit, litter and other soil surface factors are not recorded. Thus, litter and other soil surface factors may appear to be decreasing in frequency while actually increasing in cover. Thus, the photointerpretation may still be mild-to-strong evidence of trend.
4. A situation may exist where photos give no convincing evidence of change in any important attribute. Then more reliance must be placed on the frequency test. This is weaker evidence of trend.

Phase 4

The supportive and nonsupportive relationships between statistical tests of frequency and photographed indicators of trend should be assembled in an orderly way for final interpretation. Keep the management objectives in mind for the particular cluster and site for which it is a benchmark. Relate all the office interpretations (phase 3) to the tentative interpretation of trends made in the field (phase 2). Office interpretations may or may not support tentative field interpretations. Use the strongest of the assembled evidence, and decide direction of trend for both vegetation and soil.

Phase 5

After study of supplemental information, prepare a statement of what agent is interpreted to have caused the trend in range condition. For example, it may be a grazing system or a reduction in livestock numbers and utilization. Other impacts (weather, fire, rodents, game conflicts, range management practices) may be the main causal agent of change, rather than livestock manipulations. If supplemental information is insufficient, it may be impossible to name a cause. For example, weather influences are often different between and during sampling years. The type of growing season should be documented for each measurement year, as well as intervening years, so that weather influences can be considered in the interpretation process. If vital supplemental information is lacking, it should be indicated for collection in the future.

After cause of trend on the cluster area is assigned, range management decisions must be made relevant to current management objectives. These decisions may require allotment inspection on important sites similar to the cluster site. Wise and prompt action is important if range trends are down and condition is less than good.

Examples of 3-Step Condition Trend Interpretation

Two examples follow which illustrate many trend interpretation problems. They illustrate a way to proceed through phases 3, 4, and 5. In these cases, National Forest range examiners made measurements, including frequency, took the photos, and made tentative field determination of trend in range condition (phases 1 and 2). The ¾-inch loop-frequency data will be discussed as frequency, recognizing that different Forest Service Regions use different terminology for this measurement, especially for the larger categories of plant and soil surface characteristics. For example, two Regions retain the original terminology, "plant density index" (Parker 1951), for all the plants recorded on a cluster. Two Regions, including Intermountain Region (Region 4), refer to this as "plant cover index," one Region calls it "total plant hits," and another "plant index." A more precise term would be "total plant frequency." The important point is for a range examiner to know that these various terms refer to the same measurement — frequency. In the examples that follow, Region 4 terms will be retained but discussed as change in frequency.

Soda Springs Cluster

The first example, Soda Springs Cluster, is a three-transect cluster measured four times — 1954, 1959, 1964, and 1969. It is representative of a meadow type on the Caribou National Forest, Idaho.

This cluster is in a slender wheatgrass (*Agropyron trachycaulum* (Link) Malte)-mountain brome (*Bromus marginatus* Ness) plant community. Fifteen other grass and forb species were listed in 1964. The elevation is 7,200 feet, the slope less than 5 percent. Sixty percent of the approximately 25 inches of precipitation comes as snow. The soil is over 3 feet deep with few surface rocks. The site produces an estimated 1,500 pounds of air-dry herbage. Average range readiness date is July 1. Sheep graze the allotment with light deer and elk use. There is pocket gopher activity on the cluster, but of unknown severity.

Phase 3. — Four examples of nine items statistically tested are given (table 1) and related to photographs (fig. 1). Transect 2 photographs shown for four dates illustrate changes representative of those visible on the other two transects. Glossy prints used by the range examiners are of somewhat better quality than the reproductions here.

Plant cover index (frequency) was statistically tested and interpreted on photos (table 1). The increase in mean frequency (7.7 to 28.3) is significant ($P = 0.10$) by the analysis of variance. By orthogonal comparisons, it significantly ($P = 0.05$) fits an upward linear trend.

The multiple range test indicates two homogeneous subsets of mean reading times — 3, 4, and 1, 2, 3. This indicates higher frequency in 1969 (4) than in 1954 (1) and 1959 (2). The

Table 1.--Statistical tests of frequency changes related to photointerpretation of change in other attributes, Soda Springs Cluster, Caribou National Forest, Idaho

Statistical tests and photo-interpretation	PLANT COVER INDEX					LITTER					BARE SOIL					SLENDER WHEATGRASS				
	(1) 1954	(2) 1959	(3) 1964	(4) 1969	Total	(1) 1954	(2) 1959	(3) 1964	(4) 1969	Total	(1) 1954	(2) 1959	(3) 1964	(4) 1969	Total	(1) 1954	(2) 1959	(3) 1964	(4) 1969	Total
FREQUENCY BY READING TIMES:																				
Transect 1	18	24	11	33	86	26	15	36	39	116	55	60	52	28	195	8	7	2	5	22
Transect 2	3	3	20	28	54	22	3	39	26	90	73	92	38	44	247	1	1	5	7	14
Transect 3	2	4	19	24	49	34	16	44	51	145	64	80	37	25	206	0	3	3	2	8
Year total	23	31	50	85	189	82	34	119	116	351	192	232	127	97	648	9	11	10	14	44
Year mean	7.7	10.3	16.7	28.3	63.0	27.3	11.3	39.7	38.7	117.0	64.0	77.3	42.3	32.3	216.0	3.0	3.7	3.3	4.7	14.7

ANALYSIS OF VARIANCE WITH ORTHOGONAL COMPARISONS:

Variation source--	DF	PLANT COVER INDEX F	Tabular F	LITTER F	Tabular F	BARE SOIL F	Tabular F	SLENDER WHEATGRASS F	Tabular F
Readings	3	4.63*	3.29 (.10)	21.42**	4.75 (.05)	11.39**	4.76 (.05)	.19 NS	3.29 (.10)
Linear	1	12.77**	5.99 (.05)	23.92**	5.99 (.05)	23.10**	5.99 (.05)	.39 NS	3.78 (.10)
Quadratic	1	1.11 NS	3.78 (.10)	6.93**	5.99 (.05)	3.72 NS	3.78 (.10)	.04 NS	3.78 (.10)
Cubic	1	.01 NS	3.78 (.10)	33.41**	5.99 (.05)	7.35**	5.99 (.05)	.13 NS	3.78 (.10)
Transects	2	1.84 NS	3.46 (.10)	7.77**	5.14 (.05)	1.71 NS	3.46 (.10)	1.50 NS	3.46 (.10)
Error	6								
Total	11								

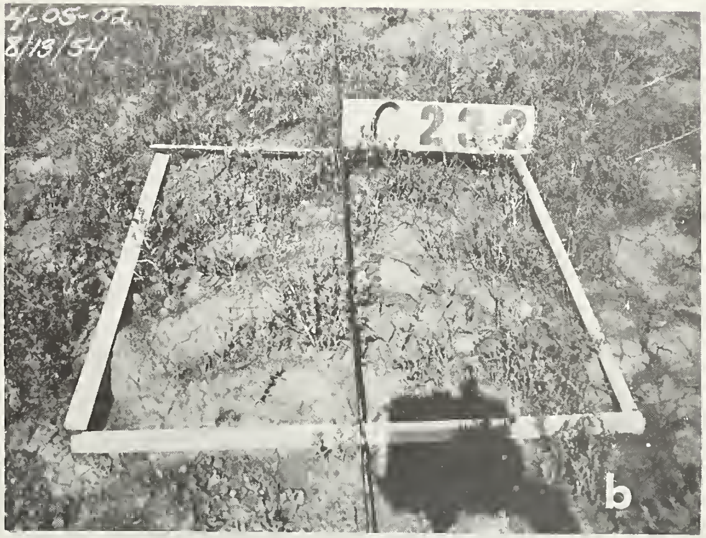
	PLANT COVER INDEX	LITTER	BARE SOIL	SLENDER WHEATGRASS
MULTIPLE RANGE TEST	2 homogeneous subsets of reading times 3, 4 1, 2, 3	3 homogeneous subsets of reading times 4, 3 1 2	2 homogeneous subsets of reading times 1, 2 4, 3	1 homogeneous subset of reading times 1, 2, 3, 4
PHOTO-INTERPRETATION	Up* Static Down Not clear	Up* Static Down Not clear	Up Static Down* Not clear	Up Static Down Not clear*
	There appears to be more plant basal cover and higher plant density.	More litter covers the soil in both 1964 and 1969.	Both soil area is less apparent.	Unable to identify individual species on photos. However, perennial grasses appear to have increased in cover, density, and percentage composition.

examiner can be reasonably certain that frequency has increased, but he does not know why until after studying photos from all three transects for four dates. Through photointerpretation, he can see that increased plant basal cover and density explains much of the increase in frequency.

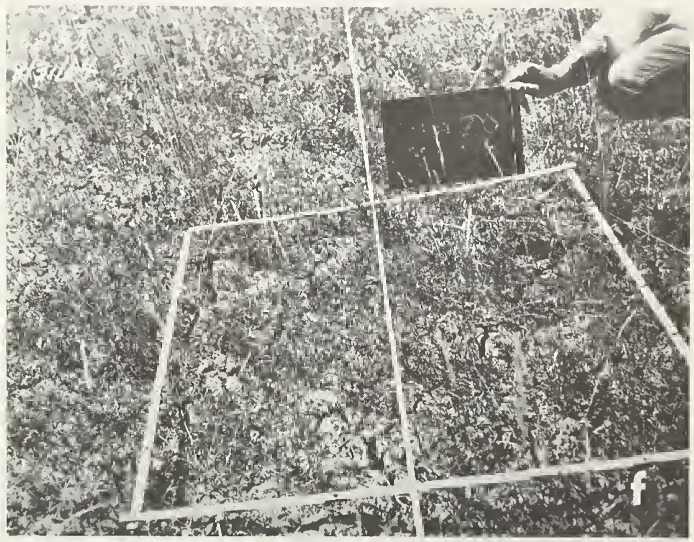
Litter is tested in the same way, and is significant (table 1). The test for differences between transects is also significant. Differences are caused by the variation of readings within years. Significance between transects may indicate transects are located on different sites. A ground check should be made if site confounding is suspected. Transect differences could also be caused by examiners' judgment of whether a loop contains more litter or soil.

Frequency trend for litter fits the linear, cubic, and quadratic curves (fig. 2). The cubic curve provides information from all four data points, and is of more value than the other curves. It shows a significant long-term upward trend in litter from 1954 to 1964 and 1969. The cubic also indicates a recent (1964 to 1969) tendency toward a static trend. Assuming management is not changed, this suggests that when the next measurement is made, litter will be relatively unchanged. The multiple range test indicates higher frequency values the last 2 years. This frequency increase in litter is explained in part by a visible increase in litter cover (fig. 1).

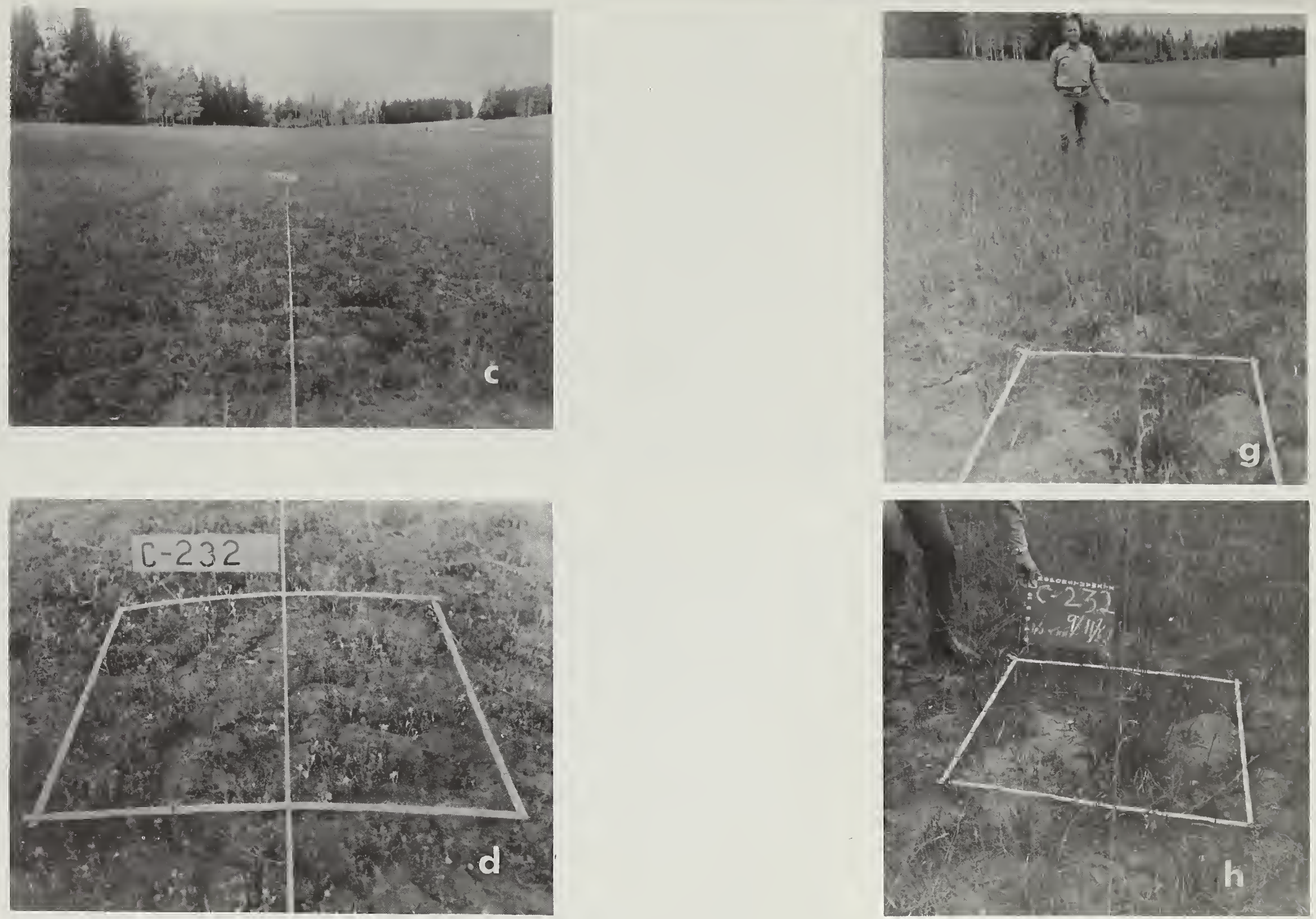
Ground cover index sums all frequency values except bare soil. In this case, it is almost entirely the summation of plant cover index and litter, both of which showed an upward trend supported by photointerpretation. For this reason, the analysis is not shown. Because more soil is covered, as seen in the photos, the



August 13, 1954



August 31, 1964



August 21, 1959

September 11, 1969

Figure 1.--Transect 2, Soda Springs Cluster, Caribou National Forest, Idaho.

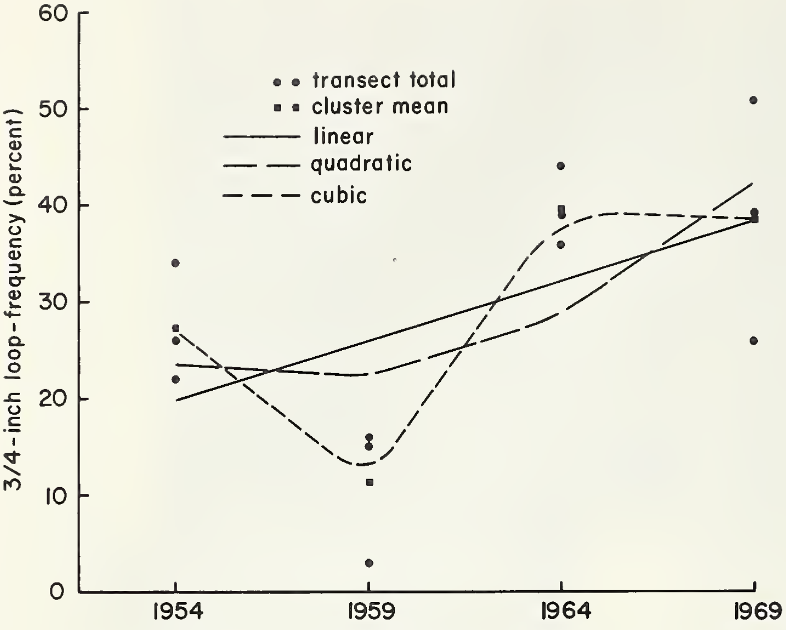


Figure 2.--Significant trend in litter, by years, Soda Springs Cluster (see table 1).

conclusion is that a desirable trend has occurred. Soil erosion hazard is less, and soil stability is probably greater.

Table 1 illustrates a desirable trend of significantly less bare soil. Areas of bare soil are less apparent in the 1964 and 1969 photographs (fig. 1e, h). Therefore, the soil erosion hazard again appears to be less in 1964 and 1969 than in earlier years. The significant cubic test suggests that the rate of increase in soil coverage has slowed since 1964.

The tests for slender wheatgrass (table 1) show no significant change in frequency. This species is not clear on the photographs, which points up the difficulty of detecting change on the photos for sparse individual species. If the two most abundant perennial grasses, slender wheatgrass and mountain brome, are combined, however, frequency increased significantly from 3.3 (1954) to 19.3 (1969). This is supported by a visible increase in cover and density of grasses (fig. 1g, h). The change is an improvement in species composition — an indicator of an upward trend in range condition.

Phase 4. — Consider all the decisions arrived at through tests of frequency related to photointerpretation of change in other attributes. Then decide whether to agree with tentative trend in condition arrived at in the field. Tentative and final trends are shown in the top half of table 2, and results of long-term photo-interpretation are shown at the bottom. Six important factors (bottom, table 2) have changed in frequency, cover, or other factors in a direction that can only be considered a long-term upward trend in both vegetation and soil over the 15-year period. There is a short-term indication, however, that the upward trend in vegetation and soil condition has slowed since 1964. Thus, the interpreter would agree with the tentative trends in vegetation and soil made in the field in 1969.

Other measured or observed items may further support these conclusions. On this cluster there were three supporting items:

1. Current soil erosion — 1954 (severe), 1959 (advanced), 1964 (slight), and 1969 (slight).
2. Plant species composition (ratio of percentages) of desirables to intermediates — 1954 (26/49), 1959 (36/36), 1964 (25/38), and 1969 (42/41).
3. Vigor (height) of slender wheatgrass, expressed as percent of a height standard from a protected area: 1954 (41), 1959 (70), 1964 (81), and 1969 (60). In 1964, this meadow was ungrazed.

Phase 5. — Determine the cause of the trends. Available supplemental information revealed the following facts:

1. Length of summer grazing season for sheep has been constant.
2. Heavy use was common prior to 1954. Since then, grazing has been moderate, except in 1964 when the allotment was ungrazed.
3. Stocking rate was stable prior to 1954. Sheep numbers were reduced substantially in 1954 and 1963.

Table 2.--Trends in range condition related to trends in frequency and photointerpretation of trends in other attributes, Soda Springs Cluster, Caribou National Forest, Idaho

	TRENDS IN VEGETATION				TRENDS IN SOIL			
	TENTATIVE (PHASE 2)		FINAL (PHASE 4)		TENTATIVE (PHASE 2)		FINAL (PHASE 4)	
Year	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1954	static	--			down	--		
1959	up	up			up	up		
1964	up	up			up	up		
1969	static	up	Yes,static since 1964	Yes, up since 1954	static	up	Yes, static since 1964	Yes, up since 1954

RESULTS OF STATISTICAL TESTS OF LONG-TERM CHANGE IN FREQUENCY: UP	STATIC	DOWN	PHOTOINTERPRETATION AGREEMENT WITH LONG-TERM CHANGE IN FREQUENCY WHEN RELATEO TO OTHER ATTRIBUTES
Plant cover index			Yes, basal cover up
Forage cover index			Yes, basal cover up
Litter			Yes, more soil covered by litter in both 1964 and 1969
Ground cover index			Yes, more soil covered by plants and litter
Perennial grasses			Yes, basal cover and density up
		Soil	Yes, less area of bare soil apparent
	Slender wheatgrass		Not clear, species cannot be identified on photos

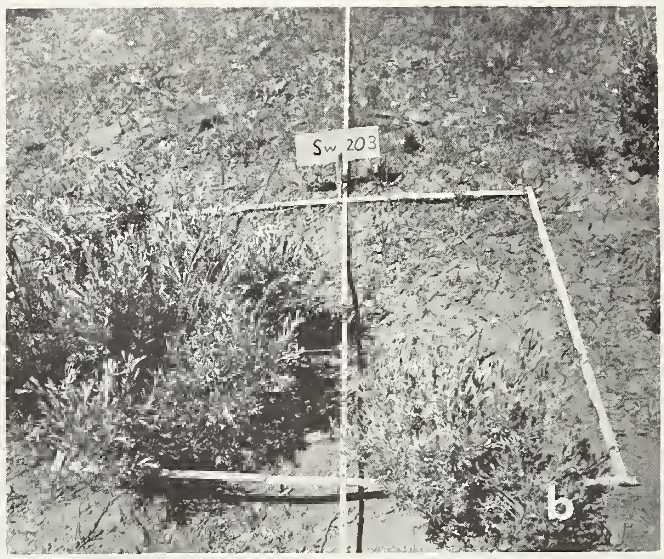
4. Deferred rotation grazing was started in 1954.
5. Big-game use has generally been light and without conflict with sheep.
6. Some destructive pocket gopher activity; no control measures mentioned.

A causal statement can be made as follows: The upward trend in vegetation and soil condition has been the result of introduction of deferred rotation grazing (1954), plus reduction in sheep numbers (1954 and 1963), with consequent lighter livestock use.

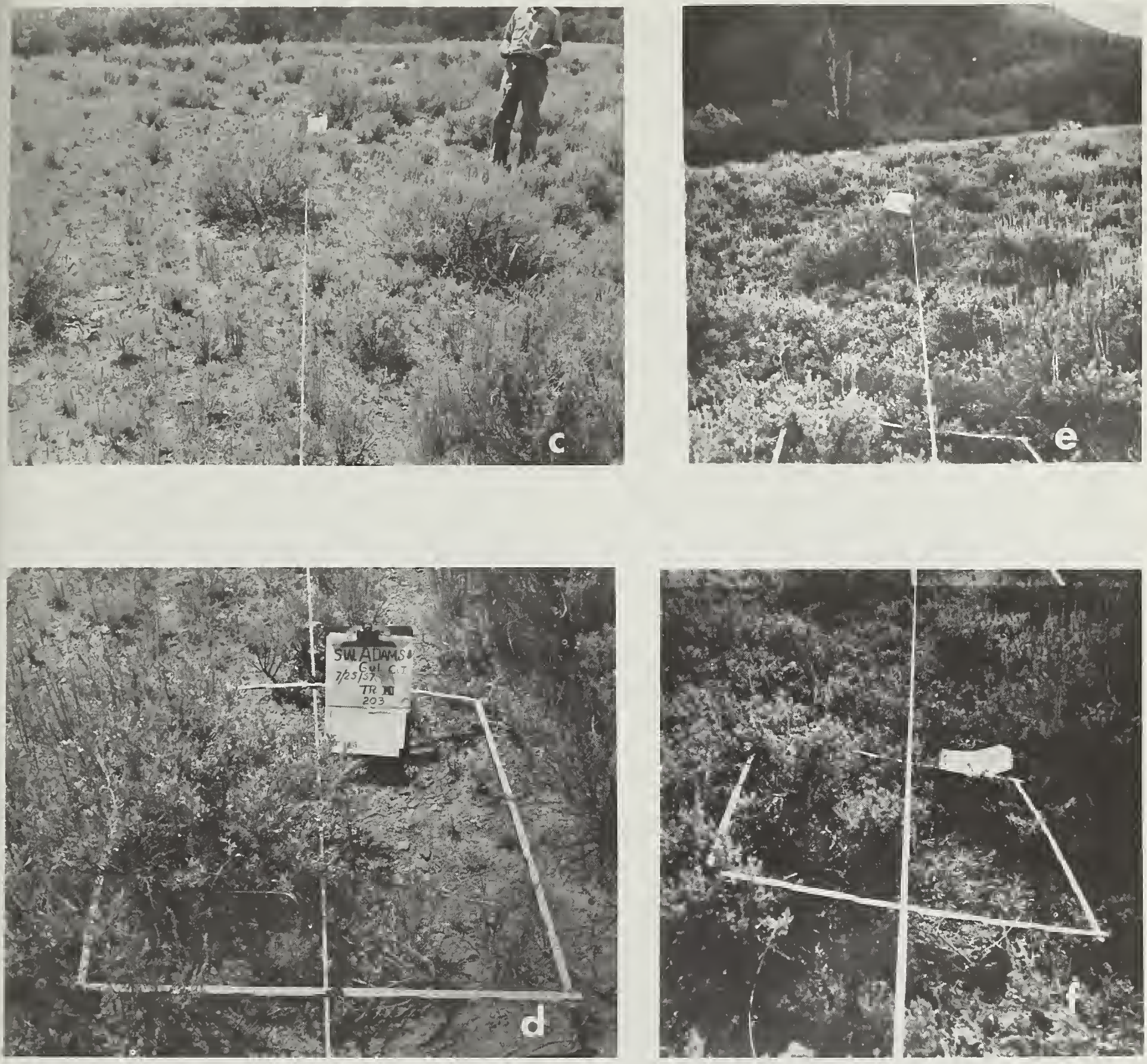
Adams Gulch Cluster

The second cluster example, also in Idaho, is on the Sawtooth National Forest. It is on a relatively flat area within an extensive sagebrush-grass site at an elevation of 6,000 feet. Precipitation is about 25 inches per year, with 60 percent as snow. The soil is a sandy clay loam 2 to 3 feet deep with few surface rocks. The cluster is located within a 60-acre area that was seeded to smooth brome *(Bromus inermis* Layss.) and crested wheatgrass *(Agropyron desertorum* (Fisch.) Schult.) in 1947 to increase the forage supply for cattle. Fourteen other plant species were noted on the area, the most important being big sagebrush *(Artemisia tridentata* Nutt.). Transect 3 illustrates the changes that have taken place (fig. 3), and is representative of what can be seen on the other two transects.

This cluster introduces special problems because of the shrubby layer of vegetation. When the ¾-inch loop hits a shrub crown, the crown is recorded as overstory and a second record is made of the basal frequency beneath the crown. If these basal understory hits are ignored, misleading interpretations of what is taking place at ground level will result. To make the most use of the data, the crown and understory basal hits must be considered separately. Shrub crowns protect the soil from rain, wind, and livestock trampling, but they also have the disadvantage of making the grasses underneath unavailable to livestock. In table 3, the frequency data are presented as they are often summarized — disregarding understory hits. These understory hits are considered, however, in the photointerpretation portion of the table. Even more complex problems can be introduced, over time, by changes in tree canopy which



June 23, 1952



July 25, 1957

July 13, 1962

Figure 3.--Transect 3, Adams Gulch Cluster, Sawtooth National Forest, Idaho.

Table 3.--Statistical tests of frequency changes related to photointerpretation of change in other attributes, Adams Gulch Cluster, Sawtooth National Forest, Idaho

Statistical tests and photo-interpretation	PLANT COVER INDEX				LITTER				BARE SOIL				SMOOTH BROME AND CRESTED WHEATGRASS				BIG SAGEBRUSH			
	(1) 1952	(2) 1957	(3) 1962	Total	(1) 1952	(2) 1957	(3) 1962	Total	(1) 1952	(2) 1957	(3) 1962	Total	(1) 1952	(2) 1957	(3) 1962	Total	(1) 1952	(2) 1957	(3) 1962	Total
FREQUENCY BY READING TIMES:																				
Transect 1	10	31	64	105	22	28	4	54	63	35	27	125	4	8	2	14	6	22	62	90
Transect 2	19	41	50	110	39	18	16	73	40	39	34	113	16	14	3	33	3	24	46	73
Transect 3	7	31	64	102	20	24	3	47	66	38	32	136	4	1	2	7	0	28	61	89
Year total	36	103	178	317	81	70	23	174	169	112	93	374	24	23	7	54	9	74	169	252
Year mean	12.0	34.3	59.3	105.7	27.0	23.3	7.7	58.0	56.3	37.3	31.0	124.7	8.0	7.7	2.3	18.0	3.0	24.7	56.3	84.0

ANALYSIS OF VARIANCE WITH ORTHOGONAL COMPARISONS:

Variation source--	DF	PLANT COVER INDEX		LITTER		BARE SOIL		SMOOTH BROME AND CRESTED WHEATGRASS		BIG SAGEBRUSH	
Readings	2	25.44**	6.94 (.05)	5.01*	4.32 (.10)	5.94*	4.32 (.10)	2.00 NS	4.32 (.10)	63.17**	6.94 (.05)
Linear	1	50.83**	7.71 (.05)	8.88**	7.71 (.05)	10.97*	7.71 (.05)	3.18 NS	4.54 (.10)	124.88**	7.71 (.05)
Quadratic	1	.05 NS	4.54 (.10)	1.14 NS	4.54 (.10)	.91 NS	4.54 (.10)	.82 NS	4.54 (.10)	1.46 NS	4.54 (.10)
Transects	2	.08 NS	4.32 (.10)	.96 NS	4.32 (.10)	.50 NS	4.32 (.10)	3.98 NS	4.32 (.10)	.89 NS	4.32 (.10)
Error	4										
Total	8										

	PLANT COVER INDEX	LITTER	BARE SOIL	SMOOTH BROME AND CRESTED WHEATGRASS	BIG SAGEBRUSH
MULTIPLE RANGE TEST	No homogeneous subset of reading times	2 homogeneous subsets of reading times	2 homogeneous subsets of reading times	1 homogeneous subset of reading times	No homogeneous subsets
	Each mean different from the other.	2, 1 3, 2	1, 2 2, 3	1, 2, 3	Each mean different from the other.

	PLANT COVER INDEX	LITTER	BARE SOIL	SMOOTH BROME AND CRESTED WHEATGRASS	BIG SAGEBRUSH
PHOTO-INTERPRETATION	Up* Static Down Not clear	Up* Static Down Not clear	Up Static Down* Not clear	Up Static Down* Not clear	Up* Static Down Not clear
	More basal and shrub crown cover. Basal frequency alone was 9 (1952), 10 (1957), and 8 (1962) or static; however, this trend is not visible on the photos because of sagebrush crowns.	Larger area of soil covered by litter. Deceptive situation here because litter under shrub crowns is not represented in these frequency values. Actually, basal litter hits (exluding crowns) is 29 in 1962--slightly up or at least static.	There is less area of bare soil, especially if shrub crowns are included.	Based on availability they are down in cover and density because of shrub crown increase. But including hits under crowns, frequency in 1962 is 6 (not 2.3) meaning many seeded plants are present but no longer available.	Crown cover increase is very apparent. Shrub density is up and shrub crown size is increasing. Dispersion of shrubs is more widespread.

influence the herbaceous and shrubby plant layers. Tree overstory should be measured and considered separately.

Phase 3. — Plant cover index (frequency) is up (table 3) when shrub crown hits and basal hits in the interspace between shrubs are added. Analysis of variance is significant between years; orthogonal comparisons show a significant linear up trend in frequency. The multiple range test indicates that frequency for any one year is significantly different from all other years. From the photos, it is obvious that cover is increasing, especially sagebrush crown cover (fig. 3). However, basal plant frequency (excluding shrub crown hits) is static: 9 (1952), 10 (1957), and 8 (1962). Because of the shrubs, this static trend in basal plant frequency is not visible in the photographs, and understory frequency data must be considered.

Litter can be considered two ways. In table 3, frequency of litter in the openings between shrub crowns was analyzed. It gave a deceptive but significant linear down trend in frequency. When frequency of litter under the shrub canopy was added to that between shrub crowns, however, frequency was 29 (1952), 38 (1957), and 29 (1962), a near static trend. After study of the dense shrub stand in the 1962 photos (fig. 3e, f), it can be reasoned that it was difficult for the examiner, looking through the dense shrub crowns, to accurately estimate litter or soil within a ¾-inch loop. With shrub leaves, bark, and twigs being shed to become litter, it can be interpreted that a larger area of soil was covered by litter in 1962 than in 1952 — a desirable situation for soil stability.

Statistical tests of bare soil show a favorable linear down trend from 1952 to 1962 (table 3), if shrub crown frequency is included. The photographs show less area of bare soil exposed to rain, wind, and livestock trampling (fig. 3e, f).

The trend of the two seeded grass species, smooth brome and crested wheatgrass, is important (table 3). Their response was the same as forage cover index and desirable plant index because they were the main components of those groups. Statistical tests of frequency for the seeded species show no significant trends, even though the values fell from 8 to 2.3, excluding basal understory frequency. When basal frequency under shrub crowns was included, frequency of the seeded species was 8.4 (1952), 8.3 (1957), and 6.7 (1962), a static situation. Based on evidence of frequency seen on the photos (fig. 3), and availability to livestock, the seeded species show a down trend in basal cover, a decrease in density, and a change in dispersion.

Big sagebrush frequency shows a significant linear up trend due to crown hits (table 3). Photointerpretation shows many attributes that affect frequency have changed. Crown cover has increased, shrub density is up, shrub crown size is larger, individual shrubs are more widely dispersed, and shrub size class distribution has changed from a few large plants in 1952 to many small-to-large plants by 1962.

Phase 4. — Consider all the decisions arrived at through tests of frequency related to changes of other important factors visible on the photographs. Then decide whether to agree or disagree with tentative condition trends arrived at in the field. Tentative and final trends in condition are shown at the top of table 4, and

Table 4.--Trends in range condition related to trends in frequency and photointerpretation of trends in other attributes, Adams Gulch Cluster, Sawtooth National Forest, Idaho

	TRENDS IN VEGETATION				TRENDS IN SOIL			
	TENTATIVE (PHASE 2)		FINAL (PHASE 4)		TENTATIVE (PHASE 2)		FINAL (PHASE 4)	
Year	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term	Short-term	Long-term
1952	up	--			up	--		
1957	down	down			static	down		
1962	down	down	Yes, down since 1957 (based on seeding)	Yes, down since, 1952 (based on seeding)	static	down	No, up since 1957	No, up since 1952

RESULTS OF STATISTICAL TESTS OF LONG-TERM CHANGE IN FREQUENCY: UP	STATIC	DOWN	PHOTOINTERPRETATION AGREEMENT WITH LONG-TERM CHANGE IN FREQUENCY WHEN RELATED TO OTHER ATTRIBUTES
Plant cover index			Yes, basal plus crown cover has increased; basal only is static
	Forage cover index		No, down, forage is being covered by shrub crowns
	Desirable plant index		No, down, desirable plants (seeded species) are being covered by shrubs
Ground cover index			Yes, basal plus crown cover has increased
		Soil	Yes, there is less area of bare soil, especially when shrub crowns are included
		Litter	No, up, if crown hits are excluded, and all basal hits included, a larger area of soil is covered
	Smooth brome, Crested wheatgrass		No, down, decrease in cover and density of available seeded species because of shrub-crown coverage
Big sagebrush			Yes, crown cover is much greater, crown sizes are increasing, shrub density is higher, dispersion is greater

long-term trend results of photo and statistical interpretation at the bottom.

Five important factors have changed. Big sagebrush increased in cover as well as frequency — a long-term downward trend based on the goal of seeding for increased grazing capacity. This increase in big sagebrush has been the main reason that both plant cover index and ground cover index have significantly increased. From a soil condition standpoint, this can be considered a long-term up trend. Litter, while shown as down in frequency as summarized, is actually up or static, if litter under shrub crowns is considered. The trend in litter cover and consequent improved soil protection is an up trend in soil condition, and not a static situation as was judged in the field in 1962.

The two seeded species show no change in frequency, but photointerpretation of shrub understory frequency indicates that herbaceous forage is becoming less available due to increases in sagebrush cover. From the cultural improvement standpoint (seeding for increased livestock forage), this is a vegetation down trend. The 1962 decision also was that both short- and long-term vegetation condition trends were down. Thus, the interpreter would agree with the tentative trends in vegetation judged in 1962, but disagree with the tentative trends in soil.

One other factor supports the long-term down trend in vegetation condition. Species composition (ratio of percentages of desirables to intermediates) has deterioriated badly: 1952 (60/11), 1957 (24/10), and 1962 (4/11).

Phase 5. — The cause of trend is assigned after reviewing the following supplemental information:

1. Cattle have always grazed the allotment from June 1 to September 15.
2. Use has always been very heavy on the area where the cluster is located.
3. Grazing has always been seasonlong.
4. Big-game use has been light and without conflict with livestock.
5. No destructive influences have been documented.
6. Sixty acres of range, including the cluster area, was seeded to smooth brome and crested wheatgrass in 1947, 15 years before the 1962 measurement.

A causal statement can be made. The area seeded in 1947 has returned to a stand dominated by big sagebrush. Heavy seasonlong grazing has been the primary factor in suppressing the seeding, and likely accelerated the increase of sagebrush. This site probably was naturally suited to support a plant community dominated by big sagebrush, so that an ecological change back to sagebrush was inevitable.

Conclusions

Trend in range condition can be interpreted from 3-step data by the following 5-phase approach. It is designed to help range examiners search for evidence of significant and biologically important trends in range condition, and identify causal agents.

Phase 1. — Correctly execute the 3-step procedure in the field at the most appropriate season of the year. This requires proper collection and summary of the required data, and procurement of high-quality photographs. It is also important to document supplemental information to aid in later office interpretation.

Phase 2. — While still in the field, tentatively identify on-the-ground condition trend and its cause. If available, use trend tables based on valid subjective scorecards. Remember that the primary measurement portion of the method is ¾-inch loop-frequency — a plant community character that is both simple (presence or absence) and complex (affected by many other plant community factors). High-quality photographs are essential and should be used to detect visible changes in plant community characteristics other than frequency. Use both documented and visible supplemental information to establish tentative cause of trend.

Phase 3. — In the office, make individual statistical tests of frequency for plant groups, important species, and soil surface factors. Then, by careful photointerpretation, relate change in frequency to plant community changes visible in the photos. Search for visible change in factors that may explain change in frequency. Use all photographs for all measurement dates. The trend interpreter usually has seen the cluster area only once — the current measurement date. Thus, an interpreter is required to detect change in plant community characters from data obtained largely by others. Photographs allow the current interpreter to view the scene and get a visual feel for the characteristics previous range examiners measured and described, as a base for evaluating changes that have since occurred.

Phase 4. — Assemble all statistical changes in frequency and photointerpretation decisions, and compare these to short- and long-term tentative trend decisions made in the field. By carefully relating all statistically tested changes in frequency to other factors visible in the photographs, it is often possible to determine trend in vegetation and soil condition. It is most important to have this job done by an individual with special knowledge of the mechanisms of ecological change, plus a unique ability to explain the interpretation clearly to others.

Phase 5. — Consider supplemental information, and assign cause of trend in condition. For some clusters, the complexity of the change that has occurred may be impossible to explain. If major modifications in livestock management have occurred, they were likely a major causal agent affecting trends. However, other factors such as weather differences between sampling years, plant diseases, fires, insects, other foraging animals, or human factors often have important effects. If these impacts have not been documented, they may be unnoticed by most range examiners. For this reason, thorough supplemental information is needed, especially for the years between measurements.

Knowing the present condition of rangeland is important. Of more value, however, is the knowledge that range condition is tending, for a known reason, to get better, worse, or remain unchanged. Only then can wise management decisions be made to change undesirable trends or perpetuate desirable trends in range condition.

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The 5-phase procedural framework uses 3-step range trend data to identify important trends in vegetation and soil characteristics and assign cause. Fieldwork is executed under strict procedural rules (phase 1), and current condition and tentative trend are determined (phase 2). Office statistical tests of change in frequency of important species groups, species, and soil surface factors are related by photointerpretation to visible changes in other important indicators of range trend (phase 3). All characteristics that indicate change are grouped and related to trends judged in the field (phase 4), and all available supplemental information is considered and most probable cause(s) of trend assigned (phase 5).

KEYWORDS: Range management, indicator plants, ground-photointerpretation, range plant frequency, 3-step method.

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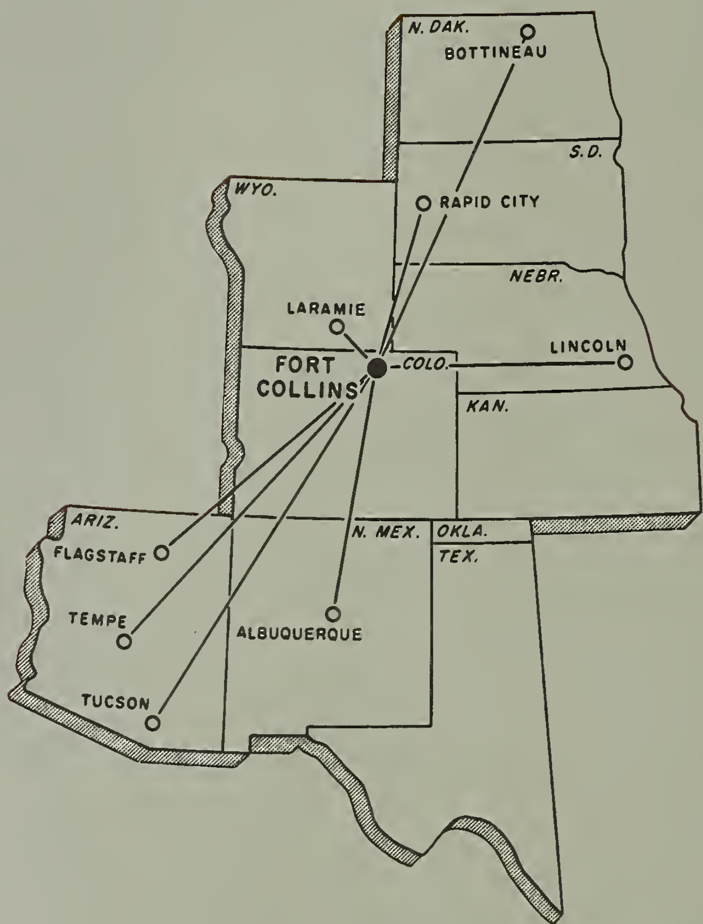
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