Department of Agronomy and Range Science
UNIVERSITY OF CALIFORNIA, DAVIS

RANGE SCIENCE REPORT

Agricultural Experiment Station Cooperative Extension

No. 23 August 1989

PROCEDURES FOR MEASURING, ANALYZING AND INTERPRETING VEGETATION TREND IN RIPARIAN AREAS

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Vegetation trend is defined as the direction of change of the plant community (McCawley and Smith 1985). When goals are specified in a management plan it is possible to determine whether the community is progressing toward these goals (upward trend), away from goals (downward trend), or is stable. Trend can be estimated by comparing the frequency of occurrence of species, ground cover and canopy cover, and age and form class of woody species on the same area at different times. Establishment of photo points will aid in illustrating trend or lack of trend.

LOCATION OF SAMPLING AREAS

Trend sampling areas should be selected to be as homogenous as possible with respect to vegetation, soil, slope, aspect, etc. They should be as representative as possible of the meadow and management situation they are intended to monitor. These are subjective judgments, but will affect how well the results on the areas can be generalized to larger areas. The degree of homogeneity within each area will directly affect the degree of change which can be detected (sensitivity).

Areas should be located in two situations:

1. Key areas -- areas which reflect the situation on the entire area and which are sensitive to changes in management. They should represent the sites or soils which are important in the area.

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2. Critical areas -- areas which may not be extensive nor reflect the management on the whole area but are important to monitor because of their exceptional resource values or unusual susceptibility to damage.

LOCATION OF TRANSECTS AND SAMPLING DESIGN AT EACH AREA OR TREND PLOT

Quadrats should be laid in transects located along a baseline for reference. One end of the baseline should be marked with a steel fence post or other permanent marker (another post may be placed at the other end if desired). The baseline should be 100 to 200 feet long. When reading the transects a tape should be stretched along the baseline.

There should be 10 transects, each 100 feet long, running perpendicular to the baseline. They can be selected at regular intervals along the baseline starting with the 10 foot marker (i.e., 10, 30, 50, 70, 90, ..., 190 feet) or at random distances.

Each transect should consist of 20 frequency quadrats. The quadrats should be located at intervals 5 feet apart along the transects. At each quadrat placement species frequency and ground cover should be recorded (see E. Field Recording of Data). Ground cover categories should include bare ground, litter, rock, gravel, and vegetation. Once frequency and ground cover have been determined along a transect, canopy cover of woody vegetation should be sampled using the line interception method (Canfield 1941) and the age and form class of those plants recorded (U.S.D.A. Forest Service 1969) (see E. Field Recording of Data). It is not necessary that the transect direction or length be precisely repeated in successive measurements.

Transects should run in a direction which will cut across the most likely variability or gradient in vegetation and/or soil. For example, on a slope transects will normally be oriented up and down the slope with the baseline on the contour. The guiding principle is to minimize differences among transects, thereby increasing precision of the sample.

ESTABLISHMENT OF PHOTO POINTS

Establishing a photographic collection to monitor vegetation changes provides the ability to portray changes on a large scale and transfer this information to audiences of different backgrounds.

The strengths of repeated photographs in monitoring vegetation change are: (1) a complete inventory of the landscape is encapsuled in the picture, (2) the documentation of rates of vegetation change and the events associated with that change, and (3) the field portion of the process can be executed rapidly and easily.

Establishment of a basic photo point requires a steel fence post, a two to five pound hammer, a set of metal letter and number stamps, a compass, and a camera.

The post can be cut in half for ease of handling. The photo point number, date, and observers' initials are stamped into the spade. The bottom of the post will be inverted so that the spade will be exposed when the post is driven into the ground. The top half of the post can then be used to locate the close-up photo center.

The long view photo should be a representative view of the area and have a distinctive landmark in the background (peak, rock outcrop, tree, etc.) to aid in repeating the photo in the future. The remaining top of the steel post will act as the center of focus for the close-up photo. If the vegetation is relatively complex, additional steel post tops may be needed as reference close-up photo centers. A compass bearing from the photo point to the center of focus must be recorded for both long view and close-up photos.

A 35 mm camera with color slide film is the best combination for taking photos, but any camera with appropriate film, used carefully, will produce useful photos.

The process of developing a photograph collection includes: 1) the retrieval of old images and the relocation of photo points, 2) the establishment of new photo points, 3) a systematic method of recording information about each photo, and 4) methods for the storage and use of the collection.

One of the more difficult obstacles to rephotographing photo points is the lack of accompanying records describing the location, time of year, and time of day the photograph was taken. A field data form should be developed to systematically record this and other information concerning the photograph and the photo point.

For each photo point there should be:

1. A description of each photo point, including:

    a. Photo point number or name
    b. Name of photographer
    c. Date of photograph
    d. Date established
    e. Time of day
    f. Magnetic declination
    g. Location (be specific so it can be easily found by someone besides yourself)
        i. Township
        ii. Range
        iii. 1/4 of 1/4 section
        iv. Altitude
        v. Description of area, including notation of prominent landmarks
    h. Comments and notations on vegetation and other conditions in the area.

2. A place for keeping the photos. This could be an envelope or prints attached to notebook sheets. It is very important that each photo be identified (on back of print or edge of slide). Successful storage can be measured by ease of retrieval.

QUADRAT SIZE AND SHAPE FOR FREQUENCY

Frequency of a given species is the percentage of quadrats in which that species occurs, i.e., it varies from 0 to 100%. As the frequency approaches these limits it is increasingly difficult to set confidence limits around the observed frequency since the values obviously cannot be less than 0% nor greater than 100%. Frequency values of less than 5% or greater than 95% are so close to the limits that drawing conclusions about these species is risky (McCawley and Smith 1985). They are at least recorded as present.

Frequency of all species increases as quadrat size increases. Therefore, when using one size of quadrat, if the most frequent species has a frequency of about 60% to 85%, the highest possible number of other species will have a frequency in excess of 5% with little risk that another frequent species will exceed 95%. If quadrat size is determined on areas in deteriorated condition some allowance should be made for expected increases in frequency.

It sometimes happens that a few species are so abundant that a quadrat designed to measure them will measure few, if any, other species at values in excess of 5%. In this case, it may be necessary to use two (rarely more than two) quadrat sizes in order to adequately measure very abundant and rarer species. This causes no difficulty in measuring changes over time on a given area, but may complicate comparisons of different areas if quadrat sizes are different. It is recommended that variation in quadrat size be kept to the minimum and that multiple quadrat sizes on the same area not be used unless absolutely necessary. If 5 to 10 of the most important species are measured with frequencies in excess of 5%, with at least one in the 40 to 65% range or slightly higher, then the quadrat is adequate.

If optimum quadrat sizes for the various vegetation types have not been established, they can be determined by testing several different sizes.

Square quadrats have traditionally been used for frequency sampling, although rectangular plots are generally recommended as more efficient for sampling of cover, density, and production. It appears that some increased efficiency might also result from rectangular quadrats for frequency, but not to the same degree as other attributes. The square quadrat is primarily used and recommended, because it minimizes in-out decisions around the perimeter and is easier to handle and observe in the field.

FIELD RECORDING OF DATA

Two observers are better than one as the time required and chances of error are considerably increased if one person attempts to read and record the data. Examples of data recording forms for frequency/ground cover (Figure 1) and canopy cover (Figure 2) are provided.

Frequency is generally recorded as rooted frequency. This means that if any part of the plant is rooted (enters the soil surface) within the quadrat the plant is tallied as present. The rule works well for most kinds of plants.

It is recommended that seedlings or very young plants whose survival is in doubt be recorded separately from mature, well-established plants. This helps to identify when a good seedling year occurred and avoids extreme peaks in frequency caused by seedlings which fail to persist in the community. It must be borne in mind that frequencies of seedlings and mature plants cannot be added to get total frequency as they could with cover or density data.

Ground cover should also be recorded at a point on the frequency frame in the same manner as a step-point transect. At each quadrat a hit would be recorded on bare ground, gravel, rock, litter, herbaceous plants (basal area), or shrubs (under live canopy). In sparse vegetation such data are mainly useful as a measure of soil surface exposed to erosion.

After frequency and ground cover have been recorded, the canopy cover of woody species should be determined using the line interception method, and the age and form class of each plant recorded along the same 100 foot transect. When the canopy of a woody plant intersects the transect the species and beginning and end measurements of its canopy are recorded. This is done for every woody plant encountered along the transect.

Age and form class designations are as follows:

Age Class

S - Seedling
Sp - Sprout (following fire)
Y - Young
M - Mature
D - Decadent

Form Class

1 - All available, little or no hedging
2 - All available, moderately hedged
3 - All available, closely hedged
4 - Largely available, little or no hedging
5 - Largely available, moderately hedged
6 - Largely available, closely hedged
7 - Mostly unavailable
8 - Unavailable

STATISTICAL COMPARISON

Confidence limits on mean frequency percentage observed are calculated separately for each species. For such calculations each transect is considered to be a sampling unit, i.e., n = 10.

To estimate whether a species has changed significantly from one date to the next a t-test of difference in sample means can be used (Little and Hills 1978). The difference may also be checked by inspection by merely observing whether the confidence limits overlap on the two dates. This is somewhat less sensitive than the t-test.

Confidence intervals are customarily calculated at the 5% probability level (95% confidence). However, it is recommended that confidence intervals be calculated at the 10% level (90% confidence). This will narrow the confidence limits and show more significant differences. A 10% chance of drawing a wrong conclusion is not excessive in range management.

An alternative way of calculating confidence intervals for frequency is to use a table based on the binomial distribution for n = 100, i.e., transects are ignored and one merely looks up the confidence interval for the frequency observed. Use of this method assumes that the probability of a species occurrence in any given quadrat is independent of its occurrence in any other quadrat. The assumption is not violated if quadrats are systematically distributed and if the vegetation occurs randomly in them. If the plot area is homogenous and quadrat spacing exceeds the pattern size of the vegetation this assumption is met. Without testing of this in the area, the transect procedure is recommended as safer. The confidence intervals in the table can be used as approximations in the field before normal confidence intervals are calculated.

Confidence limits on mean ground cover are also calculated separately for each category (bare soil, litter, rock, gravel, vegetation). For these calculations each transect is considered to be a sampling unit, i.e., n=10. To estimate whether the amount of one of these categories has changed significantly from one date to the next a t-test of difference in sample means should be used.

Confidence limits can similarly be calculated for canopy cover of woody species, on an individual species basis. A t-test should be used for determining whether a significant change has occurred between sampling dates.

DATA INTERPRETATION

Frequency is a measure of both the number and dispersion of plants on the area. An increase in either of these attributes will cause an increase in frequency. Frequency is not generally related to the size of the plant and does not correlate with production. However, under the ground rules given in D above, an increase in basal area of grasses will result in increased frequency and canopy frequency of shrubs will increase with increases in average canopy size. Comparisons of frequencies of species of similar size and life form (e.g. perennial bunchgrasses) often correlate very well with relative production of the species. For any given species an increase in frequency means that (1) the number (or size) of plants has increased or (2) the plant is more uniformly distributed over the range or (3) both.

Canopy cover is an indicator of ecological importance of species in a community since it is related to both size and number of individuals (Smith 1985). Age and form class provide a means of assessing the health of a community. A mixture of age classes, with predominantly young and mature plants, is generally desired in a community, although this will vary based upon management objectives.

Trend is measured by comparing plant community attributes measured at different times. Since some species may increase and others decrease significantly, the first step is to decide, for each site and management objective, for which species an increase is desirable, or conversely, a decrease is undesirable. One may then compare data taken from the same trend plot at two times and make, by inspection, such conclusions as: (1) More desirable (or key) species have increased significantly than have decreased, therefore the trend is up; (2) No species of any consequence have increased or decreased, therefore the trend is stable; (3) No desirable species have increased, but some undesirable species have increased, therefore the trend is down, etc.

This type of interpretation considers each species separately, i.e., there is no overall score or rating of condition arrived at by a formula. An advantage of this approach is that it requires one to study the data, deal with the complexity of vegetation, and decide whether management objectives are being met. Interpretation of trend on a plot requires consideration of three factors: (1) management applied; (2) site; and (3) weather, especially precipitation.

Trend may be attributed to management if plots on the same site under different management show a different trend or rate of trend for the same period. Trends may be different under similar management due to differences in site. Finally, similar trends across different managements or sites may reflect exceptionally wet or dry years. This latter would especially be substantiated if the trends also occurred under no management, e.g., exclosures.

The important point is that cause and effect relationships should be interpreted for each trend plot individually. Trend plots should not be averaged together for analysis or reporting purposes unless it can be shown that effects of management, site, and weather are similar enough to warrant such comparisons.

ADDITIONAL INFORMATION

More detailed description of monitoring methodologies can be found in McCawley and Smith (1985) and a series of publications produced by the Bureau of Land Management (1984-85).

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FIGURE 1

PLANT FREQUENCY DATA FORM

Number of Plots ________

Size of Plot ________

Plot No. ________

Ranch or Allotment ________________________________

Pasture ________________ Date ________________

Legal Description of Location ________________________

General Description ________________________________

____

____

Utilization or other information ____________________

____

Observers

HITS	Tally								Total	%
Bare Ground										
Gravel ($\frac{1}{4}$"-3")										
Rock (3")										
Litter										
Live Vegetation (basal)										
FREQUENCY Tree and Shrub Species										
Perennial Grass Species										
Perennial Forb Species										
Annual Species										

LINE INTERCEPT TRANSECT

Location:	Transect No. Length:	Examiner	Date

Species			Species			Species			Species			Species		
Actual Intercept	Total Inches	Age & Form Class	Actual Intercept	Total Inches	Age & Form Class	Actual Intercept	Total Inches	Age & Form Class	Actual Intercept	Total Inches	Age & Form Class	Actual Intercept	Total Inches	Age & Form Class
TOTAL														

FIGURE 2

Line intercept record:

A record is made on the line intercept transect form to the nearest inch of the lineor spread of living woody plants by species intercepted by a vertical projection from the transect line.

The age classes of browse plants are designated as follows:

(S) Seedling - Very young plant, which has become firmly established and yet obviously a newcomer on the range. It is usually distinguished by its relative size, simple branching, and succulent bark.

(Y) Young plant - Larger than a seedling with more complex branching and more fibrous bark, but does not show signs of maturity, such as rounding crowns. Juniper poles up to 10 feet are placed in this category.

(M) Mature plant - Complex branching, rounded growth form, larger size, heavier and often gnarled stems. Crown is made up of three-quarters or more of living wood.

(D) Decadent plant - Shrub or tree which is dying from age or other factors. Crown shows one-fourth or more dead wood.

(Sp) Sprouts (after fire) - Sprouts (after fire) become a separate age class.

The form classes for browse plants are numbered from 1 to 8 as follows:

1. All available, little or no hedging.
2. All available, moderately hedged.
3. All available, closely hedged.
4. Largely available, little or no hedging.
5. Largely available, moderately hedged.
6. Largely available, closely hedged.
7. Mostly unavailable.
8. Unavailable.