TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE BOISE, IDAHO SOIL CONSERVATION SERVICE

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This Technical Note describes the sampling procedure most commonly used in evaluating range trend by a frequency method, prepared by Bob Baum, State Range Conservationist, SCS, Boise, Idaho.

Several symposiums and workshops and much discussion has taken place in recent years concerning monitoring procedures on rangeland, specifically trends.

The purpose of monitoring is to determine if ongoing management actions are having the desired effects on the resource. The result of monitoring is to make things happen.

Various methods are used to assess range trends. One current approach is the use of frequency. Frequency is probably best defined as the percentage of occurrence of a species in a series of uniform size samples. It provides information about the uniformity of distribution without indicating how or how much, but it has not been widely used by range workers, probably because of a concern about sensitivity of the analysis.

The use of frequency, as other methods, have advantages and shortcomings. As a general rule, changes in frequency are the same as changes in some other component of vegetation (such as cover and weight) only when plant density (number per unit area) changes. This means that frequency will work quite nicely to document the invasion or increase of any new species, i.e. sagebrush seedlings, etc. into a community. It also means that once the number of plant stems, i.e. sagebrush seedlings, etc., have stabilized, frequency will be rather insensitive to document the increases in cover and production of the individual plants as they grow. Most changes in range condition, i.e. trend, result from changes in vigor and not changes in plant numbers, at least early in the trend cycle. Vigor changes are expressed as changes in plant size (cover and/or weight) which are poorly reflected in frequency figures.

Frequency is determined to be most reliable when used to measure changes in species composition of randomly-distributed, single stemmed species. Frequency is employed as being highly objective with a minimum amount of human decisions involved. Human decision is basically limited to whether the plant is rooted within the frame or not and to species identification.

The nested frequency plot method is most used by those evaluating trends by a frequency evaluation.

NESTED FREQUENCY PLOT METHOD

1. General Description: A series of quadrats are observed along four transects randomly selected and run perpendicular to a baseline.

2. Equipment and Supplies:

   a. Nested Frequency Data Worksheet.
   b. Set of Nested Quadrat Frames.
   c. Steel pin(s) (large nail or rod with a looped end).
   d. Hammer.
   e. Permanent orange or yellow paint.
   f. Steel post or rebar rod.
   g. Post driver (necessary if steel post used for reference post).
   h. Metal tag.
   i. Two 100-foot tapes.
   j. Compass.

3. Quadrant Frame Size: See Exhibit 1 and 2 for example of plot size.

4. Study Site Location: The key area(s) within each pasture/unit or as appropriate will be selected and identified. The study site will be confined to the key areas.

5. Baseline Location:

   a. The 100-foot baseline will be permanently located with two stakes and a recorded compass direction. The location of each baseline is documented in detail and permanently recorded so that relocation requires a minimum of time. The plot location should be plotted on a conservation plan map, topographic map, or on an aerial photo. If an aerial photo is used, record the photo number on the Nested Frequency Data Worksheet (see Exhibit 4). The baseline should be representative of the entire key area being studied. The baseline must be confined to one range site and one ecological condition class.

   b. Paint the tops of the stakes with bright-colored permanent spray paint (yellow or orange) to aid in relocation. When follow-up studies are done, repaint these stakes. Stakes should be driven to a depth at or near ground level. It may be desirable to use a large nail or stake with a looped end to reduce danger if the stake were stepped on by an animal or run over by a vehicle.

   c. Reference Post or Point: Establish a reference post (steel post) or select a reference point for relocation of the study site. Document the distance and bearing from the refrence post or point to the baseline beginning point stake. Unidentified steel posts are often removed; therefore, if a post is used, it should be marked with an inconspicuous metal tag wired to the post. The tag should indicate that the post marks the location of a monitoring study established by the ranch operator or ranch name, etc. Do not mark study locations with large conspicuous signs.

   d. Identification: Number study sites consecutively within a field or unit and/or on the ranch.

6. Photographs: Photos help to maintain continuity where a change in study technique is taking place. They should portray a good visual image of the site and help find the study location in the future. As a minimum, a general view and a close-up photo of a plot should be taken on the baseline before taking any measurements.

7. Selecting the Transects: The transect is defined as the randomly selected tape line. A minimum of four transescts will be established perpendicular to the baseline. Initial placement of the transect in relation to the baseline (see Number 5 for definition of "baseline") will be determined using a stratified random sample technique. One transect will be randomly established within each of the following groupings:

Transect No. 1	1-25
Transect No. 2	26-50
Transect No. 3	51-75
Transect No. 4	76-100

The footmark where Transect No. 1 will be established can be selected by dropping numbers 1 through 25 into a hat and randomly drawing a number. The same procedure is used to locate Transects 2, 3, and 4. These four numbers will identify where the transect will be set up. Record the actual footmark where the samples were taken. During each of the future readings, the transects will be re-established at the same footmark.

8. Number of Samples (Frames): The number of frames measured along each of the transects will vary based on the type of plant community and successional stage. In general, where the vegetation is very diverse in kind and distribution of species, a greater number of samples are needed. Conversely, in uniform vegetation, the community can be evaluated with less samples. Examples of places where fewer samples may be needed include wet meadows and some reseeded areas. Reseeded areas can be of particular concern because their diversity generally increases with age. However, the nested plots can normally accommodate these situations. The following standards have proven effective regarding the number of sample (frames) to be measured:

- Wet Meadow	40 Frames	(10 from each of the four
- Seeded Rangelands	40 Frames	25' sections of the 100' Baseline)
- All Other Vegetative Types	80 Frames	(20 from each of the four 25' sections of the 100' Baseline)

9. Setting up the Transect: After the random transects are selected, the 100-foot tape should be stretched at right angles to the baseline (50-foot tape can be used where 40 frames are used). The 50-foot mark (25-foot mark if using a 50-foot tape) of the tape is positioned over the randomly-selected footmark of the baseline. The main reason for establishing the transect is to minimize personal bias. The only requirement is that the transect be essentially at a 90-degree angle to the baseline, stretched reasonably tight, and as close to the ground as possible. Exhibit 3 shows a layout of how the transets and frames are arranged in reference to the baseline.

10. Use of Nested Plot Quadrats: Most sites contain grasses, forbs, and shrubs. Selecting the plot size for sampling mixed communities would present a real dilemma without successive nested plots. By using nested plots, data for four different sized plots is collected and evaluated for preferred frequency values. Upon confirming the size of plot needed to sample the community and/or the individual species, the basis for determining trend is established.

    Undoubtedly, the largest plot contained within the frame will often yield high frequencies in densely vegetated areas whereas the smallest plot may yield low frequencies or may even miss certain species. The appropriate size frame should give frequencies between (20-80 percent) if changes are to be reasonably detected for most species in the medium-sized plot. The data will indicate the size of plot needed to effectively sample the particular vegetation. However, all plot sizes should be recorded in subsequent plots. Data collected in a given plot size can be compared over time only for the same plot size.

11. Numerical Identification of Nested Plots: Since data will be collected from all four plots within the frequency frame, the individual plots within the frame need to be easily identifiable. For uniformity in recording data, Exhibits 1 and 2 numerically identifies the nested plots. Note the larger plot size corresponds with the higher number. It is important for the examiner to understand the concept of nested plots. For example, if a certain species were encountered in Plot No. 1, it is automatically contained within Plots No. 2, No. 3, and No. 4. If a species were found in Plot No. 3, it is also in the larger plot (Plot No. 4), but it is not within Plot No. 1 and No. 2. This numerical designation will facilitate record keeping and subsequently yield frequency data for each species encountered based on the various plot sizes.

12. Collapsible Nested Frequency Frame: Since part of the sampling may be done in remote locations, the examiner should be able to carry the needed equipment with relative ease. The basic design of a lightweight collapsible sampling frame is demonstrated in Exhibits 1 and 2. In general, heavier materials are recommended for construction of rigid frames. If the collapsible frame has to be carried on horseback, a leather or canvas pouch could be constructed. Care should be

taken to prevent the legs of the frame from being bent. If this occurs, they should be straightened out and/or reconstructed. A change in dimensions will result in a change in frequencies, thereby invalidating the collected data.

13. Placement of the Frame: Once the randomly selected transect has been set up, the frame must be placed on every fifth footmark of the transect as shown in Exhibit 3. The frame can be positioned on either side of the tape. However, it is suggested that frames be located on tape side as depicted in Exhibit 3. It is also desirable to place frames on uphill side of tape for ease and, perhaps, more accurate reading of species within frame. The frame must not be moved during sampling to include or exclude species.

    Placing the frame at the specified interval and consistently relative to the tape assures that samples are well distributed along the transect and personal bias is minimized. This procedure should be followed until data have been collected from the specified number of frames along each of the four (4) transects. Refer to Number 8 regarding the number of samples needed to adequately sample that particular vegetative type.

14. Composition and Cover Measurements: Only species rooted with them. various sized plots contained within the frame, will be recorded. No efforts will be made to count the number of individual plants. A plant is considered rooted within the plot/frame if any portion of the root crown is contained therein. Reading and recording will be as follows:

    a. Determine the presence of all species contained within the smallest nested plot. Record their presence on the Nested Frequency Data worksheet by placing a number "1" in the block for that particular sample along the belt (see Exhibit 4).

    b. Determine the presence of any additional species in the next larger plot. Enter a number "2" for these species. Record a "2" only for species not encountered in the smaller plot. Actually, the species encountered in the smaller plot are also contained within each larger plot.

    c. Determine the presence of any additional species in Plot No. 3. Enter a number "3" for those additional species encountered. Only species not encountered in the two (2) smaller plots are recorded as a "3."

    d. Repeat Step 3 for Plot No. 4.

    e. Record cover and bare soil data by noting the type of ground cover component which exists at each of the four/five points on the frame as is depicted in Exhibit 5 and/or 6. The tips of the frames should be sharpened to obtain discrete measurements. Actual measurements are made at the point where the

tip of the indiviudal legs come to rest on the ground. The legs should be pressed against the ground and an observation made directly over the tips. For each placement of the frame, four/five separate cover measurements will be dot tallied. Record cover hits in the following categories:

- Vegetation
- Persistent Litter
- Non persistent Litter
- Gravel (2mm-3")
- Cobble and Stones (3"+)
- Bare Gound
- Cryptogams (lichens, moss)

15. Computation of Frequency: Frequency is defined as the percentage of occurrence of species in a series of uniform size samples. Exhibit 7 serves as an example for the computation of frequency for Agropyron spicatum. To compute frequency on Plot No. 2, count up all the "1's" and "2's" then divide by the number of frames per transect.

Plot No. 2 - $\frac{5}{20}$ = 25 Frequency

To compute frequency for Plot No. 4, repeat the procedures for Plot No. 3, but total up all the "1's," "2's," "3's," and "4's."

16. Summarization of Data: The number of occurrences and the frequency will be summarized on the Nested Frequency Summary Worksheet (see Exhibit 8). The summarization for the plot will be done separately for each individual species. The first time a study is run, the data for each species from each of the four (4) transects will need to be carefully analyzed to determine which frame size will best represent the frequency of that species. In subsequent studies, the selected size plot will be used to evaluate frequency. Keep in mind the frequency should range from 20 - 80 percent.

17. Cover Calculations: Ground cover is computed by totalling the 16. dot tallies obtained on vegetation, litter, rock, gravel, cryptogams, and bare soil. The canopy cover data, if collected, is evaluated separately from the ground cover data. The canopy cover data will give information on the percentage of canopy and the amount of bare ground with an overstory.

References:

Use of Frequency for Range Trend Assessment, W.A. Laycock and W.J. McGennies, USDA-ARS

Nevada Rangeland Monitoring Handbook, INTERA

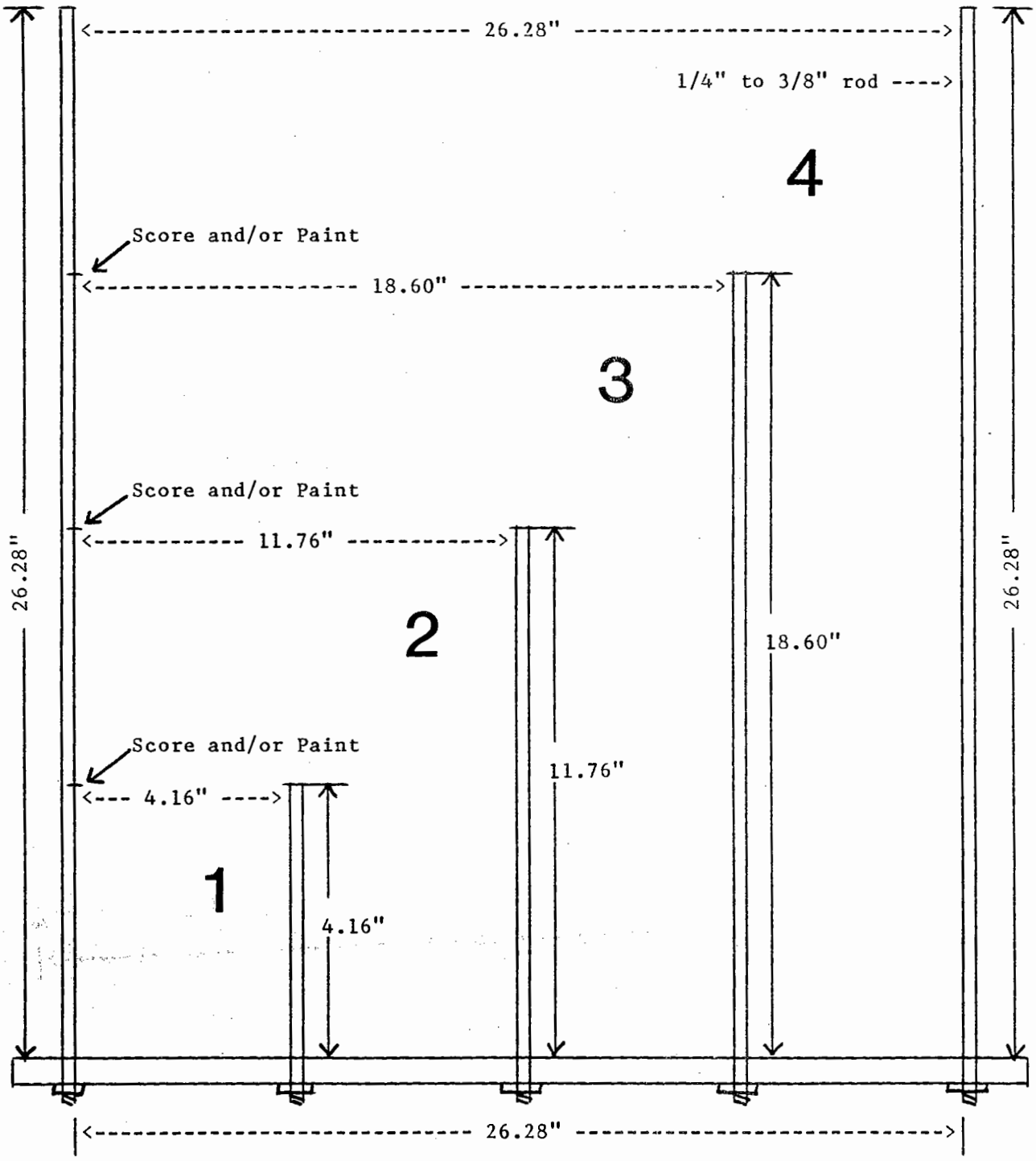
Minimum Monitoring Standards Handbook, Minimum Monitoring Standards Task Committee, INTERA

A Simple Range Trend Monitoring Procedure, New Mexico State University Cooperative Extension Service

Range Research: Basic Problems and Techniques, C. Wayne Cook and James Stubbendieck

Exhibit 1

DESIGN OF PLOT FRAME

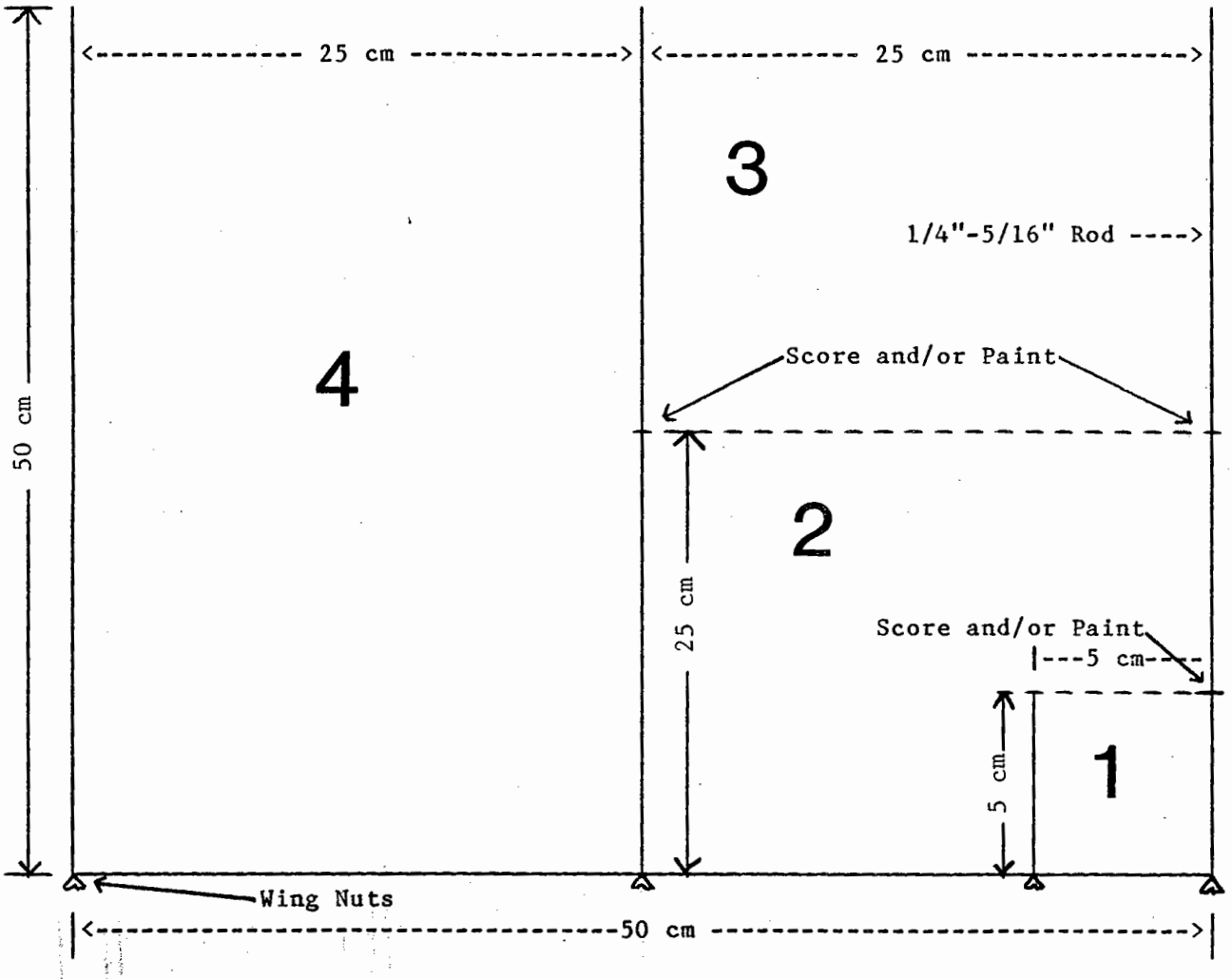


Calculations: If used to estimate or record weight/plot

Plot No. 1	4.16" squared = 0.12' square	= gram wt. x 800 = lbs/Ac.
Plot No. 2	11.76" squared = 0.96' square	= gram wt. x 100 = lbs/Ac.
Plot No. 3	18.60" squared = 2.4' square	= gram wt. x 40 = lbs/Ac.
Plot No. 4	26.28" squared = 4.8' square	= gram wt. x 20 = lbs/Ac.

Note: All measurements are inside to inside
Note: Plot depictions not true to scale

DESIGN OF PLOT FRAME



Plot No.	Plot Size
1	5 cm X 5 cm
2	25 cm X 25 cm
3	25 cm X 50 cm
4	50 cm X 50 cm

Note: All measurements are inside to inside
Note: Plot depictions not true to scale

NESTED FREQUENCY PLOT LAYOUT

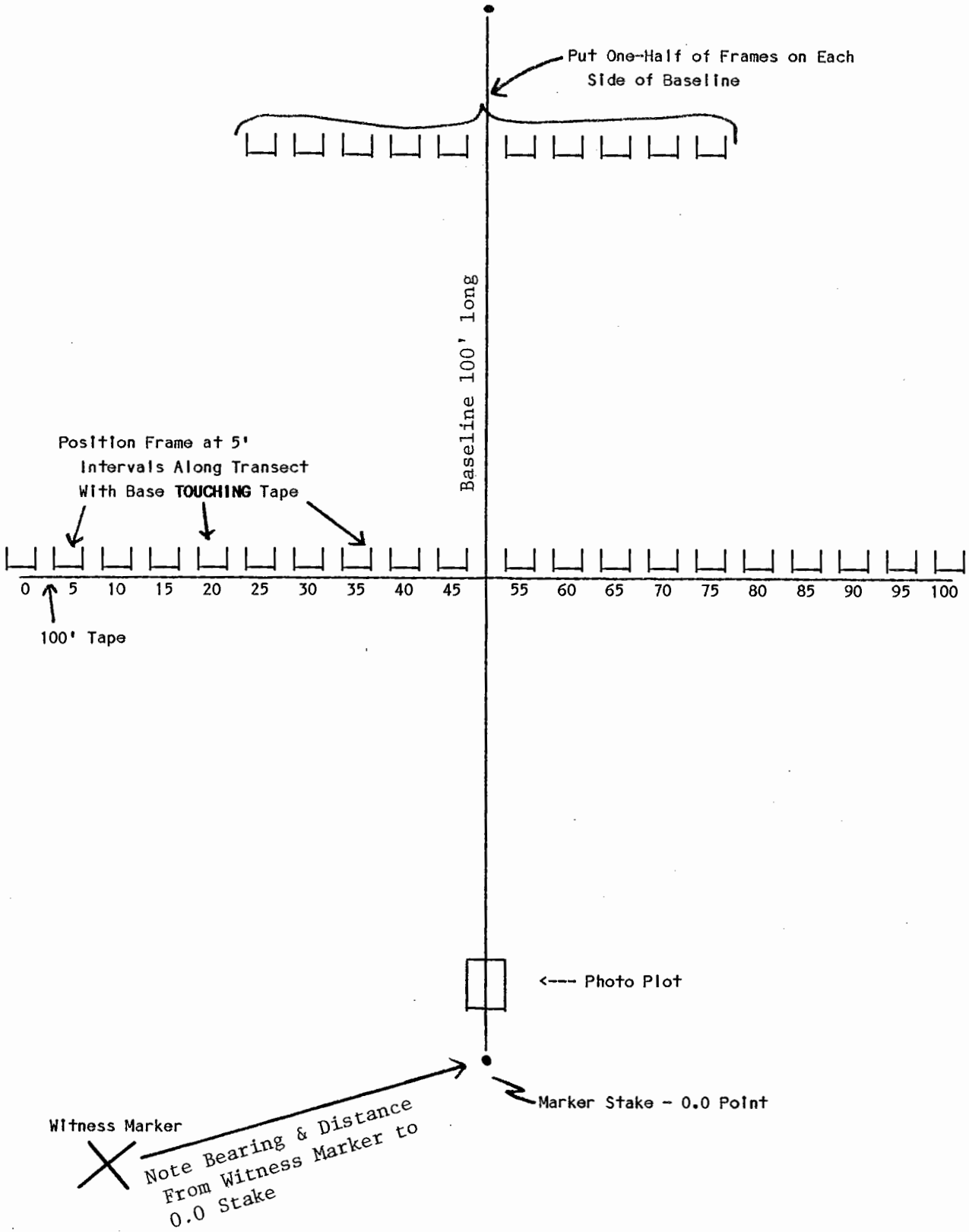


Exhibit 4

NESTED FREQUENCY DATA WORKSHEET

FIELD OFFICE _____ LANDOWNER _____ PASTURE IDENT. _____ DATE _____

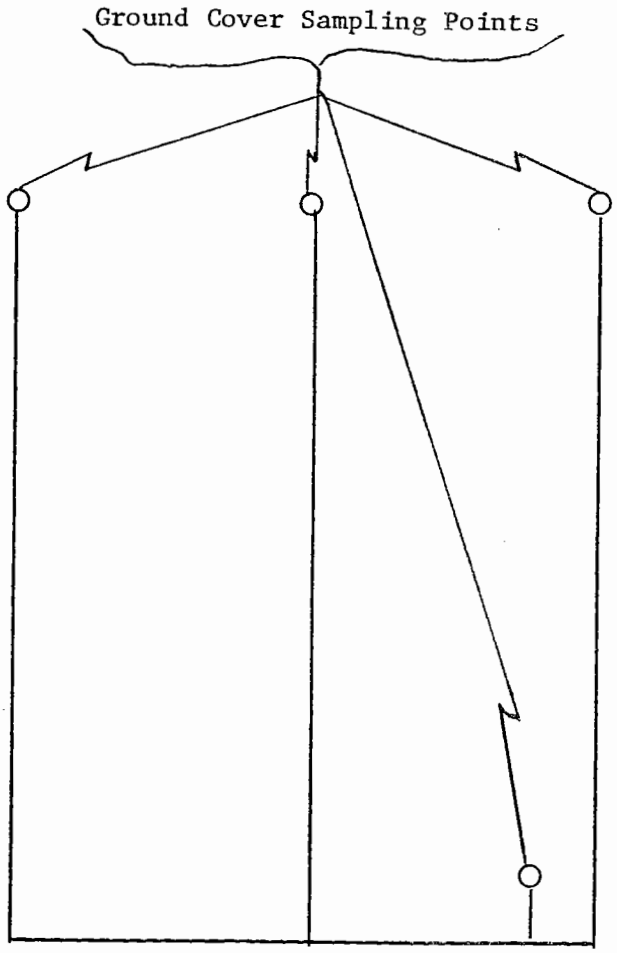
RANGE _____ KEY AREA NAME/NO. _____ MEASURED BY _____

	SPECIES	SAMPLE NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	FREQUENCY BY PLOT 1	2	3	4	NUMBER OF OCCUR.	GROUND COVER (Record hits)
GRASSES																											Vegetation
																											Litter (Persist) (Woody)
																											Litter (Non-Persist
FORBS																											Gravel 2mm-3"
																											Cobble/Stone >3"
																											Bare Ground
																											Cryptogams
SHRUBS																											
																											Crusted soil 1/

REMARKS: Record plant vigor, especially climax or important forage species; record other unusual situations, i.e. severe insect infestation, severe climatic conditions, etc.

1/ These hits would be read at the same time bare ground is recorded. This recording will give indication of soil surface capping, previous animal impact, possible water runoff, etc.

COVER POINTS FROM PLOT FRAME



COVER POINTS FROM PLOT FRAME

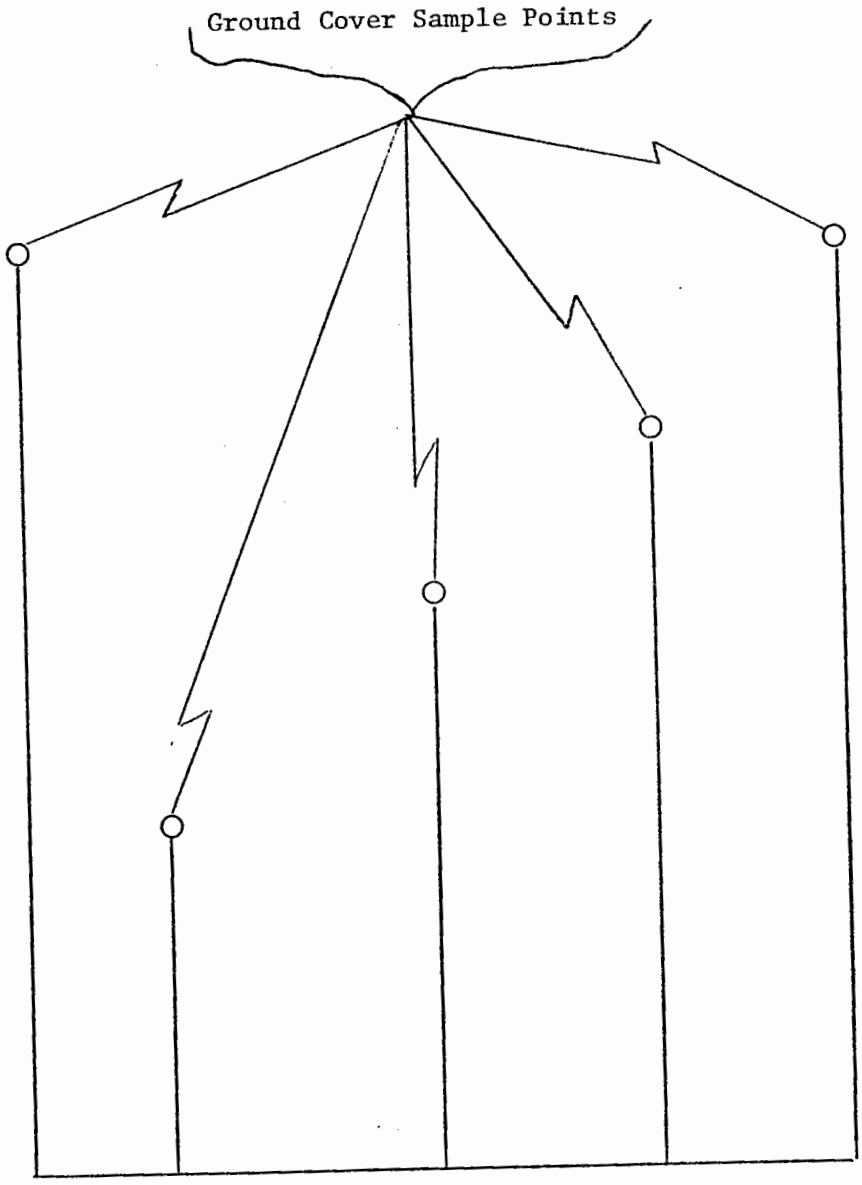


Exhibit 7

NESTED FREQUENCY DATA WORKSHEET

FIELD OFFICE Burley LANDOWNER 'Me Too PASTURE IDENT. Northstar DATE 5/3/86

RANGE 013XY023ID KEY AREA NAME/NO. Northstar #1 MEASURED BY I Will

	SPECIES	SAMPLE NUMBER 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	FREQUENCY BY PLOT 1	2	3	4	NUMBER OF OCCUR.
GRASSES	AGSP	2	3	2		3	1		4	4	4		2	1	4		4	4	3	3	3	10	25	50	80	16
	FEID	1	1		3		2		2	3		3		1	2	2			3	3	1	20	40	65	65	13
	PONE3	4	4			1	4	1		3		3		1				1		3		20	20	35	50	10
	BRTE				3				4					4					3			0	0	10	20	4
	BASA3		1				3					2					4				4	5	10	15	25	5
FORBS																										
SHRUBS	ARVA2	2			3			1	1				3				4			1	3	15	20	30	35	8

GROUND COVER (Record hits)

Vegetation ☒ ☒ 1/ 25

Litter (Persist) (Woody) ☒ 11

Litter (Non-Persist ☒ 17

Gravel 2mm-3" ☒ 13

Cobble/Stone >3" 4

Bare Ground ☒ ☒ 26

Cryptogams 4

Crusted soil ☒ 1/ 13

REMARKS: Record plant vigor, especially climax or important forage species; record other unusual situations, i.e. severe insect infestation, severe climatic conditions, etc.

1/ These hits would be read at the same time bare ground is recorded. This recording will give indication of soil surface capping, previous animal impact, possible water runoff, etc.

FIELD OFFICE _____ TRANSECT _____

LANDOWNER _____ DATA BY _____

PASTURE IDENT. _____ DATE _____

NESTED PLOT FREQUENCY SUMMARY

Species	Number of Occurrences/% Frequency By Plot			
	1	2	3	4
	/	/	/	/
	/	/	/	/
	/	/	/	/
	/	/	/	/
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	/	/	/	/
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Total No. Plots Read _____

GROUND COVER SUMMARY

	Total Point Hits	% Cover
Vegetation		
Litter (Persistent		
Litter (Non-Pers.)		
Gravel 2mm - 3"		
Cobble - stone >3"		
Bareground		
Cryptogams		
TOTAL		
Crusted soil		
Species:		

REMARKS: