

Southeastern Arizona Monitoring Program

Methods and Ground Rules

THE UNIVERSITY OF ARIZONA COOPERATIVE EXTENSION

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SOUTHEASTERN ARIZONA MONITORING PROGRAM

Methods and Ground Rules

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GENERAL INFORMATION

October, 2000 marked the beginning of a cooperative monitoring program in southeastern Arizona between the Gila District BLM, Coronado National Forest, and The University of Arizona Cooperative Extension. One of the goals of the program is to collect monitoring data using the same methods (where appropriate) across jurisdictional lines.

With the exception of fetch, all of the monitoring methods in this booklet are contained in more detail in interagency handbooks and university publications (listed in the References section). From the beginning of the cooperative program ground rules were established to ensure consistency of data over time and among collectors. Establishing written ground rules makes field work efficient and minimizes errors. If data are not collected the same way every time, the data are not useful for comparison. In addition, different rules on different dates destroy the value of monitoring data. Some changes and additions in data collection and methods have led to this revision.

Before You Go to the Field

Look at the monitoring file and take it or a copy of the previous monitoring information with you to the field. Be sure that you know how many plots/transects were read previously (100 vs 200 quadrats). You will also need the photos to do the repeat photography. Sometimes the diagrams on the back of the data sheets provide useful information for getting to the site (i.e., mileage from a known point, trail location, landmarks, plot layout).

Data Sheets and Collection

- Put down as much information as you can on the data sheet while you are at the site.
- Fill in the pertinent location information (allotment, date, key area, observers, etc.) on the front side of your data sheet or in the VGS database.
- Look at the back of the previous year's transect layout sketch. Follow the layout from previous monitoring to provide repeatable data. Check to make sure there is not more than one layout.



Southeastern Arizona Monitoring Program

Data Reading and Recording

A routine is helpful in reading and recording. Move the plot frame at one pace intervals. Focus on the same point in the distance to keep a straight transect line, don't avoid shrubs, and look up while placing the plot frame.

Both VGS and paper data sheets lend themselves to easily record in this order:

1. Ground cover
2. Fetch
3. Frequency
4. Dry weight rank

Read the plot frame in the above order for efficiency.

- You won't forget to give ground cover or fetch.
- Your recorder will not have to move back and forth on the page or tablet screen.

When splitting shrub/tree base and canopy frequency, only make one tally for the species either in the base or canopy (i.e., if you have a shrub base hit, don't also mark a canopy hit). The base and canopy frequency for each shrub/tree can then be combined later, if needed.

Seedlings can cause a false pulse in your frequency data that may be interpreted incorrectly in the future. In years of abundant seedlings, consider making a separate category/qualifier for seedling plants, but also count them in the regular space.

Take a few minutes to tally your data while you are at the site. Make sure that the ground cover adds up to 100%. Compare the frequency of key species to previous monitoring. Make notes of apparent cause of any changes (unusual rainfall, fire, etc). Make additional notes (wildlife, recreation, insect activity, livestock, etc.) that may be helpful to others for interpretation of the data.

GPS General Information

Check previous monitoring reports for GPS locations. When the program began, agencies were using UTM coordinates in NAD27CONUS. Agencies have now switched to NAD83. Older key areas will be referenced as NAD27 and more recently established key areas will be listed as NAD83. The difference between the two can be off as much as 200 meters.

REPEAT PHOTOGRAPHY

Repeat photography can be useful to help monitor how rangeland vegetation may change across space and/or time. Comparing pictures of the same site taken over a period of years furnishes visual evidence of vegetation and soils changes. All photographs should be taken in color. Each time repeat photographs are taken, follow the same process and photo sequence that was used in taking the initial pictures. This routine will also make labeling the photographs easier once you are back in the office. Make sure your shots include the same area and landmarks/skyline in the repeat pictures that were included in the initial pictures.

The protocol for repeat photography includes:

1. Bring to the field the historical photographs or copies of them to help you find the site and line up your shots.
2. Remember to completely fill out the Photograph ID sheet. Use a large, black marker to fill out the sheet, writing as largely and legibly as possible.
3. In all, at least five different pictures need to be taken. Pictures need to be taken in the direction the transect runs and in each of the four cardinal directions.
 - a. The use of a compass is a good way to ensure that you are taking the photographs in the correct direction. This helps in the future when others come out to read the transect and try to match up the photographs with their direction.
 - b. The transect direction photo should always show the transect marker (T post, angle iron, rock cairn, etc.) and the completed Photograph ID sheet. (Figures 1 and 2.)
 - c. Stand on the transect's starting point to take each of the photographs for the four cardinal directions. Use the historical photographs to align your photo to match as closely as possible. Try to get as much land view as possible but still get skyline in your photo frame for reference points. The importance of taking photographs in each of the cardinal directions is that it helps to record the condition of the entire site and not just one view. These additional photographs are very valuable to use in the future to help others see the “bigger picture” and to find the site by identifying landmarks.
 - d. Sometimes looking back at the historical photographs, the photo was taken in a different direction from which the transect was run. In cases such as these go ahead and take a photograph to match the historical photo (make sure you note the direction). Then take another photograph showing the view of the transect direction. (Figures 3 and 4.)

Figure 1. Rock cairn marks transect location and direction of transect.



Figure 2. T post marks transect location and direction of transect.



Figure 3. Southeast view matching historical photo, 6, Oak Creek Allotment, Safford Field Office, BLM. August 29, 2006.



Figure 4. Southwest view of transect direction, 6, Oak Creek Allotment, Safford Field Office, BLM. August 29, 2006.



GROUND COVER

Ground cover is the percentage of material, other than bare ground, covering the land surface. For this program, cover categories include live vegetation, litter, gravel, and rock. Ground cover plus bare ground totals to 100 percent. Cover data is collected with each quadrat placement. Three consistent points from the quadrat are the focal point for cover category classification.

Ground Rules:

- Three ground cover hits are recorded per quadrat placement.
- Litter is dead plant material directly covering the ground, dead perennial vegetative bases, or animal material. If a small stem or piece of litter is not considered large enough to intercept raindrop impact, the hit is the ground covering below it.
- Bare ground is soil with particles up to 1/4"; gravel are particles 1/4"-3" in size; rocks are >3".
- Annual forbs and grasses are considered litter cover when in contact with the ground and large enough to intercept raindrop impact.
- Only perennial plant bases can receive the designation of a live vegetation hit.

FETCH

Fetch is the distance from the nearest perennial plant base within 360° of the quadrat point. Fetch, reported with descriptive statistics, relates to plant distribution and watershed characteristics. Perennial plant cover can reduce soil erosion by creating an obstruction, which in turn slows the rate of overland flow. A shorter distance between perennial plant bases lessens the opportunity for water to acquire energy that is needed to remove soil and litter from a site. Over time, this information can be used to assess changes in the spatial distribution and connectivity of vegetation patches and document trends in the fragmentation of plant cover on rangelands for the purposes of assessing rangeland health.

Ground Rules:

- One hundred points are measured from a consistent ground cover point.
- Distances are measured to the nearest inch.
- If live vegetation is hit on the ground cover point, the distance is zero.

PACE FREQUENCY

Pace frequency is the number of times a plant species is present within a given number of uniformly sized sample quadrats. The quadrats (plot frames) are placed repeatedly across a stand of vegetation. Plant frequency is expressed as percent presence for each species encountered within a total number of quadrat placements. Therefore, frequency reflects the probability of encountering a particular plant species within a specifically sized area (quadrat size) at any location within the key area. The total number of frequency hits among all species will not equal the total number of quadrat placements. Frequency is an expression of species density and distribution, but not an absolute measure. A 40 x 40 cm (0.16 m²) quadrat is used for pace frequency.

Ground Rules:

- Species present within the bounds of the sample quadrat are recorded with a single tally.
- If no species are present, no frequency data are recorded.
- Annual grasses and forbs are counted whether green or dried.
- Tree/shrub canopy and basal hits are recorded separately. Over time, these parameters can indicate changes in tree/shrub size (canopy) or frequency of occurrence (basal).
- A canopy hit is any part of the tree or shrub that overhangs the quadrat (enters an imaginary vertical projection of the plot frame).
- Quadrat placements are placed at one-pace intervals (2-steps), patterned in transects (straight lines) that are run parallel to each other, generally contouring the slope, within the area of one ecological site (vegetation and soil type).
- Perennial forbs should be identified individually, not lumped. The level of accuracy on species identification may only be to genus in certain circumstances.
- Herbaceous plants (grasses and forbs) must be rooted within the quadrat to be counted.
- A grass or forb plant base present under the quadrat frame is considered "in."

PVC vs. metal/rebar frames:

- Metal/rebar frame: Plants rooted within or under the metal frame should be counted as being within the quadrat.
- PVC frame: When using a frame made out of PVC, plants rooted directly under where the PVC touches the ground should not be considered inside the frame. This is due to the fact that PVC is much wider and covers an area larger than the 40 x 40 cm quadrat size. Only the area within, and not under the PVC should be counted.
- To be certain, measure the frame to determine if the boundaries are within the frame or if the boundaries include under the frame.

Nested Plots

A nested plot is used in situations where one species is very abundant and occurs almost continuously throughout the community with small spacing between individuals. A quadrat small enough to appropriately sample the abundant species might be too small for other species occurring on the same site. In such cases, nested quadrats are recommended.

A nested plot (quadrat) is a small quadrat (typically 10 cm² in grasslands) nested in the corner of a large quadrat and frequency of the most abundant species is recorded in the small quadrat at the same time other species are recorded for the large quadrat.

The best sampling precision is reached for a particular species when it is present in 40% to 60% of the quadrats sampled. This will provide the most sensitivity to changes in frequency. Good sensitivity to changes in frequency is obtained for frequency values between 20% and 80%. Frequency values between 10% and 90% are useful but data outside this range should be used only to indicate species presence; other than that it is not able to give an accurate representation of the change occurring in the plant community.

Examples of plant species nested plots are most commonly used for are: blue grama, curly mesquite, and Lehmann lovegrass.

Ground Rules:

- Use nested plot when species frequency values approach 80%.
- Use only on herbaceous plants.
- For the focus species, nested frequency is recorded concurrently with regular frequency hits within the 40 x 40 cm frame.

DRY WEIGHT RANK (DWR)

The dry weight rank procedure was developed for estimating species composition by weight in pastures. It is similar to direct estimation of composition by species in quadrats except that in dry weight rank the observer only ranks the three species which contribute the highest percentage of the biomass in the quadrat.

At each quadrat the observer simply decides which three species in the quadrat have the highest yield on a dry matter basis. The highest yielding species is given a rank of 1, the next highest 2, and the third highest a 3. In effect, the dry weight rank method assumes that a rank of 1 corresponds to 70% composition, rank 2 to 20%, and rank 3 to 10%. All other species present are ignored, although they may be recorded for frequency.

Ground Rules:

- Read 100 quadrats. If you are using DWR with frequency, read the first 100 quadrats. This gives flexibility to make up for empty quadrats when doing 200 paces. Dot tally empty quadrats so that you can make them up after the initial 100 placements if using paper to record.
- If you are in an area that results in less than 100 plots with vegetation even after 200 placements, document this on the data sheet.
- The portion of a plant which contributes to the ranking of weight is any part of the plant occurring within a vertical projection of the quadrat perimeter. The vertical projection has no height limit.
- Plants do not have to be rooted in the quadrat.
- If some quadrats have less than three species, follow the alternative method of multiple ranks, which involves assigning more than one rank to some species. Therefore if only one species is found in a quadrat it may be given ranks 1, 2, and 3 (or 100%). If two species are found one may be given ranks 1 and 2 (90%), ranks 1 and 3 (80%), or ranks 2 and 3 (30%) depending on the relative dry weight of the two species.
- When using VGS to record DWR, only rank the base species in the DWR panel. This keeps the percent composition all in one place in the report (vs part of the percent showing in basal and part showing in canopy).

LINE INTERCEPT

Line intercept is the amount of cover a plant occupies along the course of a line. Line intercept is expressed as percent cover along the length of a line (tape). The percent cover for a plant species is an average of cover over all of the lines used in the study. Composition values can also be derived by dividing the total species cover by the total plant cover. Composition is also an average among all lines used in the study.

Two or more 100 ft. tapes are used for line intercept (one for baseline, one or more for intercept).

Ground Rules:

- Cover by species is collected. Measurements are taken in inches for each individual species that intercept the line.
- If there is a more than 3 in. break in cover, break out into separate measurements. If less than 3 in., assume a closed canopy.

DENSITY & AGE/FORM CLASS FOR BROWSE

Belt transects can be especially useful in measuring vegetation attributes for shrub and browse species. Belt transects (12' x 100') are used to collect cover (see line intercept), and provides for collecting density, and age & form class data. The 100' tape serves as the center line for the belt transect. Two 6 foot poles are used either side of the tape to form a long, narrow quadrat.

Determining plant density is accomplished by counting the number of individuals in the belt transects. Density counts are kept by species, and by age and form class for each species. The age classes give a representation of the diversity present in the shrub community and the form classes represent the amount of use shrubs are receiving.

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.

(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 - Sprouts (i.e., after fire or land treatment) 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.

PRODUCTION

Definitions

There are a variety of terms used in monitoring production. It is important to know what kind of production is being collected and what the data will be used for (species composition, forage allocation, etc.). The following definitions are from the Interagency Technical Manual for Sampling Vegetation Attributes. The listings below are the most commonly used in southeastern Arizona and more definitions can be found in the Manual.

Standing crop – the amount of plant biomass present above ground at any given point.

Peak standing crop – the greatest amount of plant biomass above ground present during a given year.

Total forage – the total herbaceous and woody palatable plant biomass available to herbivores.

Production is measured on a dry weight basis.

Harvest Method

Ten plots are clipped to the ground surface and put into paper bags to dry. Name and number the bags by ranch, key area, date, and bag number. Dry the samples for several weeks before weighing them with a gram scale. Page 115 of the Interagency Technical Manual has a table with easy conversions from grams to pounds per acre depending on the size of the plot clipped.

Comparative Yield Method

The comparative yield method can be used with the same frame as used for pace frequency. A description of the method, sampling procedures and calculations can be found starting on page 116 of the Interagency Technical Manual.

UTILIZATION

Utilization is a measure of the percent of current years' growth that has been removed from a forage plant. This measurement is based on the percent removal by weight, not height. In most grass species, the majority of the weight (or biomass) is at the base of the plant. Often the top half (height) of a plant may only contain 10-20% of the actual weight of the plant.

Definitions

Utilization – the proportion or degree of current year's forage production that is consumed or destroyed by animals (including insects).

Seasonal Utilization – the amount of utilization that has occurred before the end of the growing season.

The monitoring program uses two methods for utilization, the Grazed/Ungrazed method and the Key Forage Plant method. Both require a pace transect consisting of 100 paces.

Grazed/Ungrazed Method

- Look at the forage plant nearest the toe of your boot, 180° in front of you.
- Dot tally perennial grass plants under the headings of grazed or ungrazed.
- If using the Semidesert Mixed Perennial Grasses regression line, count the nearest perennial forage species. If using another group or species, count the closest of these species for the tally.
- Use the number of plants grazed to find the utilization estimate on the graph.

Key Forage Plant Method

- Clip and weigh beforehand to get your eye in for each key species.
- Select the key perennial grass species to be monitored.
- Look at the forage plant nearest the toe of your boot, 180° in front of you.
- Dot tally by use class.

AGAVE MONITORING

A 200 foot baseline is established in the key area. Beginning at the 10 foot mark, a 100 foot tape is run perpendicular to the baseline. This is repeated at 20 foot intervals for a total of 10 transects (10', 30', 50', 70', 90', 110', 130', 150', 170', 190'). Two six foot poles are used on either side of the transect tape to create a 12' x 100' quadrat.

Ground Rules:

- The number of individual agave plants in each quadrat is recorded.
- Only plants rooted in the quadrat are counted.
- To minimize error due to edge effects, individual plants falling on the right and bottom (baseline) edges are counted as in, and individual plants falling on the left and top edge are counted as outside the quadrat.
- Additionally, observations of agaves bolting or having an inflorescence removed are recorded (or qualifiers are used in VGS).

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APPENDICIES

Confidence Intervals for Binomial Populations - 100 Quadrats
Confidence Intervals for Binomial Populations - 200 Quadrats
Relation Between Percent Plants Grazed and Utilization Graph

CONFIDENCE INTERVALS FOR BINOMIAL POPULATIONS—100 QUADRATS

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

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

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

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

From: Some Methods for Monitoring Rangelands and Other Natural Area Vegetation (see references).

CONFIDENCE INTERVALS FOR BINOMIAL POPULATIONS--200 QUADRATS

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

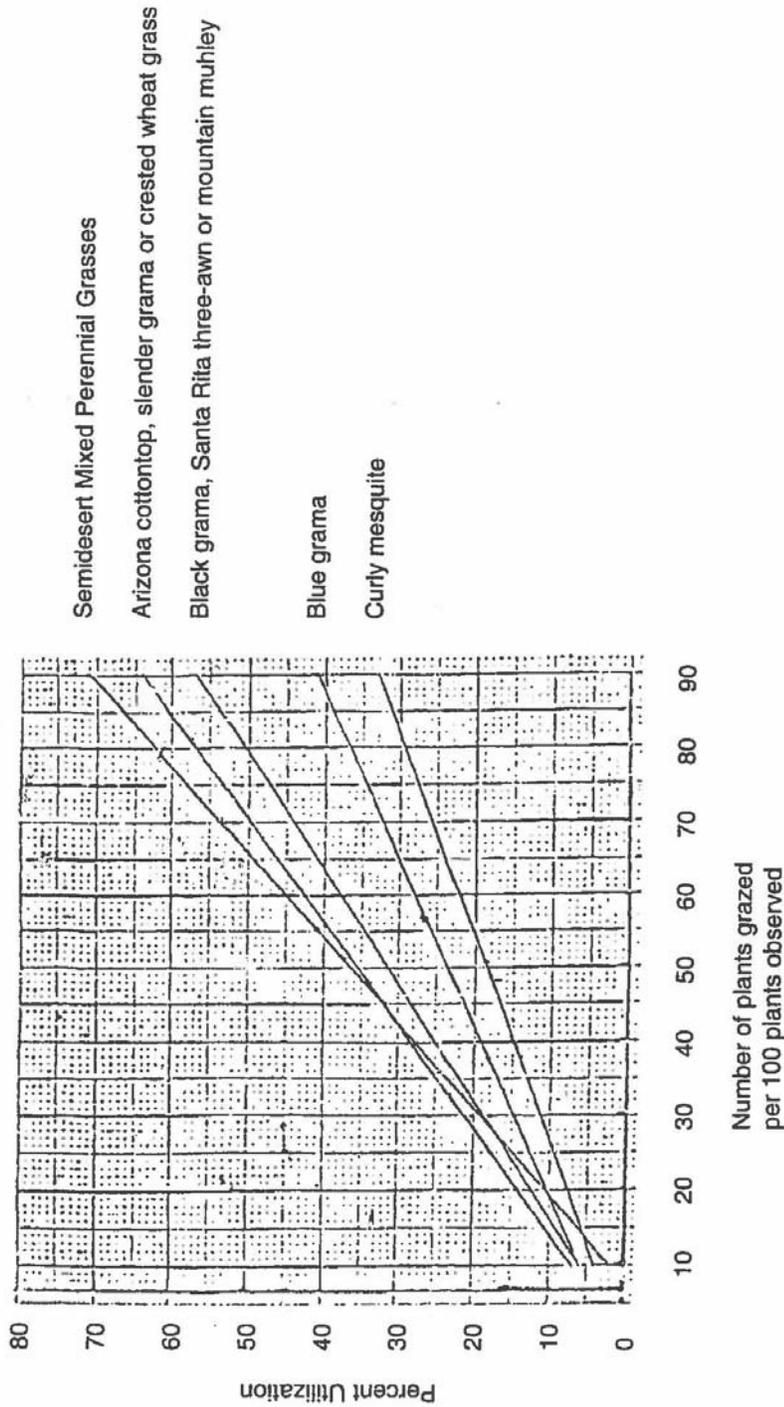
$$\sqrt{\frac{Pq}{200}} t_{\alpha/2, 199} \quad ; \quad \text{where } t_{.95} = 1.97 \text{ and } t_{.80} = 1.29$$

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

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

From: Some Methods for Monitoring Rangelands and Other Natural Area Vegetation (see references).

Relation Between Percent Plants Grazed and Utilization for Common Arizona Perennial Grasses



To estimate use: (1) observe 100 grass plants of the species you are interested in, (2) record the number of plants that have been grazed, (3) find percent use from graph by following vertical line up from "number of grazed plants" till it meets the species line you want then read the percent use on the vertical scale at left.