TECHNICAL NOTES

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

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METHODS FOR DETERMINING THE CROWN CANOPY OF SHRUBS AND TREES

The area occupied or cover, has often been used as a primary attribute in vegetation studies. There are several methods applicable for measuring crown canopy of shrubs and trees. Each method must be considered in terms of objectives of the study, type of vegetation studied, time required to make a determination, and accuracy desired. The following information is presented as an aid to field personnel engaged in various kinds of resource inventories.

Line Intercept Method

This method is commonly used for measuring plant composition and crown cover for both shrubs and trees. It consists of recording the horizontal linear measurements of plants along a line. In this case, only shrubs and/or trees are considered. Plant intercepts of shrubs and tree canopy along a 100-foot tape are measured, and the total of the intercepts is accepted as the percentage of ground surface covered by the plants. Then the canopy cover of individual species or groups of species are expressed as a percentage of the whole line. A line of 100 feet is generally used in sparse vegetation and short lines (50 feet) are commonly used in dense cover. All shrubs sites in Idaho would be using 100 feet as baseline.

This method is best suited on grass-shrub types of vegetation and clear definitions of what constitutes a plant crown, such as the size of interstices within a plant. The method is fast and accurate and reasonably free of bias.

Zig-Zag Transect

A modified technique of the forester's zig-zag transect can be used to determine both shrub and tree canopy. The type of transect is the same one used by the foresters for measuring average spacing, average diameter, D+X spacing, etc., in tree stands.

1. Determine, before starting, what shrub or tree will be inventoried. It may be used for one species or several species may be added together.

2. Choose a direction of travel which will take you through the stand in order to see a good cross section of it. Go toward a visible landmark and maintain the same general direction of travel.

3. Select a starter shrub or tree which is part of the stand to be measured. No measurements are made of the starter plant, it serves only as a starting point. At the base of the starter shrub, face the chosen direction, place heels together with feet making a 90° angle (figure 1).

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Locate the next closest shrub, the center of which is within the angle defined by your feet. This is shrub #1. If more than one shrub falls within the 90° angle, choose the one closest to the direction of travel.

4. Measure the distance from the center of the starter shrub to the center of shrub #1 and the diameter of the first shrub, by chaining or by pacing. Record the distance and diameter on the inventory sheet (exhibit 1). Standing at shrub #1, repeat steps previously described to select and measure shrub #2. Continue in this manner until a minimum of 20 shrubs have been measured. The line of travel should be in a zig-zag fashion as shown in figure 1.

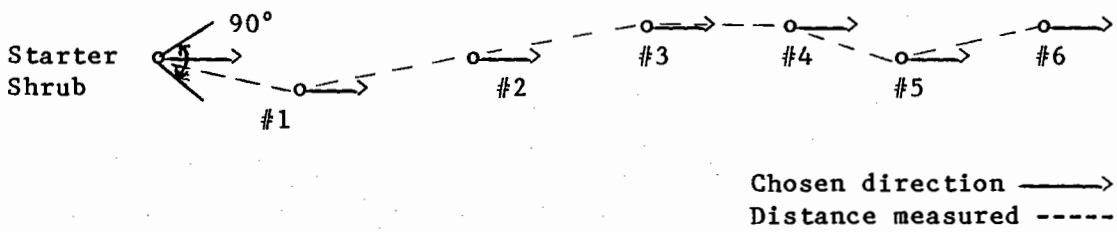


Figure 1. Sequence of shrub and rules of selection.

5. Skip over openings and clumps or patches of shrubs not part of the main stand. Do not include shrubs or trees on the edges of openings or clumps. Pass through them on the chosen direction of travel and begin measurements on the opposite side.

To Determine Percent Crown Canopy

Use the following procedure:

1. After running the zig-zag transect and recording data on the form (exhibit 1), total the column for spacing and divide the number of plants sampled to get the average spacing.

2. Repeat (or can be done at same time distances are measured) this procedure for the crown diameter (feet) and enter the average crown diameter in the space provided on exhibit 1.

3. To find percent of canopy cover use one of two procedures.

   Procedure 1. Refer to exhibit 2. Locate the average spacing on the left side of the graph. Now locate the average crown diameter in feet at the top of the graph. Read down from the top to where the average spacing line intersects the average diameter line. Read diagonally to the right for the percent of canopy cover. In the case where the average spacing line intersects the average diameter line, between the diagonal lines of percent canopy, one must interpolate between the next highest and lowest diagonal lines to read percent canopy.

Procedure 2. By calculation. For example, a 2-foot average diameter plant with an average 3-foot spacing.

a. To determine area of crown:

$A = 3.14r^2$, for a 2-foot diameter plant = $3.14(1)^2$
A = 3.14 sq. ft. average area of plant.

b. To determine number of plants per acre:

Sq. ft. per acre ÷ average spacing of plants squared
$43{,}560 \div 3^2 = 4{,}840$ plants per acre.

c. To determine percent canopy cover per acre:

1. Average area of plant x number of plants = sq. ft. in acre plant occupies.
   3.14 x 4,840 - 15,198 sq. ft. per acre.

2. Sq. ft. in area plant occupies ÷ sq. ft. in acre x 100 = % canopy cover of plants in acre.
   15,198 ÷ 43,560 x 100 = 35% canopy cover/acre.

This type of transect has been primarily used for estimating wood production in pinyon-juniper and has not had large-scale field testing for range shrub cover. In theory, it is comparable to the line-intercept or fixed-plot method. It has applicability in pinyon-juniper areas.

Fixed Plot Method

This method is commonly used to study vegetation on a more detailed basis, but could be adapted for determining shrub and tree canopy cover. It consists of locating a plot representative of the vegetation, usually from 1/100 to 1/10 acre in size. The crown canopy is measured and/or estimated for each species and tallied for each plant. The percent canopy cover per acre would then be calculated in the same manner as for the zig-zag transect method. One or more plots may be necessary to determine the shrub cover, depending on the uniformity of the cover. It would apply to shrub and pinyon-juniper types.

Photo Interpretation

This method employs the use of aerial photographs to determine woody plant canopy cover. It is reasonably accurate for determining the total shrub and/or tree cover. The major limitation is that photo resolution is usually not sufficient to identify woody plants to species, especially shrubs. Also care must be exercised in only reading shrub and tree crown, i.e. do not read shadow cast, etc.

Range site boundaries can be drawn on aerial maps or taken from soil survey maps. Representative plots of the woody plant cover are then identified and comparison charts for visual estimation of foliage cover are used to determine the total canopy cover. Refer to exhibit 3.

Point Observation Plot (square-foot density)

This is an estimate method where accuracy on each plot is sacrificed for a larger number of sample plots. The crown canopy of each species in a representative plot is estimated, occularly, in square feet. It is necessary that the estimators have a mental concept of how much of the particular species is required for one square foot of vegetation. In training for this concept, a shrub or portion of vegetation is clipped and placed in a square foot frame so that it occupies the frame without distortion. Daily checking of his/her concept is required by each estimator. Plot size may range from 25 square feet in dense vegetation to 100 square feet in more sparse vegetation.

This method is rapid to use and is more reliable when the same group of individuals make estimates on all study areas. It has less value when different personnel take data at different times or places. Because the data obtained with this method is subjective, the quality and validity of data is subject to criticism.

Spherical Densiometer

This is a pocket size instrument that is used for measuring forest overstory density. It may have some application on certain range sites with large tree overstory such as ponderosa pine. The instrument consists of a small 2-inch diameter concave or convex mirror divided into 1/4-inch squares. The observer stands in a representative location and holds the instrument level, 12 to 18 inches in front of him at elbow height. He/she assumes four equi-spaced dots in each square on the grid and systematically counts dots equivalent to quarter-square canopy openings.

The total count is multiplied by 1.04 to obtain percent of overhead area not occupied by canopy. The difference between this and 100 is an estimation of overstory density in percent. (Assuming each dot to represent one percent is often accurate enough.) Four readings are made per location, facing north, east, south, and west, then recorded and averaged to determine total canopy cover. A common error is to count dead limbs instead of foliage, which will bias the answer. The method is rapid and recognized by foresters as an acceptable procedure.

Estimation Techniques

Estimation techniques are perhaps the simplest of the techniques developed to determine cover. Cover can be estimated directly in percentage, but more often is estimated according to cover classes. Many systems of cover classes have been used; however, the system devised by Daubenmire (1959) has most often been used. In this sytem, six cover classes were used:

Class	Range %	Midpoint
1	0-5	2.5
2	5-25	15.0
3	25-50	37.5
4	50-75	62.5
5	75-95	85.0
6	95-100	97.5

Unequal sub classes 1 and 6 were used to prevent skewed data for extremely sparse or dense vegetation. For each quadrant, the observer simply records the cover class. Data are summarized using the class midpoints.

One drawback with cover estimations is that training and adjustments of estimates are difficult. No direct determination of cover is possible, and estimates are subject to personal bias.

References

WNTC Ecological Sciences Technical Note W-10, Henry D. Galt

Colorado Range Note No. 27, Edward C. Dennis

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

SHRUB INVE[illegible] WORKSHEET

Shrub(s) Measured: (1) _____ (2) _____ (3) _____ (4) _____ Date _____

Site Description No.: _____ Soil Series (Phase) _____ PSU No. _____ Point No. _____

Data by: _____ Measurement Method _____

NUM	Total Woody		NUM	Shrub Species #1		NUM	Shrub Species #2		NUM	Shrub Species #3		NUM	Shrub Species #4	
	Dist. (ft)	Diam. (ft)		Dist. (ft)	Diam. (ft)		Dist. (ft)	Diam. (ft)		Dist. (ft)	Diam. (ft)		Dist. (ft)	Diam. (ft)
1			1			1			1			1		
2			2			2			2			2		
3			3			3			3			3		
4			4			4			4			4		
5			5			5			5			5		
6			6			6			6			6		
7			7			7			7			7		
8			8			8			8			8		
9			9			9			9			9		
10			10			10			10			10		
11			11			11			11			11		
12			12			12			12			12		
13			13			13			13			13		
14			14			14			14			14		
15			15			15			15			15		
16			16			16			16			16		
17			17			17			17			17		
18			18			18			18			18		
19			19			19			19			19		
20			20			20			20			20		
21			21			21			21			21		
22			22			22			22			22		
23			23			23			23			23		
24			24			24			24			24		
25			25			25			25			25		
26			26			26			26			26		
27			27			27			27			27		
28			28			28			28			28		
29			29			29			29			29		
30			30			30			30			30		
TOTAL														

SUMMARY					
	Ave. Dist. _____ ft.	Ave. Dist. _____ ft.	Ave. Dist. _____ ft.	Ave. Dist. _____ ft.	Ave. Dist. _____ ft.
	Ave. Diam. _____ ft.	Ave. Diam. _____ ft.	Ave. Diam. _____ ft.	Ave. Diam. _____ ft.	Ave. Diam. _____ ft.
	Ave. Canopy _____ %	Ave. Canopy _____ %	Ave. Canopy _____ %	Ave. Canopy _____ %	Ave. Canopy _____ %
	Plts/Acre _____ No.	Plts/Acre _____ No.	Plts/Acre _____ No.	Plts/Acre _____ No.	Plts/Acre _____ No.

EXHIBIT NO. 1

INSTRUCTIONS FOR COMPLETING FORM

Heading

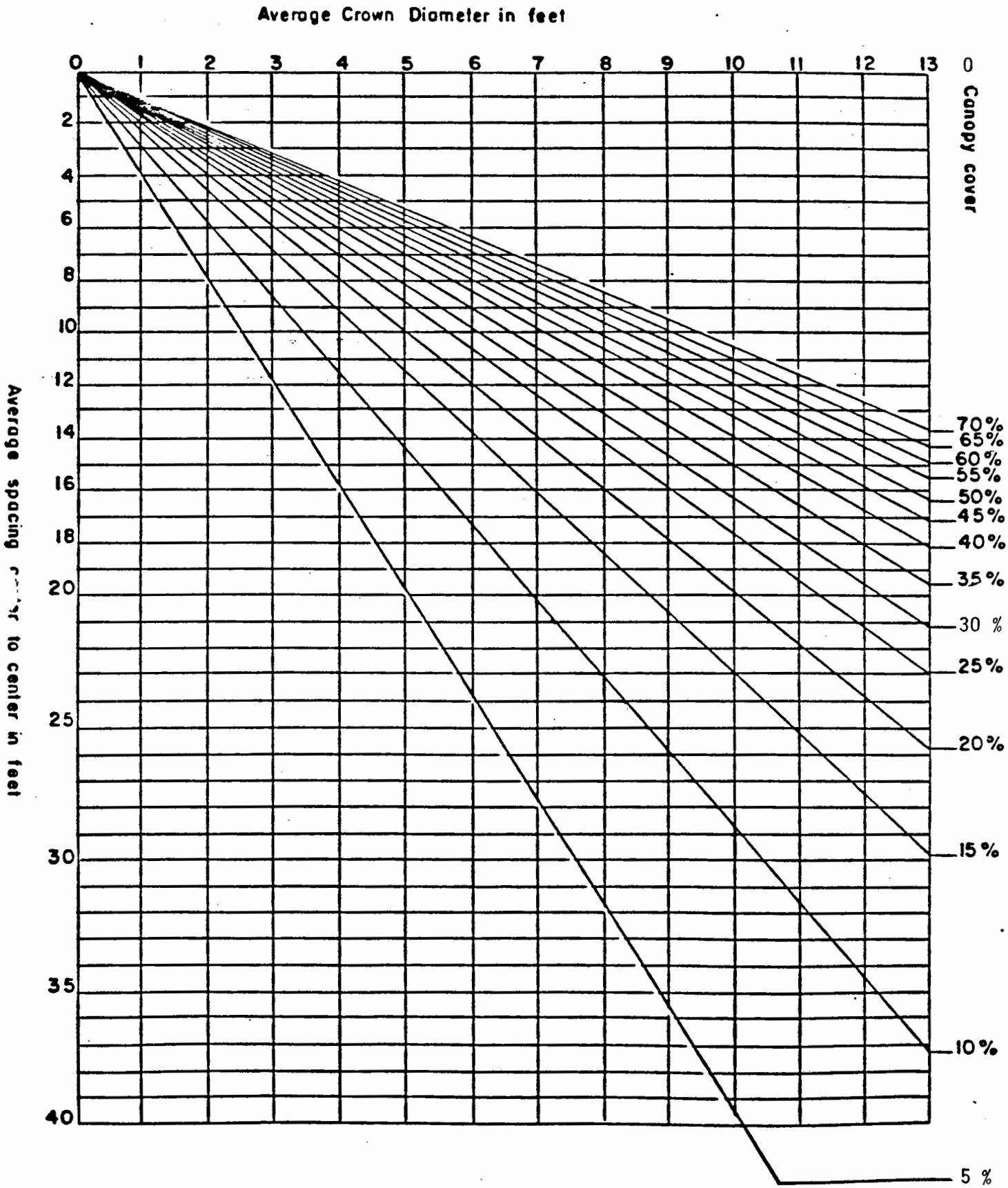
Shrub(s) Measured. . .	Enter Plant Symbol Codes, i.e. ARTRW, etc.
Date	Enter date data gathered.
Site Description No. .	Enter site description number for site, i.e. 011XY001I.
Soil Series (Phase). .	Enter soil series name and phase.
PSU No.	Enter PSU number when used for NRI data collection.
Point No.	Enter sample point number when used for NRI data collection.
Data by:	Enter name(s) of person(s) collecting data.
Measurement Method . .	Enter name of measurement method used, i.e. line intercept, pace transect, etc.

Main Body of Form

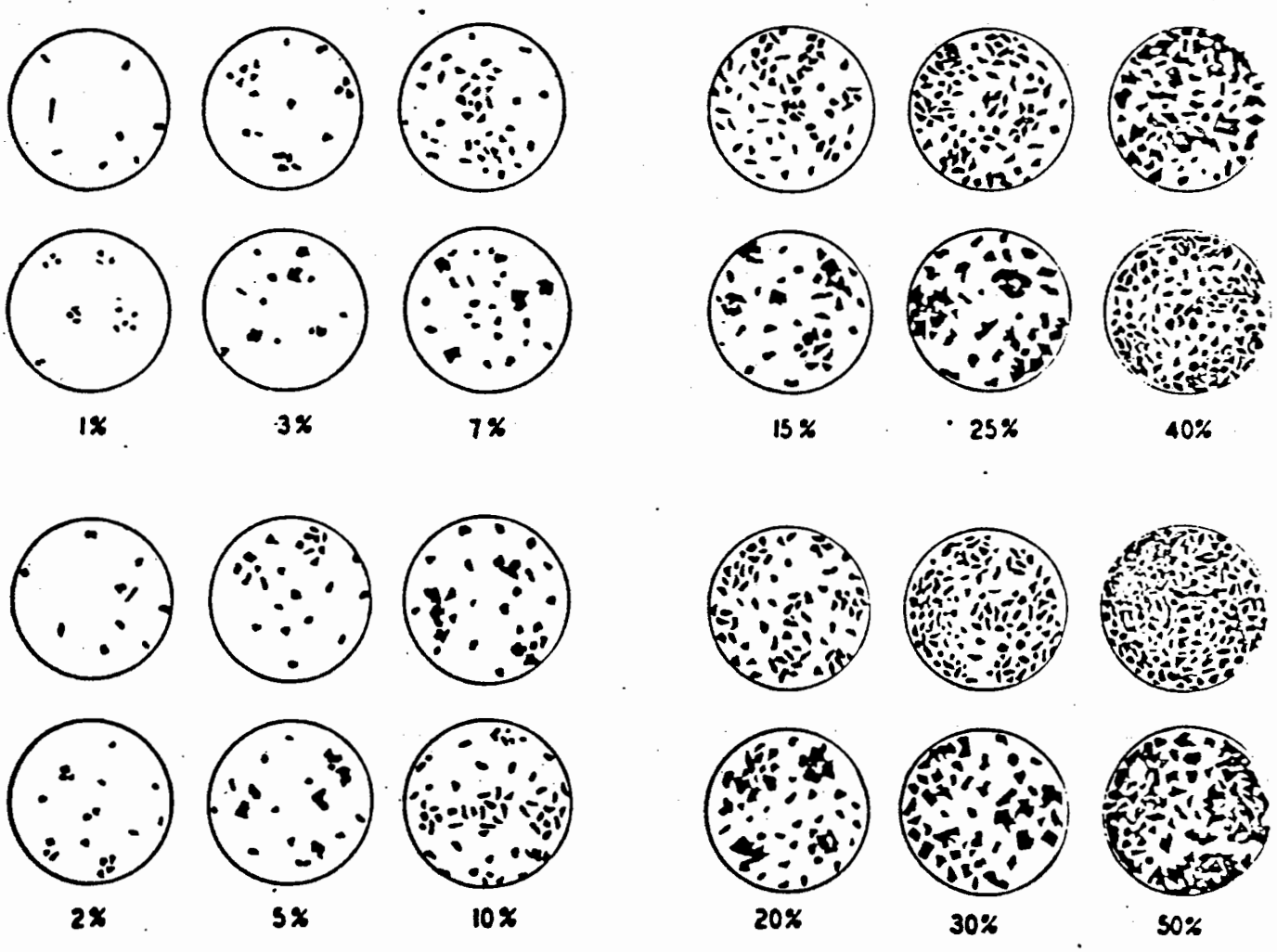
Number	Data already entered on form.
Total Woody.	Includes all woody plants (half shrubs, shrubs, woody vines). Only the overall woody canopy cover is measured for this item. Multiple (overlapping) canopy levels should <u>not</u> be included. Therefore, the percentage can never exceed 100.
Distance	Enter a figure for distance between each shrub in feet and/or tenths of feet only when using the zig-zag transect method.
Diameter (ft). . .	Enter a figure in feet and/or tenths of feet for each shrub measured. Enter crown intercept when using <u>line intercept method</u>. Enter a check mark for hits when using the step point (pace transect) method.
Shrub Species #'s 1-4	These correspond to shrub(s) listed in heading. When measured for NRI, shrub(s) listed will correspond to multiple layers (Shrub Species #1 will always be that occupying the top canopy layer, Shrub Species #2 the next layer, etc.).
Distance	Use same method as under "Total Woody" above.
Diameter	Use same method as under "Total Woody" above.
TOTAL (Dist. ft) . . .	Enter transect length in feet <u>except</u> when using zig-zag transect method. When using zig-zag transect method, enter total of distances measured within the transect.
(Diam. ft) . . .	Enter total for all shrubs in measured transect.

Summary

Ave. Dist.	Enter data only when using the zig-zag transect method.
Ave. Diam.	Enter data only when using the zig-zag transect method.
Ave. Canopy.	Enter data from charts when using the zig-zag transect method; enter figure derived from calculations from dividing crown canopy summaries by transect length when using line intercept method; or enter figure derived from calculations from dividing number of hits by transect length when using step point method.
Plts/Acre.	Enter data from chart, when using zig-zag transect method.


Average Crown Diameter in feet
0
1
2
3
4
5
6
7
8
9
10
11
12
13
Average spacing center to center in feet
2
4
6
8
10
12
14
16
18
20
25
30
35
40
Canopy cover
0
70%
65%
60%
55%
50%
45%
40%
35%
30 %
25%
20%
15%
10%
5 %

COMPARISON CHARTS FOR VISUAL ESTIMATION OF FOLIAGE COVER 1/



1/ Developed by Richard D. Terry and George V. Chilingar. Published by the Society of Economic Paleontologist and Minerologist in its Journal of Sedimentary Petrology 25 (3): 229-234, September 1955.

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