B. Frequency Methods - Pace Frequency, Quadrat Frequency, and Nested Frequency Methods

1. *General Description* All three methods consist of observing quadrats along transects, with quadrats systematically located at specified intervals along each transect. The only differences in these technique are the size and configuration of the quadrat frames and the layout of the transect. The following vegetation attributes are monitored with this method:

   - Frequency
   - Basal cover and general cover categories (including litter)
   - Reproduction of key species (if seedling data are collected)

   It is important to establish a photo plot (see Section V.A) and take both close-up and general view photographs. This allows the portrayal of resource values and conditions and furnishes visual evidence of vegetation and soil changes over time.

2. *Areas of Use* This method is applicable to a wide variety of vegetation types and is suited for use with grasses, forbs, and shrubs.

3. *Advantages and Limitations*

   a Frequency sampling is highly objective, repeatable, rapid, and simple to perform, and it involves a minimum number of decisions. Decisions are limited to identifying species and determining whether or not species are rooted within the quadrats (presence or absence).

   b Frequency data can be collected in different-sized quadrats with the use of the nested frame. When a plant of a particular species occurs within a plot, it also occurs in all of the successively larger plots. Frequency of occurrence for various size plots can be analyzed even though frequency is recorded for only one size plot. This eliminates problems with comparing frequency data from different plot sizes. Use of the nested plot configuration improves the chance of selecting a proper size plot for frequency sampling.

   c Cover data can also be collected at the same time frequency data is gathered. However, cover data collected in this manner will greatly overestimate cover; unless the tines are honed to a fine point, observer bias will come into play. Another limitation is that the use of one size quadrat will likely result in values falling outside the optimum frequency range (greater than 20 percent to less than 80 percent) for some of the species of interest.

4. *Equipment* The following equipment is needed (see also the equipment list in Section V.A, page 31, for the establishment of the photo plot):

   - Study Location and Documentation Data form (see Appendix A)
   - Frequency form (see Illustration 4)
   - Nested Frequency form (see Illustration 5)
   - Permanent yellow or orange spray paint
   - Frequency frames (see Illustrations 6 and 7)

- One transect location stake: 3/4 - or 1-inch angle iron not less than 16 inches long
- Hammer
- Tally counter (optional)
- Compass
- Steel post and driver
- Tape: 50-, 100-, or 200-foot delineated in tenths and hundreds or a metric tape of the desired length.

5. *Training* A minimum amount of training is needed for this method. Examiners must be able to identify the plant species and be able to tell whether or not a species occurs, according to study specifications, within a quadrat. Examiners must be familiar with the cover categories and how to collect cover data using the tines on the quadrat frame.

6. *Establishing Studies* Careful establishment of studies is a critical element in obtaining meaningful data (see Section III).

   a **Site Selection** The most important factor in obtaining usable data is selecting representative areas (critical or key areas) in which to run the study (see Sections II.D). Study sites should be located within a single plant community within a single ecological site. Transects and sampling points need to be randomly located within the critical or key areas (see Section III).

   b **Pilot Studies** Collect data on several pilot studies to determine the number of samples (transects or observation points) and the number and size of quadrats needed to collect a statistically valid sample (see Section III.B.8).

   c **Selecting Quadrat Size** The selection of quadrat size is important and depends on the characteristics of the vegetation to be sampled (see Section III.B.6).

      (1) As a rule of thumb, it is expected that all frequency percentages for important species should fall between 10 and 90 percent or, if possible, between 20 and 80 percent. This will provide the greatest possible chance for detecting an important trend for a species when the study is read again. Use a frame size that will produce frequencies falling in this range for the greatest number of species possible.

      (2) To build a sample frame, see Illustration 6, which shows an example of a frequency frame.

      (3) Use the same size quadrat throughout a study and for rereading the study. If frequencies for a specific species approach the extremes of either 0 or 100 percent, it may be necessary to use a different sized quadrat for that species. The nested plot concept would be suitable in this instance.

   d **Nested Plot Technique** The use of one size plot is usually not adequate to collect frequency data on all the important species within a community. For each species occurring on a site, there is a limited range of plot sizes capable of producing frequency percentages between 20 and 80 percent. A plot size appropriate for one species may not be appropriate for another. The nested plot

concept is a simple approach to collecting data on two or more different sized plots at one time. Several different sized plots are placed inside each other in a smallest to largest sequence (see Illustration 7).

e **Number of Studies** Establish at least one frequency study on each study site; establish more if needed (see Sections II.D and III.B).

f **Study Layout** Frequency data can be collected using either the baseline, macroplot, or linear study designs described in Section III.A.2 beginning on page 8. The baseline technique is the one most often used.

Align a tape (100-, or 200-foot, or metric equivalent) in a straight line by stretching it between the baseline beginning stake and the baseline end point stake (see Figure 4 on page 13.) A pin may also be driven into the ground at the midpoint of the transect. Do not allow vegetation to deflect the alignment of the tape. A spring and pulley may be useful to help maintain a straight line.

With the baseline technique, any number of transects can be run perpendicularly to the baseline, depending on the intensity of the sample needed (see Figure 1 on page 9). Each transect originates at a randomly selected mark along the baseline. The randomization is restricted so that half of the transects are randomized on each side of the halfway mark. (Directions for randomly selecting the location of transects to be run off of a baseline using random number tables are given in Appendix D.)

The starting point for each transect off the base line and the distance between each quadrat should not be any closer than the width of the quadrat being used to avoid the possibility that any two quadrats might overlap.

g **Reference Post or Point** Permanently mark the location of each study with a reference post and study location stake (see beginning of Section III).

h **Study Identification** Number studies for proper identification to ensure that the data collected can be positively associated with specific studies on the ground (see Appendix B).

i **Study Documentation** Document pertinent information concerning the study on the Study Location and Documentation Data form (see beginning of Section III and Appendix A).

7. *Taking Photographs* The directions for establishing photo plots and for taking close-up and general view photographs are given in Section V.A.

8. *Sampling Process* In addition to collecting the specific study data, general observations should be made of the study sites (see Section II.F).

a **Running the Transect** Study data are collected along several transects. The location of each transect (distance along the baseline) and the direction (to left or right from the baseline) are randomly determined for each study site. A quadrat is read at the specified interval until all quadrats have been read. The interval between quadrats can be either paced or measured. To widen the area

transected, add additional paces or distance (20 paces, 50 feet) between quadrats. Additional transects can be added to obtain an adequate sample.

(1) Start each transect by placing the rear corner of the quadrat frame at the starting point along the baseline tape.

(2) Place the quadrat frame at the designated interval along a transect perpendicular to the baseline until the specified number of quadrats have been read. The interval between quadrats can be measured or estimated by pacing.

(3) When a transect is completed, move to the next starting point on the baseline tape and run the next transect.

b **Collecting Cover Data** Record, by dot count tally, the cover category at each of the four corners and at the tip of any tines on the frame. Enter this data in the Cover Summary section of the Frequency and Nested Frequency forms (see Illustrations 4 and 5). The cover categories are bare ground (gravel less than 1/12 inch in diameter is tallied as bare ground), litter, and gravel (1/12 inch and larger). Additional cover categories can be added as needed. Vegetation is recorded as basal hits or canopy layers in the bottom portion of the form. Up to three canopy layers can be recorded. For additional information on collecting vegetation cover data, see Section V.F.8.b on page 72. Cover data can also be recorded on the Cover Data form, Illustration 13, page 75.

Read the same points on the frame and the same number of points at each placement of the frame throughout a study and when rereading that study.

c **Collecting Frequency Data** Collect frequency data for all plant species. Record the data by species within each quadrat using the Frequency form (Illustration 4). Only one record is made for each species per quadrat, regardless of the number of individual plants of a species that occurs within the quadrat.

(1) Herbaceous plants (grasses and forbs) must be rooted in the quadrat to be counted.

(2) On many occasions, rooted frequency on trees and shrubs (including half shrubs) does not provide an adequate sample (occurring within 20% of the plots). To increase the sample size on trees and shrubs, the canopy overhanging the quadrat can be counted.

(3) Annual plants are counted whether green or dried.

(4) Specimens of the plants that are unknown should be collected and marked for later identification.

(5) Frequency occurrence of seedlings by plant species should be tallied separately from mature plants.

d **Nested Plot Method** Collect frequency data for all plant species. For uniformity in recording data, the four nested plots in a quadrat are numbered from 1 through 4, with the largest plot size corresponding with the higher number. Each time the quadrat frame is placed on the ground, determine the smallest size plot each species occurs in and record the plot number for that quadrat on the Nested Frequency form (Illustration 5).

9. *Calculations* Make the calculations and record the results in the appropriate columns on the Frequency form (see Illustration 4).

a **Cover** Calculate the percent cover for each cover category by dividing the number of hits for each category by the total number of hits for all categories, including hits on vegetation, and multiplying the value by 100. The total of the percent cover for all cover categories equals 100 percent. Additional information on calculating ground cover, canopy cover, and basal cover can be found in Section F.9 on page 73.

b **Frequency: Single Plot** On the Frequency form, Illustration 4, total the frequency hits by species. Calculate the percent frequency for each plant species by dividing the total number of hits for that species by the total number of quadrats sampled along the transect and multiplying the value by 100. Record the percent frequency on the form.

c **Frequency: Nested Plot** Percent frequency by species can be calculated for each transect and/or for the total of all transects.

(1) ***Compiling data*** Determine the number of occurrences for each species for each plot size.

(a) Count the number of occurrences of a species in plot 1 and record the value in the Hits portion of column 1 in the Frequency Summary portion of the Nested Frequency form (see Illustration 5).

(b) Count the number of occurrences of the same species in plot 2 and add this number to the number recorded for plot 1. Record this total in the Hits portion of column 2.

(c) Count the number of occurrences of the same species in plot 3 and add this number to the number recorded for plot 2. Record this total in the Hits portion of column 3.

(d) Count the number of occurrences of the same species in plot 4 and add this number to the number recorded for plot 3. Record this total in the Hits portion of column 4.

(2) ***Frequency for each transect*** Calculate the percent frequency of a plant species by plot size for a transect by dividing the number of occurrences by the number of quadrats sampled and multiplying the value by 100. Record in the "% Freq" section of the Frequency Summary portion.

(3) ***Total frequency for all transects*** Calculate the percent frequency of a plant species by plot size for the total of all transects by adding the occurrences of a species by plot size on all transects, dividing the total by the total number of quadrats sampled for the study, and multiplying the value by 100. Record the percent frequency in the appropriate plot size on a separate form.

10. Data Analysis

To determine if the change between sampling periods is significant, a Chi Square contingency table analysis should be used. Frequency must be analyzed separately for each species. Chi Square (See Technical Reference, *Measuring & Monitoring Plant Populations*) can also be used to detect changes in cover classes between sampling periods.

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Frequency

Page ____ of ____

Study Number	Date	Examiner	Allotment Name & Number	Pasture

Transect Location	Number of Quadrats	Quadrat Size

Plant Species	Quadrat Number										Total
	0	10	20	30	40	50	60	70	80	90	100	

Cover Summary

Vegetation (Basal)		Vegetation (Canopy)		Litter		Bare Ground		Gravel/Stone			
Hits	%Cover	Hits	%Cover	Hits	%Cover	Hits	%Cover	Hits	%Cover	Hits	%Cover

Notes (use other side or another page)

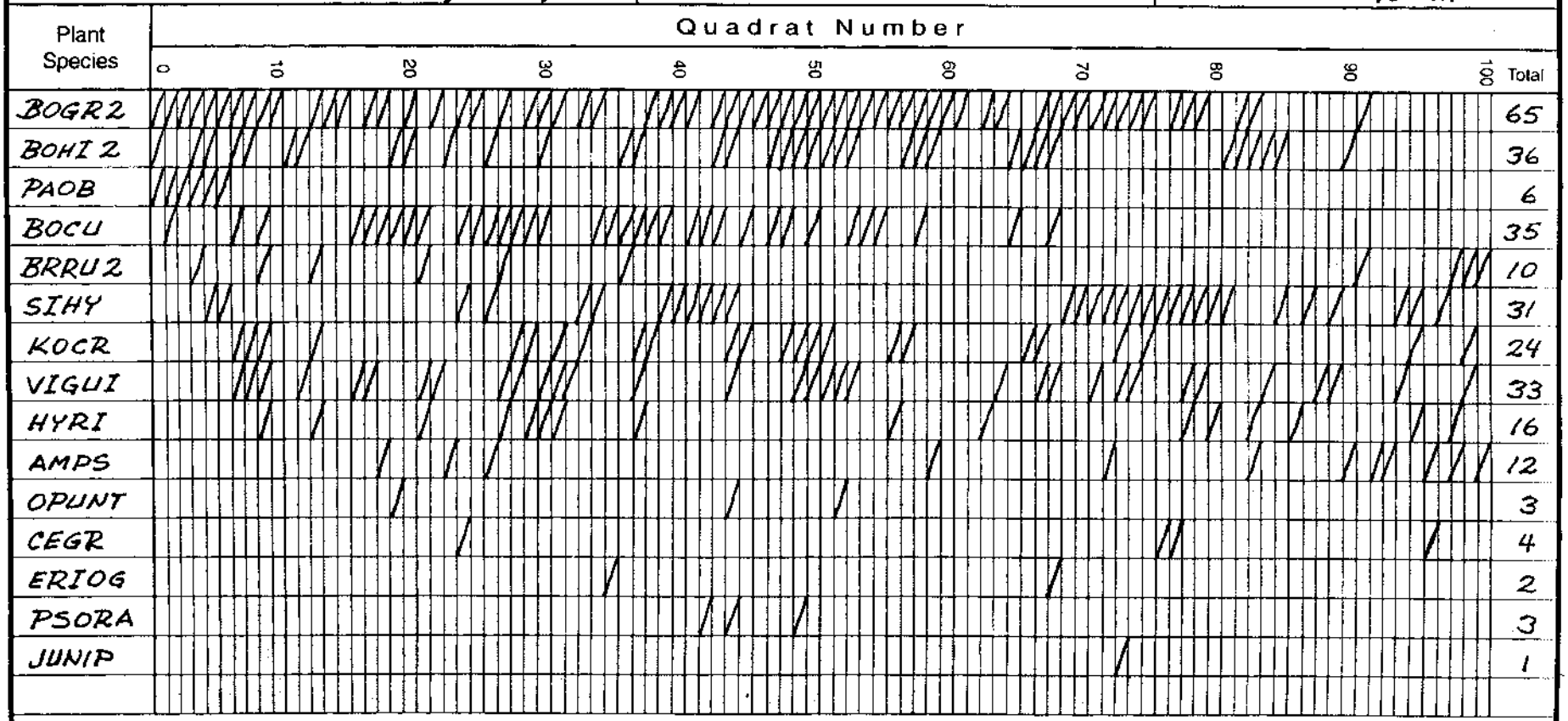
Illustration 4

Frequency

Page 1 of 1

Study Number	Date	Examiner	Allotment Name & Number	Pasture
07N-04W-13-05	10/27/95	Buddy Clump	Blue Dome - 03131	

Transect Location	Number of Quadrats	Quadrat Size
1 mile East of Weatherby Cattleguard	100	40 x 40 cm



Cover Summary

Vegetation (Basal)	Vegetation (Canopy)	Litter	Bare Ground	Gravel/Stone	
Hits 20	Hits 46	Hits 164	Hits 136	Hits 34	Hits
%Cover 5	%Cover 12	%Cover 41	%Cover 34	%Cover 8	%Cover

Notes (use other side or another page)

Illustration 4

Nested Frequency

Page ___ of ___

Study Number	Date	Examiner	Allotment Name & Number	Pasture

Transect Location	Number of Quadrats	Quadrat Size

Plant Species	Quadrats																				Frequency Summary by Plot Size								Cover Summary
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1		2		3		4		
																					Hits	% Freq	Hits	% Freq	Hits	% Freq	Hits	% Freq	
																													Vegetation (Basal) Hits %Cover
																													Vegetation (Canopy) Hits %Cover
																													Litter Hits %Cover
																													Bare Ground Hits %Cover
																													Gravel/Stone Hits %Cover
																													Cryptogamic crust Hits %Cover

Observations/Comments

Notes (Use other side or another page)

Canopy* Dont record ground cover under canopy hits of shrubs under 10ft in height

Illustration 5

Nested Frequency

Page 1 of 1

Study Number	Date	Examiner	Allotment Name & Number	Pasture
Bear Mountain #1	10/3/95	Rex Allen	Bear Mtn 10205	3

Transect Location	Number of Quadrats	Quadrat Size
2 miles north of Roger's well	20	

Plant Species	Quadrats																				Frequency Summary by Plot Size							
																					1		2		3		4	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Hits	% Freq	Hits	% Freq	Hits	% Freq	Hits	% Freq
POSE	1	2	2	2	2	2	2	2	1	2	2		2	2	2	1	3			2	3	8	16	80	17	85	17	85
SIHY	2	2	4			3	2	3	1	2	4	2	3	3	2	3	2	2	4	3	1	5	9	45	15	75	18	90
PHLO 2	3		3						3			1	2			2	2	2			1	5	5	25	8	40	8	40
CHVI 8	2					4	2								4						0	0	2	10	2	10	4	20
BRTE		2	4	3	1	1	2	1	2	3	2	2	1	2	2	2	1	2	1	1	7	35	16	80	18	90	19	95
ARTR 2		2						4		2	4		3		3		4				0	0	2	10	4	20	7	35
ASTRA			3		3																0	0	0	0	2	10	2	10
SSSS			4									4									0	0	0	0	0	0	2	10
PPFF						3				4					4						0	0	0	0	1	5	3	8
ERIOG							4					4									0	0	0	0	0	0	2	10
AAGG								4					3	4			1				1	5	1	5	2	10	4	20
PHHO															4						0	0	0	0	0	0	1	5

Cover Summary

Vegetation (Basal)

Hits 13 %Cover 13

Vegetation (Canopy)

Hits 17 %Cover 17

Litter

Hits 21 %Cover 21

Bare Ground

Hits 31 %Cover 31

Gravel/Stone

Hits 18 %Cover 18

Crytogamic crust

Hits %Cover

Observations/Comments

Notes (Use other side or another page)

Canopy* Dont record ground cover under canopy hits of shrubs under 10ft in height

Illustration 5

Rangeland Monitoring

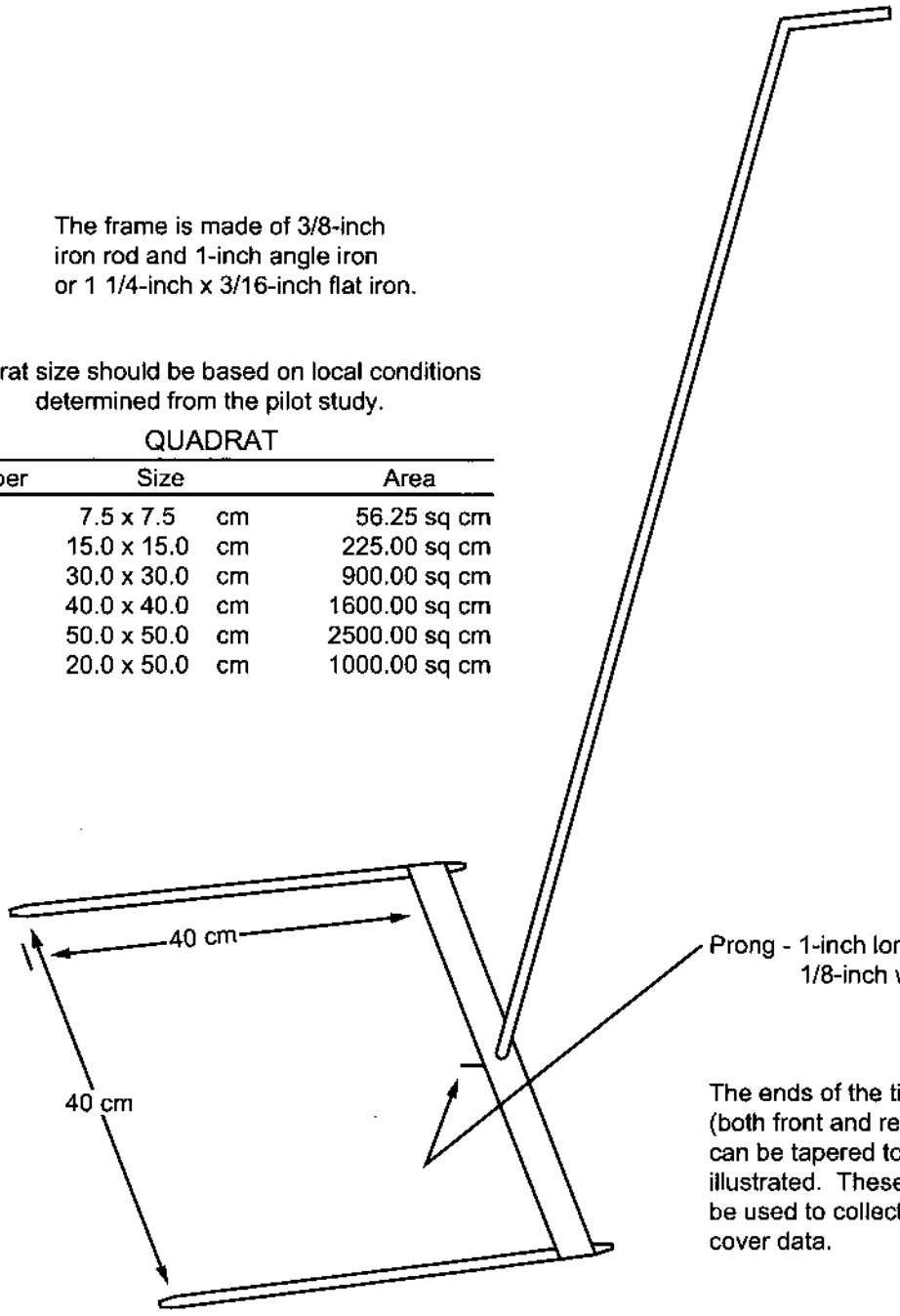
Frequency Frame

The frame is made of 3/8-inch iron rod and 1-inch angle iron or 1 1/4-inch x 3/16-inch flat iron.

Quadrat size should be based on local conditions determined from the pilot study.

QUADRAT

Number	Size		Area
1	7.5 x 7.5	cm	56.25 sq cm
2	15.0 x 15.0	cm	225.00 sq cm
3	30.0 x 30.0	cm	900.00 sq cm
4	40.0 x 40.0	cm	1600.00 sq cm
5	50.0 x 50.0	cm	2500.00 sq cm
6	20.0 x 50.0	cm	1000.00 sq cm



The ends of the tines (both front and rear) can be tapered to points as illustrated. These points can be used to collect additional cover data.

Illustration 6

Rangeland Monitoring

Nested Plot Frame

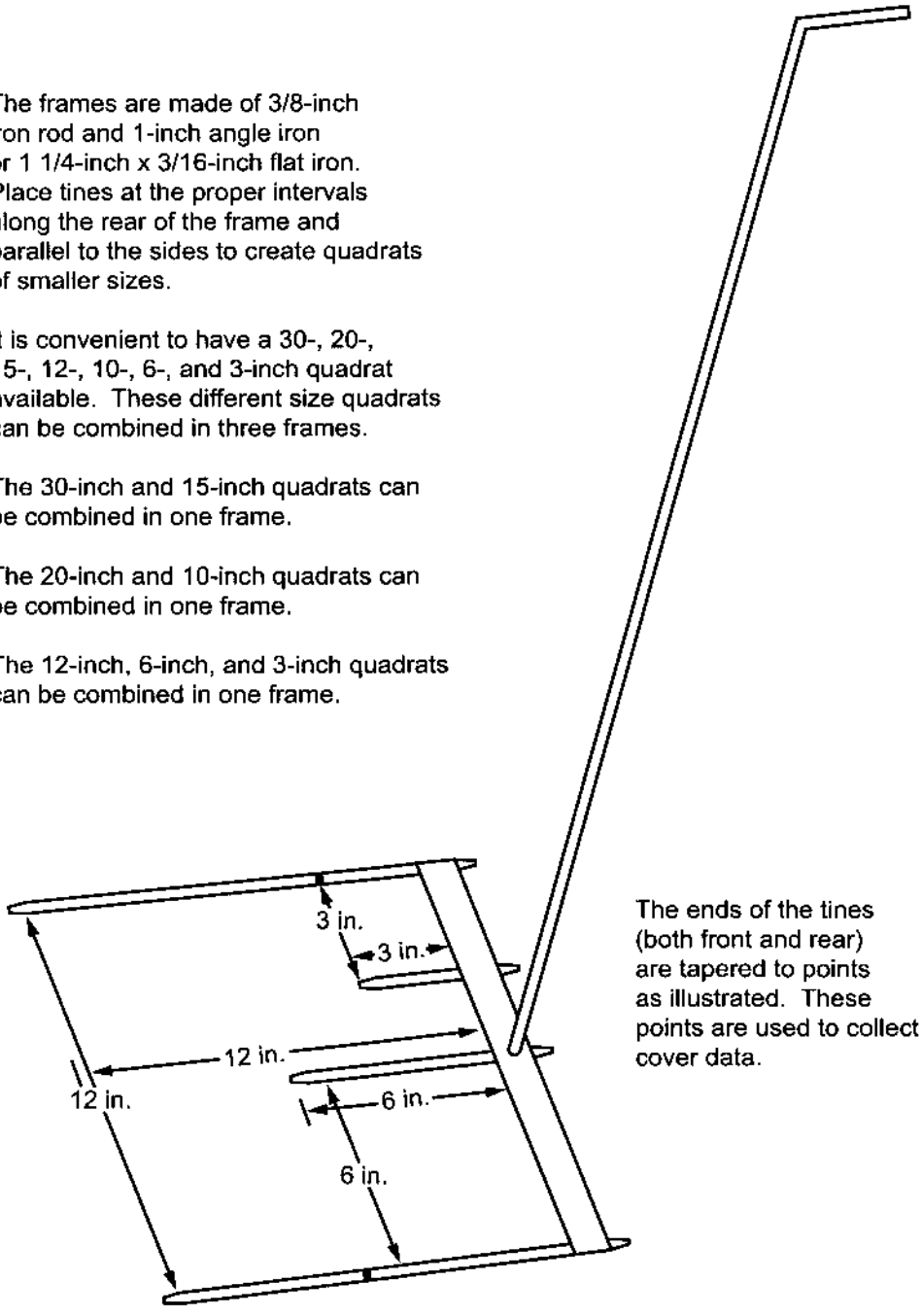
The frames are made of 3/8-inch iron rod and 1-inch angle iron or 1 1/4-inch x 3/16-inch flat iron. Place tines at the proper intervals along the rear of the frame and parallel to the sides to create quadrats of smaller sizes.

It is convenient to have a 30-, 20-, 15-, 12-, 10-, 6-, and 3-inch quadrat available. These different size quadrats can be combined in three frames.

The 30-inch and 15-inch quadrats can be combined in one frame.

The 20-inch and 10-inch quadrats can be combined in one frame.

The 12-inch, 6-inch, and 3-inch quadrats can be combined in one frame.



The ends of the tines (both front and rear) are tapered to points as illustrated. These points are used to collect cover data.

Illustration 7