Technical Report No. 145

BASIC FIELD DATA COLLECTION PROCEDURES FOR THE GRASSLAND BIOME 1972 SEASON

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GRASSLAND BIOME

U. S. International Biological Program

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ABSTRACT

Details of the treatment design and sampling scheme to accumulate a basic set of state variable and driving variable data from the Grassland Biome sites during the 1972 field season is described. Sample data forms are included, and their uses are explained. *Changes from procedures followed in the 1971 field season* (described in Technical Report No. 85) *are signified by a double asterisk* (**) *in the right-hand margin.*

BASIC DESIGN

Each site in the Comprehensive Network will consist of at least one grazed and one ungrazed treatment with two replicates for each treatment. Ideally, these areas should be sufficiently large so that all types of sampling planned in the Comprehensive Network studies can be made within each area (about 30 acres or 13 ha). Each treatment and replicate should be conspicuously labeled in the field so that all workers may clearly identify their data sheets. Each area should be mapped and marked with stakes to facilitate location of sampling points.

DATA COLLECTION FREQUENCIES

The following is a summary of minimum data collection requirements at all Grassland Biome sites.

I. Primary Producer Data
   - A. Aboveground biomass (AGBM) for each treatment
     1. From start of growing season until time of peak standing crop--every three weeks
     2. Other times during the year--every two months
   - B. Species list--twice during growing season
   - C. Range condition--at peak standing crop
   - D. Litter, Standing Crop--when AGBM is measured
   - E. Litter, Accumulation--every month
   - F. Belowground biomass (BGBM)--three or four times per year
   - G. Phenology--three times per week

II. Small Mammal Data for Each Treatment
   - A. Live trap grids
     1. Jornada, Pantex--four times per year
     2. Other sites--three times per year
   - B. Snap trapping--as for live trapping
   - C. Lagomorphs--as for live trapping
   - D. Runways, mounds, and excavations--as for live trapping

III. Cattle Data
   - A. Cattle weights--when put on, then every 28 days, and when removed
   - B. Forage intake--when AGBM is measured

IV. Avian Data
   - A. Flush census--twice in breeding season
   - B. Strip census--at time of flush census and in midwinter

C. Roadside census--once each in spring migration, breeding season, fall migration, and midwinter

V. Invertebrate Data for Each Treatment

A. Aboveground numbers--when AGBM is measured but at least once per month

B. Soil microarthropods--when BGBM is measured

C. Soil macroarthropods--when BGBM is measured

D. Invertebrate weights--collect continuously, report at end of season

VI. Microbiology Data for Each Treatment

A. Decomposition

1. Full series--set out once at start of growing season, three retrievals

2. Partial series--set out twice, early March and end of growing season, three retrievals each

B. CO_2 evolution--every three to four weeks and after precipitation events $\geq$0.05 inches

VII. Abiotic Data

A. Automatic data recording system--hourly, change tapes monthly

B. Hygrothermograph--continuously, change and reduce charts weekly if possible but at least monthly

C. Gravimetric soil water--when AGBM is measured

VIII. Site Factor Data

A. Physical description--once only

B. Soil description--once only

C. Bulk density--once only

LABORATORY SAMPLE COLLECTION FREQUENCIES

The following is a summary of minimum sample collection requirements at all Grassland Biome sites.

I. Primary Producer Samples

A. Aboveground material--three samples of each major species and of each group of minor species six times per year. Samples are of (i) live, (ii) standing dead, (iii) crowns. Collection times are:

1. Start of growing season.
2. Between start of growing season and time of peak standing crop.
3. At time of peak standing crop.
4. Between time of peak standing crop and the end of the growing season.
5. At the end of the growing season.
6. During the middle of the non-growing season.

Samples to be composited by replicate and ground with a 40 mesh screen.

B. Litter--two samples composited by replicate when aboveground samples are collected.

C. Roots

1. A hand separated sample from each 10 cm core segment, composited by replicate, three times per year: at the start of the growing season, at peak standing crop, and at the end of the growing season.
2. A washed sample from each 10 cm core segment, composited by replicate, twice per year: at the beginning and end of the growing season.

II. Small Mammal Samples--stomach contents of up to 10 individuals of each small mammal species will be collected at each small mammal sampling date.

III. Site Factor Samples

A. Descriptive soil analyses

1. 150 g to 1 lb. each from (i) top 4 cm, (ii) A horizon, and (iii) B horizon (once only).

2. Three 60 cm cores from root corer divided into 10 cm segments, not composited (once only).

B. Dynamic soil analyses--400 g sample from each 10 cm segment to 60 cm, composited by replicate (when root *samples* are collected)

BASIC FIELD DATA AND PHENOLOGY

For convenience and rapidity of processing data, standard field data sheets will be utilized. The sheets are designed for ease of recording raw data in the field and for convenience of transcribing these data to punched cards for machine processing. Some data sheets are color coded by data type for convenience of handling and sorting. The forms are bound together at the bottom, to prevent their movement by wind when the top is secured by a clipboard.

Each set of data must be accompanied by certain identifying information. These basic data occupy the first 19 columns of an 80-column punched card and are outlined below (X's indicate number of characters to be punched).

XX	TYPE OF DATA - code for aboveground biomass, litter, small mammal, etc.
XX	SITE - code for Ale, Bison, . . ., Pantex
XXX	INITIALS - for initials of *Field Worker* recording the data
XXXXXX	DATE - two spaces each for day, month, and year, in that order
X	TREATMENT - code for type of treatment
X	REPLICATE - taken from marker sign at field plot
XXXX	PLOT SIZE - quadrat or plot size (area in square meters for aboveground biomass, area in hectares for birds and small mammals)

A general information form (NREL-00) may be used to record information concerning the site and conditions at the time of sampling. This contains general information and data on plant phenology and is to be completed *for each treatment*. It will provide useful reference material in case there are questions concerning weather conditions at the time of sampling, time required for sampling, etc.

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GENERAL INFORMATION SHEET

Site_____ Date_____ Time_____ Investigators_____

_____

Type of study and methods_____

_____

Weather: Temperature_____ Wind_____ Cloud_____

General comments_____

_____

Additional measurements taken:_____

_____

Remarks:_____

_____

PHENOLOGY	Genus	Species	Subspecies	Phenology	Percent
01 Germinated or sprouted					
02 Early vegetation					
03 Immature vegetative (non-flowering plants)					
04 Prebud	29-30	31-32	33	35-36	38-40
05 Bud stage					
06 Early bloom					
07 Mid-bloom					
08 Full bloom					
09 Late bloom					
10 Milk stage					
11 Dough stage					
12 Ripe seed					
13 Past ripe					
14 Mature vegetative (non-flowering plants)					
15 Stem cured					
16 Vegetative regrowth					
17 Winter dormant					

NREL-00 NATURAL RESOURCE ECOLOGY LABORATORY - COLORADO STATE UNIVERSITY - PHONE (303) 491-5571 - FORT COLLINS, COLORADO 80521

Herbage phenology data should also be recorded *between* herbage sampling periods, so that records are available *three times weekly*. This frequency ** is essential if phenology records are to be useful. These data are obtained by general observation, not by sampling.

Data Recording--Phenology

XX	GENUS	for major species, as per code according to the *National List of Scientific Plant Names*, USDA Soil Conservation Service, Lincoln, Nebraska, 1971. In the event of a code not being available in that document, please supply a key to the code you use. For miscellaneous categories record MIGR, MIFO, MISH, MISU, MISE, or MIOT (identified on p. 9), as appropriate, in columns for GENUS and SPECIES.
XX	SPECIES	
X	SUBSPECIES	

XX PHENOLOGY - see code

XXX PERCENT - percentage of plants of that species in the particular phenophase (more than one phenophase may be recorded for a species)

HERBAGE DYNAMICS--ABOVEGROUND BIOMASS

Sampling Methods

Aboveground biomass refers to standing live plant material and standing dead plant material. Sampling sites will be located randomly within replicates. The sample size *for the few major species* (those species that contribute more than 5% of the total season-long production) is to be 0.5 m^2, in a circular frame. The number of samples to be clipped per replicate will be that number required to estimate the biomass of each species to within 20% of the true biomass with a probability of 0.8. This number for the initial sampling can be determined from 1971 data. Generally, it will be less than 10.

Double sampling by weight estimation is *optional*. It should be continued ** at those sites at which it proved beneficial in 1971. Where it is used, weight estimation of the major species will be made on the plots before clipping, and on an additional 10X plots which are not clipped, where X is the number of clipped plots. Before clipping or estimating each quadrat, estimate percent ** bare ground in the quadrat and record the estimate in the column labeled CROWN WEIGHT on Form NREL-01.

When a quadrat is clipped, the material removed will be separated by species (for the major species), oven-dried, and weighed. Species other than major species will be lumped by category into the following: miscellaneous grasses (MIGR), miscellaneous forbs (MIFO), miscellaneous shrubs (MISH), ** miscellaneous succulents (MISU), miscellaneous sedges (MISE), or miscellaneous other (MIOT). Everything standing will be clipped at ground level. Litter will not be included. The standing dead of the current year's growth (recent dead) and of last year's growth (old dead) will be separated by major species where possible. Crowns will be separated and categorized as to species. Crowns will be reported as being in *category* 5 (see section on Data Recording). Live

stolons will be combined with crown material. Dead stolons will be included with the litter.

Plants with persistent live aboveground parts will be handled as follows: (i) live material of the current year's production will be reported as being in *category* 1 and (ii) live material of previous years' production will be reported in *category* 4.

Major species which cannot be sampled adequately on 0.5 m^2 plots (e.g., *Artemisia*, *Yucca*) will be sampled by a technique of the investigators' choosing, such as a density × size method. Data and results of this technique will be included in the final report. **

Aboveground biomass will be sampled at three-week intervals from the start of the growing season until the time of peak standing crop. At other times during the year, sampling will be performed once every two months as a minimum, with more frequent sampling when a rapid change in one or more of the components is anticipated or observed. **

The aboveground material including crowns will be separated, dried (at 60°C), and weighed. At six sample dates during the year [(i) start of growing season, (ii) before peak standing crop, (iii) at peak standing crop, (iv) after peak standing crop, (v) at the end of the growing season, and (vi) during the middle of the non-growing season] a portion will be composited by replicate per group or species per date and ground with a 20-mesh screen. At least 6 g of each sample will be sent to the Natural Resource Ecology Laboratory for percent ash, nitrogen, phosphorus, soluble carbohydrates, lignin, and CWC determination.

Twice during the growing season a complete list of species will be compiled and reported. This list will include those species which are not included as major species in biomass estimation.

Phenology of the "major species" will be recorded at each sampling period on the white General Information Sheet (NREL-00). Each species should be listed, the appropriate phenology code designated, and the approximate percentage of the plants in that category estimated.

Species Code

To insure cross-site uniformity, species codes used for major species will be those found in *National List of Scientific Plant Names*, USDA Soil Conservation Service, Lincoln, Nebraska, 1971. Copies of this document will be supplied by the Natural Resource Ecology Laboratory if needed. Other species will be lumped as miscellaneous grasses, forbs, shrubs, succulents, sedges, or other and coded as MIGR, MIFO, MISH, MISU, MISE, or MIOT. **

Precision

The objective is to obtain an estimate of the mean herbage yield by species with a standard error no greater than 20% of the mean at the 80% level of confidence. When sample data are available, the number of plots required for this degree of precision can be calculated.

Dry weights will be recorded to the nearest 0.01 g.

Data Recording

A sample field sheet (NREL-01) for the recording of data follows. A copy of the original form will be immediately forwarded to the Natural Resource Ecology Laboratory.

The following information will be recorded:

XXX QUADRAT NUMBER - number assigned to a particular quadrat by the investigator. (This number should be unique for the TREATMENT.)

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FIELD DATA SHEET – ABOVEGROUND BIOMASS

TA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	QUADRAT	CLIP-EST.	GROWTH FM.	GENUS	SPECIES	SUBSPECIES	CATEGORY	WEIGHT ESTIMATE	SACK NO.	DRY WEIGHT	CROWN PLOT SIZE	CROWN WEIGHT
			DAY	MO.	YR.															
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	21-23	25	27	29-30	31-32	34	35	36-40	42-45	47-52	54-57	59-64
01																				

DATA TYPE
- 01 Aboveground Biomass
- 02 Litter
- 03 Belowground Biomass
- 10 Vertebrate - Live Trapping
- 11 Vertebrate - Snap Trapping
- 12 Vertebrate - Collection
- 20 Avian Flush Census
- 21 Avian Road Count
- 22 Avian Road Count Summary
- 23 Avian Collection - Internal
- 24 Avian Collection - External
- 25 Avian Collection - Plumage
- 30 Invertebrate
- 40 Microbiology - Decomposition
- 41 Microbiology - Nitrogen
- 42 Microbiology - Biomass
- 43 Microbiology - Root Decomposition
- 44 Microbiology - Respiration

SITE
- 01 Ale
- 02 Bison
- 03 Bridger
- 04 Cottonwood
- 05 Dickinson
- 06 Hays
- 07 Hopland
- 08 Jornada
- 09 Osage
- 10 Pantex
- 11 Pawnee

TREATMENT
- 1 Ungrazed
- 2 Lightly grazed
- 3 Moderately grazed
- 4 Heavily grazed
- 5 Grazed 1969, ungrazed 1970
- 6 Grazed 1970, ungrazed 1971
- 7
- 8
- 9

CLIP-ESTIMATE
- 1 Harvested
- 2 Harvest and Est.
- 3 Estimated
- 4 Est. for Insect
- 5 Est. for Reference
- 6 Est. for Future Clip

GROWTH FORM
- 1 Perennial grass
- 2 Annual grass
- 3 Sedge, rush, etc.
- 4 Annual forb
- 5 Biennial forb
- 6 Perennial forb
- 7 Half-shrub
- 8 Shrub
- 9 Tree
- 0 Miscellaneous

CATEGORY
- 1 Live
- 2 Old dead
- 3 Recent dead

NREL-01, NATURAL RESOURCE ECOLOGY LABORATORY - COLORADO STATE UNIVERSITY - PHONE (303) 491-5571 - FORT COLLINS, COLORADO 80

X CLIP-EST - code to indicate whether the quadrat was clipped, clipped and estimated, estimated only, or estimated for other use

X GROWTH FORM - code for stage of growth or type of plant (This is part of the identification and should not be omitted.)

XX GENUS
XX SPECIES
X SUBSPECIES

for major species, as per code according to the *National List of Scientific Plant Names*, USDA Soil Conservation Service, Lincoln, Nebraska, 1971. In the event of a code not being available in that document, please supply a key to the code you use. For miscellaneous categories record MIGR, MIFO, MISH, MISU, MISE, or MIOT, as appropriate, in columns for GENUS and SPECIES. **

X CATEGORY - code for live (1), standing dead of last year (2) or current year (3), perennial live portions (4), or crowns (5) **

XXXXX ESTIMATED WEIGHT - in grams

XXXX SACK NUMBER - (or WET WEIGHT if sample for moisture content)

XXXXXX DRY WEIGHT - include decimal point

XXXX CROWN PLOT SIZE - leave blank

XXXXXX PERCENT BARE GROUND - enter percent bare ground for the quadrat being clipped or estimated, in the column labeled CROWN WEIGHT

HERBAGE DYNAMICS--LITTER

Sampling Methods--Standing Crop

The same sample sites will be utilized for collection of litter that were used for clipped plots in the aboveground biomass studies. The plot size, therefore, is to be 0.5 m^2. Litter will be collected by quadrats separately in a bag for drying and weighing. All of it should be taken; a vacuum should be used. Material will be oven-dried at 60°C and weighed. To determine the amount of sand and mineral material present after weighing, a subsample should be weighed, ashed, and the weight of residue recorded. Weights should be determined to the nearest 0.01 g, and data recorded on Form NREL-02. In addition, on the six dates when aboveground *laboratory samples* are collected, a sample of litter composited by replicate will be ground in a Wiley Mill with a 20 mesh screen and divided into two samples of 5 g each. These will be sent to the Natural Resource Ecology Laboratory. Request analysis of botanical composition for one sample and N, P, and ash analyses for the other. These samples can be separated from quadrat collections after the dried weights are obtained, and the ashed weights for the quadrats can be calculated from the subsample remaining.

Sampling Methods--Litter Accumulation

Either de-littered plots or accumulation screens will be used to evaluate rates of transfer from live or standing dead to litter. Standing material will not be removed from de-littered plots. Size of these plots will be a minimum of 15 × 15 cm. A minimum of 30 plots per treatment may give acceptable results. Accumulated material should be harvested at monthly invervals. Harvesting will be accomplished by clipping around the periphery of each plot to remove the material that has fallen. A slightly

raised frame of screen wire was used at Osage to retard decomposition of the material between collecting periods. Data will be recorded on Form NREL-02.

Data Recording

A sample field data sheet (NREL-02) for litter sampling follows. The information to be recorded is:

XXX QUADRAT - this number should correspond to the number used on the forms for ABOVEGROUND BIOMASS and INVERTEBRATES if the sampling is taken in the same plot

X TYPE OF LITTER COLLECTION - code for distinguishing between total material of quadrat (1), part of material from quadrat (2), or de-littered or cleared plot (3).

XXXX SACK NUMBER

XXXXXX DRY WEIGHT OF LITTER - to nearest 0.01 g (record decimal point)

XXXX DRY WEIGHT OF SUBSAMPLE - in column labeled SACK WEIGHT

XXXXXX ASH WEIGHT - weight of material after ashing of subsample

XXXXXX PREVIOUS DATE - for computation of time interval since last removal of litter for de-littered plots

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FIELD DATA-SHEET - LITTER

D. TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	QUADRAT	TYPE	SACK NO.	DRY WT.	SACK WT.	ASH WT.	PREVIOUS DATE			
			Day	Mo	Yr										Day	Mo	Yr	
1-2	3-4	5-8	9-10	11-12	13-14	15	16-18	19-20	21-22	23	24-26	27-32	33-38	39-44	45-46	47-48	49-50	51-80
												31-37						

DATA TYPE
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- 04 Cottonwood
- 05 Dickinson
- 06 Hays
- 07 Hopland
- 08 Jornada
- 09 Osage
- 10 Pantex
- 11 Pawnee

TREATMENT
- 1 Ungrazed
- 2 Lightly grazed
- 3 Moderately grazed
- 4 Heavily grazed
- 5 Grazed 1969, ungrazed 1970
- 6
- 7
- 8
- 9

TYPE
- 1 Quadrat, total
- 2 Quadrat, part
- 3 Cleared plot
- 4 Litter bag

HERBAGE DYNAMICS--BELOWGROUND BIOMASS

Sampling Methods

Belowground biomass will be sampled by collection of soil cores. Cores should be collected three or four times a year. At least one core should be aken in each clipped 0.5 m^2 quadrat. The core will be divided into 10 cm intervals. The total length of the core should be sufficient to account for at least 90% of the root material in the soil profile. In order to remove roots from soil core segments, each sample should be washed, and the root material that can be floated off retained as the sample. The sample should be oven-dried at 60°C, weighed to the nearest 0.01 g, ashed, and the residue weighed. Rhizomes will be included with belowground material. **

Take an equal number of separate cores for lab analysis. Composite samples of hand separated root material, by depth increment, from each replicate should be sent to the Natural Resource Ecology Laboratory. This is to be done three times per year: at the start of the growing season, at peak standing crop, and at the end of the growing season.

In addition, *very clean*, washed root samples, composited as above, should be collected twice during the growing season and sent to the Natural Resource Ecology Laboratory. One of the collections should be made early (at about 10% of plant growth) and the other at, or just after, the time of peak standing crop. These samples will be used for determination of ash content of roots.

Data Recording

A sample field data sheet (NREL-03) for recording results of belowground biomass follows. The information required is:

XXX QUADRAT - the same number as used to identify quadrat on other data forms

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FIELD DATA SHEET - BELOWGROUND BIOMASS

DATA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	QUADRAT	CORE DIAM.	HORIZON	TOP DEPTH	BOTTOM DEP.	LENGTH	WASH WT.	DRY WT.	ASH WT.	CROWN DRY WT.
			Day	Mo	Yr													
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	20-22	23-25	26	27-29	30-32	33-35	36-38	39-43	44-48	49-53

DATA TYPE

01 Aboveground Biomass
02 Litter
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10 Vertebrate - Live Trapping
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42 Microbiology - Biomass
43 Microbiology - Root Decomposition
44 Microbiology - Respiration

SITE

01 Ale
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 Hopland
08 Jornada
09 Osage
10 Pantex
11 Pawnee

TREATMENT

1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Grazed 1969, ungrazed 1970
6
7
8
9

HORIZON

1 AO
2 A
3 B
4 C

XXX	CORE DIAMETER - to nearest 0.1 cm
X	HORIZON - code for soil horizon
XXX	TOP DEPTH - depth to top of segment, in centimeters
XXX	BOTTOM DEPTH - depth to bottom of segment, in centimeters
XXX	LENGTH - length of segment, in centimeters
XXXXX	MATERIAL - crowns (1), rhizomes (2), roots (3) (in column labelled WASH WEIGHT)
XXXXXX	DRY WEIGHT - of ovendry material, in grams
XXXXXX	ASH WEIGHT - of residue after ashing, in grams
XXXXXX	CROWN DRY WEIGHT - leave blank

VERTEBRATES--CATTLE

Sampling Methods--Cattle Weights **

Weight records will be kept on each animal grazing on a grazed treatment area. Animals will be weighed when they are put on, every 28 days thereafter, and when they are removed from the pasture for the season. All weights will be taken after an overnight shrink. Preferably, weights should be taken near the first of each month so data will be as comparable as possible across sites.

At the time of peak standing crop, range condition will be estimated within the sampling exclosure in the grazed area. This estimate will be reported (in percent) with the data on cattle weights.

Sampling Methods--Cattle Forage Intake **

Cattle diets will be sampled by bite count on grazed treatment areas on dates when aboveground biomass is sampled on those areas. Three animals will be selected and observed for two hours each on each of two successive days so that six trials per sample period result. For each trial, the number of bites taken on each consumed forage species will be recorded. Animals should be selected from different age and sex classes. Use of a portable tape recorder is suggested in collecting the raw data. The observer can record the bites as they are taken, rerun the tape after the trial, and summarize the data by species. The summarized data should be recorded and sent to the Natural Resource Ecology Laboratory. During each trial, an "average" sized bite of each consumed species should be clipped, oven-dried, and weighed so that food consumption can be estimated.

Data Recording--Cattle Weights

Information on cattle weights will be recorded on form NREL-72. The forms will be sent to the Natural Resource Ecology Laboratory at the end of the season, when animals are removed from the pasture. All data for a given animal should be reported on consecutive lines if more than one line is required.

XXXX GRAZED AREA - area of grazed pasture in hectares (a ha = 2.47 acres)

X AGE - at beginning of period, see key on data form

X SEX - see key on data form

X WEIGHT UNITS - see key on data form

XXXXX ANIMAL I.D. - assigned at site, unique for each animal

The remaining entries should be obvious.

Data Recording--Cattle Forage Intake

Information on cattle forage intake will be recorded on Form NREL-73.

XXXX TIME - 24 hour clock, standard time

XXX AIR TEMPERATURE - in degrees Fahrenheit, typical of trial

XX WIND SPEED - in miles per hour, typical of trial

XXXXX ANIMAL I.D. - assigned at site, unique for each animal

X AGE - at time of trial, see key on data form

X SEX - see key on data form

XXXXX SPECIES - standard code for genus and species of consumed forage as found in *National List of Scientific Plant Names*, USDA Soil Conservation Service, Lincoln, Nebraska, 1971.

XXXX BITES - number of bites on this species this trial

XXXX DRY WEIGHT - ovendry, of typical bite, in grams

VERTEBRATES--SMALL MAMMALS

Sampling Methods--Live Trapping

Small mammal populations will be sampled by marking, releasing, and recapturing animals in grids of live traps. Where possible a grid should ** be established and run on each grazing treatment. The grids will consist of 12 × 12 stations, with two traps per station. Stations will be 15 m apart. Each grid will cover an area of 6.8 acres (2.7 ha). There will be at least five consecutive days of trap-mark-release on the grids. This will be followed by five consecutive days of trap-mark-release on assessment lines. This will provide basic data for estimation of population densities. Density of major species will be estimated four times during the year at the southern sites (Jornada and Pantex) and three times at the other sites.

Rodents will be marked by a system of toe amputation and/or with numbered metal ear tags. Fig. 1 shows the method to be used. Looking at the underside of the animal, the feet are read from left to right and top to bottom to give the four digits of the identification number, one digit per foot. The toes on each foot are read from left to right. If there are four toes on the foot, then there are four possible numbers that can be assigned to that particular foot: 1, 2, 3, or 4. If there are five toes on the foot, there are five possible numbers. Clipping of one toe from each foot gives a four-digit identification number. Animals with toes like the illustration will provide a possible 899 different combinations of four-digit numbers to be assigned to that species. This requires clipping of no more than one toe per foot. In the case of a natural amputation which occurs after marking, there will be two toes missing from the foot. In such cases (provided that the natural amputation cannot be distinguished from the artificial), that digit of the identification number is indicated as a 9.

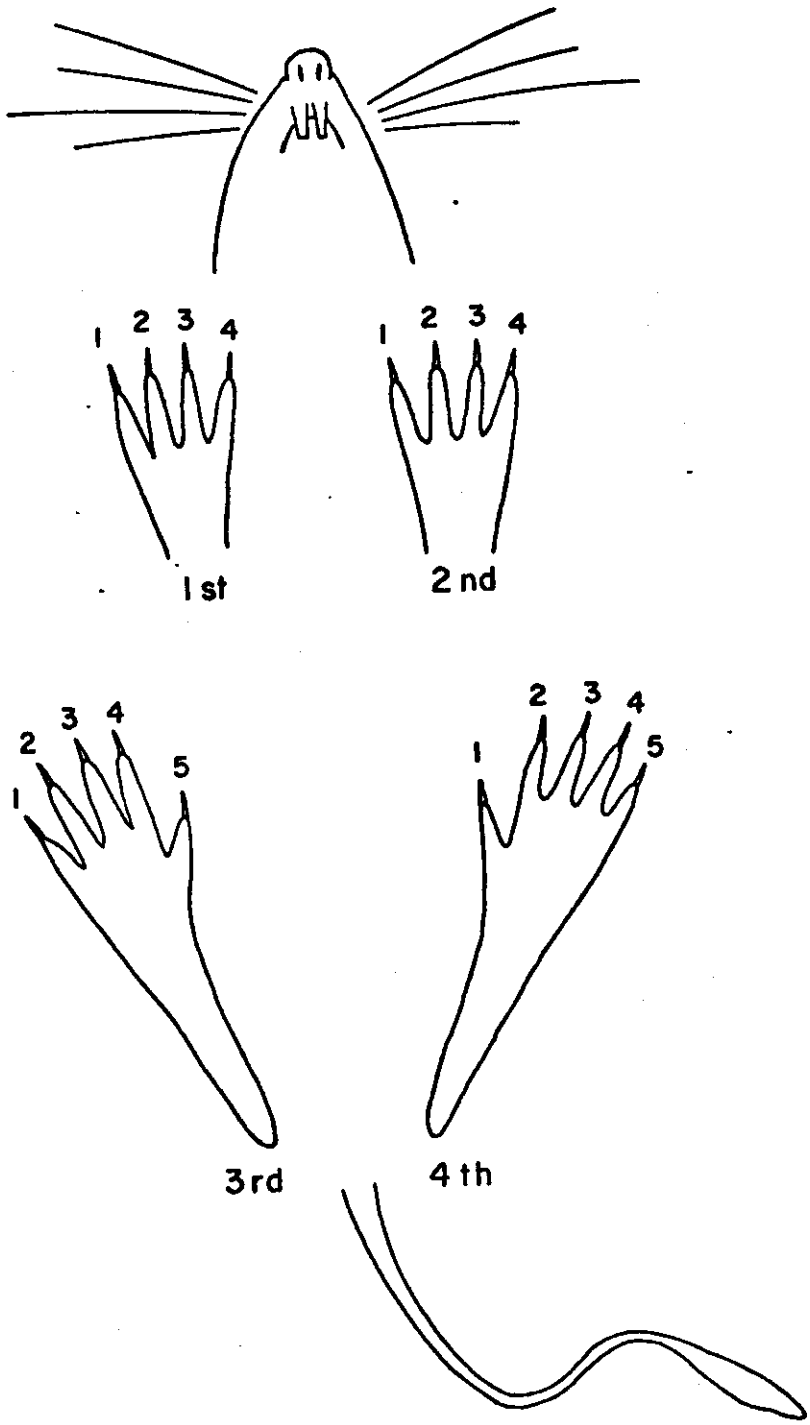


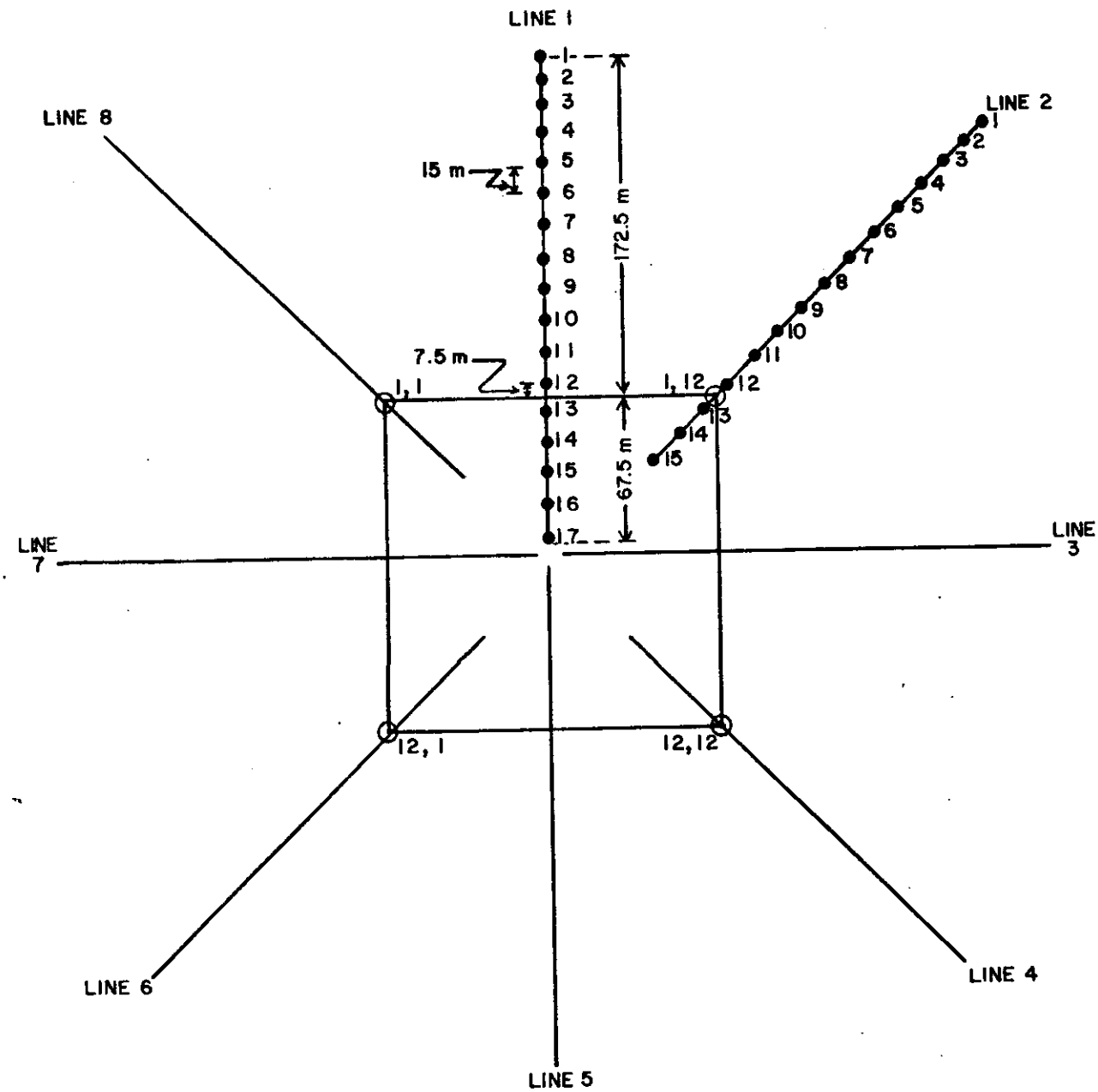
Fig. 1. Four-digit number for rodent marking.

This system often permits the original identity of the animal to be determined without confusion.

Trapping on assessment lines will permit estimation of the area sampled ** by the grid. Animals captured on the assessment lines are examined to see if they were marked on the grid. Unmarked animals will *not* be marked. All animals trapped will be released. Interstation interval on these lines will be 15 m with two traps per station. Eight assessment lines will be established per grid. Four of the lines will bisect the corner angles of the grid and will extend 37.5 m into the grid. The other four lines will be perpendicular bisectors of the grid sides and will extend 67.5 m into the grid. All eight lines should extend out 172.5 m from the grid. Diagonal lines will thus have 15 sets each, and perpendicular lines 17 sets each--for a total of 256 traps (two traps per set). The assessment line which bisects Row 1 of the grid will be Line 1, and the other lines will be numbered sequentially in a clockwise direction. Trap stations on each line will be numbered sequentially with the outermost trap on each line being Trap 1. Fig. 2 shows the design of the grid and assessment lines.

Sampling Methods--Snap Trapping

Kill trapping will be conducted to obtain information on diets. In the process, some demographic data will be derived from these specimens. Animals trapped will be removed and saved for autopsy. At autopsy the animals will be weighed and measured; the testes of the males will be measured to the nearest millimeter, both length and width. For females, the condition of the mammary glands and the reproductive tracts will be recorded. *Nipples* may be small (non-lactating, nulliparous females); enlarged but not prominent (non-lactating, parous females); or enlarged and prominent (lactating,



$\bullet_n$ Trap stations on assessment lines (shown only for lines 1 and 2).

$O_{n,n}$ Grid stations (only corner stations shown).

Fig. 2. Small mammal trap grid and assessment lines (not drawn to scale).

parous females). The *total number of embryos* will be recorded, including those that appear to be abnormal or resorbing. The number being *resorbed* will be recorded separately and will include only those embryos which are distinctly smaller and undergoing tissue lysis and disorganization. The *embryo length* will be recorded as the crown-rump length in millimeters of the embryo as it lies in its normal position. The total weight of the embryos and reproductive tract combined will be recorded to the nearest 0.01 g. Numbers of new and old *placental scars* will be recorded. New scars are distinguished by plentiful blood supply to the implantation site and/or a large amount of dark pigment deposited at the site. Old scars are distinguished by lack of blood supply and fainter pigmentation. The number of *corpora lutea* can be determined from the intact ovaries by examining the surface of the ovaries for firm, spheroidal, pinkish to yellowish structures.

Total stomach contents of all individuals of each major species will be preserved in Formalin and labeled. The label should contain the following information:

i. site,

ii. date collected,

iii. collector's number,

iv. code for genus and species,

v. sex, and

vi. age (adult or juvenile).

Sampling Methods--Pocket Gophers

Pocket gophers will be censused by a mark-release-recapture method. Live traps will be set in exposed burrows where animal activity is evident.

Sampling Methods--Lagomorphs

A minimum 10 mile sample transect will be taken from a moving vehicle at night with a strip 25 yards on one side of the path of the vehicle. This will require a driver and an observer. A different distance may be used depending on habitat and observer preference. The critical factor in setting the strip width is the habitat to be censused. One of the assumptions in this technique is that *all* individuals of the species being censused, which are within the census strip, will be seen. If the strip width is set too wide, so that some animals are hidden by vegetation or local topography, an artificially low population estimate will result. The requirement that a strip on only one side of the vehicle's path be censused is also a result of the necessity for complete coverage of the census area.

Odometer readings to the nearest tenth will be recorded at the start of the run and each time a jackrabbit is flushed at the point of flush on the route. An odometer reading will be recorded at the termination of the run.

At each mile of the route and at the starting and ending points, the observer will *visually* select a point that he believes is just on the edge of his strip. The distance in feet from the line of travel to this point will be *measured* and recorded. The purpose of this is to get an estimate of the variability of the width of the strip being observed. This information is used in calculating the variance of animal density.

Sampling Methods--Runways, Mounds, and Excavations

In order to estimate the extent to which small mammals modify their environment by developing runways, mounds, and burrows, plots will be established and the extent of such structures ascertained. The number and

size of plots needed to achieve this goal at each site is left to the investigators' discretion. Each plot, with its structures, will be mapped on graph paper. Areas of the various structures will be determined by planimeter and recorded on Form NREL-16. All plots observed will be summarized on this form, regardless of whether structures were present or not. If no structures are present, no data need be recorded beyond Column 25 of the form. Only this form, and not the maps, will be sent to the Natural Resource Ecology Laboratory.

Data Recording--Live Trapping (Grid)

A sample data sheet (Form NREL-10) for the recording of live trapping results from the grids follows. Separate sheets will be used by different observers, or on different days, or as continuation sheets if more than one is required on any one day.

XX GENUS - first two letters of the generic name

XX SPECIES - first two letters of the species name

X SUBSPECIES - single letter to be used only as a tie breaker in case previous columns fail to separate two species

X CONDITION - used to indicate whether an animal escaped or is in poor condition; leave blank if normal

X MARK - this is the condition of the mark on the animal; blank if normal

XXXX NUMBER - four-digit identification of the individual (see Fig. 1)

X MALE - code for reproductive condition of male animals

X FEMALE - code for reproductive condition of female animals

XXXXX WEIGHT - weight in grams if animal is weighed in field (to nearest 0.1 g)

X MOLT - condition of molt, blank if not evident

XX ROW - location of capture identified by number of row in grid

XX COLUMN - number of column in grid

XXXX PREVIOUS NUMBER - in case of a natural amputation, the old number of the animal

Data Recording--Assessment Lines **

These data will be recorded on Form NREL-17. Data will be recorded in the same manner as for the grid trapping except that "PLOT SIZE" is not recorded and that "ROW" and "COLUMN" have been replaced by "LINE NUMBER" and "TRAP NUMBER."

XXXX NUMBER - record only if animal is already marked when captured. Do not mark previously unmarked animals.

X LINE NUMBER - number of the assessment line on which capture was made (Fig. 2)

XX TRAP NUMBER - number of the trap station at which capture was made (Fig. 2)

Data Recording--Snap Trapping

Two field sheets (Forms NREL-12A and NREL-14) are required for recording of data from sacrificed animals taken in snap traps. Data on animals captured in the snap traps are recorded on the sheet for MAMMAL COLLECTION. Information included is:

XX GENUS - first two letters of genus name

XX SPECIES - first two letters of species name

X SUBSPECIES - tie breaker, if required

XXXXXXX SPECIMEN NUMBER - number assigned by collector (letters and/or numbers)

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FIELD DATA SHEET--VERTEBRATE - ASSESSMENT LINES

Data Type	Site	Initials	Date			Treatment	Replicate	Genus	Species	Subspecies	Condition	Mark	Number	Male	Female	Weight	Molt	Line Number	Trap Number	Previous Number
			Day	Month	Year															
1-2	3-4	5-7	8-9	10-11	12-13	14	15	21-22	23-24	25	27	29	31-34	36	38	40-44	46	49	51-52	54-57
17																				

Data Type

17 Vertebrate - assessment lines

Site

01 ALE
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 Annual
08 Jornada
09 Osage
10 Pantex
11 Pawnee
12

Treatment

1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Ungrazed current year only
A Diet light
B Diet moderate
C Diet heavy
D ESA - O
E ESA - W
F ESA - N
G ESA - WN

Male

0 Adult, non-breeding
1 Subadult, non-breeding
2 Juvenile, non-breeding
3 Adult breeding?
4 Subadult breeding?
5 Juvenile breeding?
6 Adult breeding
7 Subadult breeding
8 Juvenile breeding
9 Undetermined

Female

0 Adult, vulva inactive
1 Subadult, vulva inactive
2 Juvenile, vulva inactive
3 Adult, vulva turgid
4 Subadult, vulva turgid
5 Juvenile, vulva turgid
6 Adult, vulva cornified
7 Subadult, vulva cornified
8 Juvenile, vulva cornified
9 Pregnant

Condition

0 Normal
1 Escaped
2 Torpid
3 Dead

Molt

0 No evidence
1 Post-juvenile
2 Post-subadult
3 Adult (vernal)
4 Adult (autumnal)
5 Molt of unknown stage
6 Undetermined

Mark

0 Normal
1 Unmarked
2 Ear tag
3 Toe clip
4 Ear tag and toe clip
5 Natural amputation

NREL-17 NATURAL RESOURCE ECOLOGY LABORATORY - COLORADO STATE UNIVERSITY - PHONE (303) 491-5571 - FORT COLLINS, COLORADO 80521

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FIELD DATA SHEET - MAMMAL COLLECTION

DATA TYPE	SITE	INITIALS	DATE			TREATMENT	REPLICATE	PLOT SIZE	TRAP DAY	HOUR	GRID TRAP		GENUS	SPECIES	SUBSPECIES	SPECIMEN NUMBER	MARK	LENGTH	TAIL	FOOT	EAR	WEIGHT	MOLT	PARASITES	STOMACH WEIGHT	FOOD	EYE LENS	SPECIMEN	MAP REFERENCE		
			Day	Mo.	Yr.						Row	Col																	TWN	RNG	S
1-2	3-4	5-7	8-9	10-11	12-13	14	15	16-19	20-22	23-26	27-28	29	30-32	33-34	35	36-42	43	44-47	48-50	51-53	54-56	57-61	62	63	64	65	66	67	68	69-72	73-76	77-78

MARK
0 None
1 Snap-trap grid, unmarked
2 Snap-trap grid, marked
3 Live-trap grid, unmarked
4 Live-trap grid, marked
5 Other trapping

MOLT
0 No evidence
1 Post-juvenile
2 Post-subadult
3 Adult (vernal)
4 Adult (autumnal)
5 Molt of unknown stage
6 Undetermined

PARASITES - EYE LENS
0 Not saved
1 Preserved

SPECIMEN
0 Not saved
1 Skin
2 Skull
3 Skin and skull
4 Skeleton
5 Liquid preservative

FOOD
0 None
1 Stomach only
2 Cheek pouch only
3 Both

DATA TYPE
01 Aboveground Biomass
02 Litter
03 Belowground Biomass
10 Vertebrate - Live Trapping
11 Vertebrate - Snap Trapping
12 Mammal - Collection
13 Snap Trap Effort
14 Mammal Reproductive
20 Avian Flush Census
21 Avian Road Count
22 Avian Road Count Summary
23 Avian Collection - Internal
24 Avian Collection - External
25 Avian Collection - Plumage
30 Invertebrate
40 Microbiology-Decomposition
41 Microbiology-Nitrogen
42 Microbiology-Biomass
43 Microbiology-Root Decomposition
44 Microbiology-Respiration

SITE
01 Ale
02 Bison
03 Bridger
04 Cottonwood
05 Dickinson
06 Hays
07 Hopland
08 Jornada
09 Osage
10 Pantex
11 Pawnee

TREATMENT
1 Ungrazed
2 Lightly grazed
3 Moderately grazed
4 Heavily grazed
5 Grazed 1969, ungrazed 1970
6
7
8
9

X MARK - source of specimen and type of mark, according to code

XXXX LENGTH - total length, in millimeters

XXX TAIL - tail length, in millimeters

XXX FOOT - hind foot, in millimeters

XXX EAR - ear from notch, in millimeters

XXXXX WEIGHT - weight in grams, to nearest 0.1 g (before stomach is removed)

X MOLT - pelage condition, according to code

X PARASITES - 1, if collected

XXX STOMACH WEIGHT - wet weight in grams, to nearest 0.1 g

X FOOD - indicate collection, according to code

X EYE LENS - 1, if collected

X SPECIMEN - type of specimen preserved, according to code

XXXXXXXX MAP REFERENCE - Township, Range, and Section

Additional data on internal anatomy of specimens collected is recorded on the field sheet (Form NREL-14) entitled MAMMAL REPRODUCTIVE. This sheet is a continuation of the last, and therefore 42 columns are identical to the previous information on the specimen. Additional data required, beginning in Column 44, is:

X EXTERNAL - reproductive condition--male

XXXXX TESTES - length and width, in millimeters

X EPIDIDYMUS - condition, according to code

X SEMINAL VESICLES - condition, according to code

X EXTERNAL - reproductive condition--female

X MAMMARY - condition, according to code

X PUBIC SYMPHASIS - condition, according to code