

**WGFD Wildlife Division
Vegetation/Habitat Monitoring Protocol**

FINAL - 8/1/04

Requested by Jay Lawson and John Emmerich to be monitored annually by wildlife biologists and game wardens starting in fall of 2004. Developed by Steve Kilpatrick, Jerry Altermalt, Rick Straw, Keith Schoup, Galy Butler and Bill Gerhart with input and feedback from wildlife management coordinators and others.

Purpose: Provide baseline habitat trend data that increases the awareness of habitat condition/trend among wildlife biologists and game wardens as they manage wildlife populations.

Primary Uses and Sideboards:

- Use vegetation and habitat trend data to assist with justification of season recommendations and population objectives. Results will be summarized by habitat biologists and reported annually in JCRs by wildlife biologists.
- Increase awareness of wildlife biologists, game wardens, others, and the public of annual vegetation condition and long-term trends.
- Keep the process relatively simple for annual monitoring and assessment and include a minimum of one transect for each warden district and two transects for each population biologist district. Each transect will be visited at a minimum twice each year with data collected in the fall and in the spring. Historical transect locations and coordination with other land management agencies should be considered too.
- Vegetation monitoring priority is in sagebrush and sagebrush steppe communities, however, other shrub communities and other vegetation type communities will be monitored as identified by Regional personnel.
- **Transect Locations, Numbers, Types and Other Considerations:**
 1. Regional personnel will determine monitoring transect numbers, locations, and vegetation types within various herd units or other sampling stratification they deem appropriate.
 2. Wildlife Administration requested sagebrush monitoring sites within each Region, and to have at least one transect each game warden was responsible for and two transects each wildlife biologist was responsible for and that each transect would be visited by the game warden or wildlife biologist once in the spring and once in the fall, data collected thereon, summarized by the habitat biologist for inclusion in JCRs by the wildlife biologist and used as one of the tools for season and population recommendations.
 3. Habitat personnel will assist with initial transect establishment, data collection and summarization and provide training the first year. Thereafter, data collection will be the responsibility of the game warden and/or wildlife biologists, and will be summarized by the habitat biologist, included in JCRs by the wildlife biologist and used as one of the tools for hunting season and population objective recommendations.
- Long term monitoring may be established at sites deemed appropriate by Regional personnel.

Much of the basic protocol and procedure as well as more detailed explanations, purposes and uses for collecting the information is outlined in the Appendix XIII of the Handbook of Biological Techniques, WGFD 1982, pages 360-420 and Handbook of Investigative Techniques, WGFD 1981 which are, in part, attached as a PDF to the end of this document.

Transect monitoring protocol and minimum information collection follows:

- Transect location determination should be a cooperative effort of Regional personnel. Transects shall be established in "key" or "indicator" areas that appear to reflect what is occurring within the larger area and where you believe the vegetation community may show reactions or changes to population management. Small, isolated areas of severe use should not be selected for monitoring. Conversely, areas that receive unrepresentative light use should also be avoided. Transect location should be placed in relatively large vegetative complexes representative of the community or type you are sampling such that you can cover at a minimum one-eighth mile and preferably one-quarter mile or more in length.
- Transect location marking will be done with a witness post (steel or metal "T" post) at the established starting point. Photo points as noted in the Techniques Manual are pipe or rebar located approximately 25' from the witness post (compass direction noted from witness) in the general line of travel of the transect. This post serves as the photo point for close-up oblique and aspect view photo of basic transects and of the cage.
- One permanent comparison 4' x 4' hog panel or horse panel cage is located adjacent to but offset left of the transect general line of travel. It shall be located approximately 5' from the photo point stake along the left hand side of general line of travel and no closer than about 10' from the 3' x 3' close-up plot.
- Monitoring sites will be permanent with steel witness posts, photo stakes, etc. Permission should be obtained from the landowner/manager prior to putting out stakes, cages, etc. These may be run adjacent to or in conjunction with current or past monitoring efforts. Data collected, photos, procedures and where the information is stored or housed should be documented for each transect within the appropriate JCR files and maintained by wildlife biologist and habitat biologist.
- **Minimum data collection requirements for the monitoring stations established regardless of vegetation community type or specific plant species include:**
 1. Annual production collected in late summer/fall after plant growth and prior to leaf drop or loss.
 2. Annual utilization (additional temporary cage sampling may be required if period of use and/or different ungulate species are using the area and there is a desire or need to separate the use periods) collected in late winter or early spring prior to plant growth and after most animals have left the area.
 3. Pellet group density collected during the spring (additional description in following sections).
 4. Repeat photos (3 photos) collected in the spring and fall.
 5. Nearby weather station summaries (use JCR weather information summaries) or on-site data if collected.

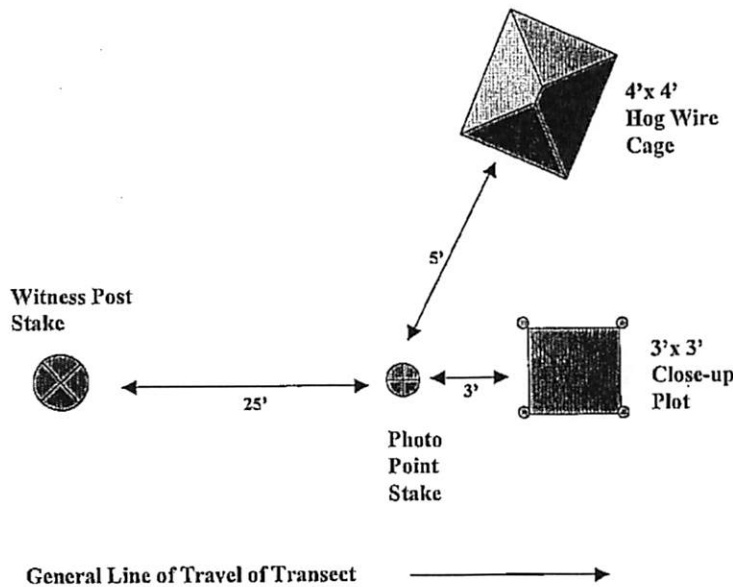
6. Permanent 4'x4' hog wire cage to show large ungulate non-use as compared to use areas.
 7. Shrub/tree age class categories for monitoring stations in shrub/tree vegetation types collected in the fall.
 8. Shrub/tree hedging class categories for monitoring stations in shrub/tree vegetation types collected in the fall.
- **Basic Techniques:** (Please refer to Appendix XIII of the Handbook of Biological Techniques, WGFD 1982, pages 360-420 and Handbook of Investigative Techniques, WGFD 1981 as many of the techniques are the same or very similar). **Note:** Basic techniques apply to both shrub and herbaceous transects unless differentiated below and underlined.
 1. Transect location is delineated with a witness stake, either a steel post or pipe, a unique name or identification assigned and UTM recorded in datum NAD27 with a GPS unit.
 2. Rebar or pipe set for taking photo points (generally in digital format) including close-up oblique with corner stakes or rebar marking and the 3'x3' wood or PVC photo-marking frame, aspect view and a protected cage view as per Laramie Region and similar to Biological Techniques pages 361-362 and shown below.
 3. Transect ID photo form and transect data sheets as per Laramie Region included herein which shows transect name and date.
 4. Herbaceous transects production clipped, bagged, air-dried and weighed from a minimum of 10 plots in fall after forage growth is complete or spring prior to green-up to determine total production, Additional temporary cage sampling may be required if period of use and/or different ungulate species are using the area and there is a desire or need to separate the summer from total use periods. This would require the use of temporary welded wire fabric cages to provide caged and protected forage areas that can be clipped and weighed for comparison to at least 10 unprotected areas to determine what is removed after the summer use period. The temporary cages would then be moved in the fall at the time of clipping and the unprotected sites clipped again in the spring for total utilizations assessment similar to Biological Techniques pages 400 – 402 and cages and utilization record on pages 365 and 366 and Cody Region procedures included herein.
 5. Shrub or tree transect - measure current annual production on a minimum of 5 leaders with a plastic ruler from at least 50 plants at paced intervals (fall) as per the Laramie Region for extensive browse utilization.
 6. Shrub or tree transect - measure annual utilization depending on species as either # of leaders browsed or bitten from a minimum of 10 leaders from 50 plants at paced intervals, as an option, if desired or deemed appropriate you may also measure the leader lengths from a minimum of 5 leaders with a plastic ruler from 50 plants at paced intervals (note or summer/fall/winter or other time frames for different seasons of use or ungulate users may be required too) as described in the Laramie Region procedures for extensive browse utilization.

7. Read at least 10 circular 1/100 acre plots (stake with 11.78ft. rope string as radius) to collect pellet group density at the 5, 10, 15, 20, 25, 30, 35, 40 and 45 paced intervals similar to the method as described in Biological Techniques pages 415-418 during the spring collection period as described in more detail below.
 8. Shrub or tree transect - record hedging and age class on a minimum of 50 plants along the paced interval as described in the Laramie Region procedures.
- **Basic Equipment List:**
 1. Standardized data sheets
 2. Digital camera or other camera
 3. GPS unit
 4. Clippers
 5. Paper bags for samples
 6. Watch with second hand
 7. Plastic ruler and tape
 8. Stake with 11.78ft. rope for radius of pellet group density plots
 9. Hog wire cage, steel t-posts, and rebar
 10. Transect Photo ID 8 ½" x 11" minimum to ID site location with transect name and date
 11. 3'x3' plot frame material alternately painted red/white in 6" intervals
 12. Welded fabric wire cages and stakes for herbaceous production and utilization where there is seasonal and dual or more ungulate use assessment required

Other techniques and procedures are included as additional review material and are viewed as informational, however, the shrub/tree technique described and used for the most part in the Laramie Region and the herbaceous technique described for the Cody represent the minimum annual data collection needs. Additional information may be collected as long as the minimum is collected each year. The additional information is provided in Appendix A.

Photo Point Schematic for Transect Monitoring Sites

- 1) Photo point stake (pipe or rebar) is established 25' from witness post in the general line of travel of the transect.
- 2) Camera is held at normal standing position at eye level for all 3 photos.
- 3) Close-up oblique photo is taken from the photo point in the general line of travel of the transect of the 3' x 3' plot marked on the corners with short rebar stakes located 3' from the photo point with the transect ID in the plot corner.
- 4) Aspect view photo is taken from the photo point in the general line of travel of the transect with 10% of the skyline or horizon in the back ground and with the transect ID in center fore ground.
- 5) Cage close-up photo is taken from the photo point centered on the cage bottom with the transect ID at the lower front corner of the cage. The cage is off-set left of the general line of travel of the transect about 10' from the 3' x 3' plot at 5' from the photo point stake.
- 6) All 3 photos should be taken during the fall and spring sampling periods.



Circular 1/100 Acre Pellet Group Plots

Each plot is measured by using a rod or stake with an 11.78' chain or rope attached. The 11.78' radius samples an area equal to 1/100 of an acre. All pellet groups, cow patties, horse piles, sage grouse droppings, turkey droppings or other species desired should be recorded. All groups that appear to be current years will be recorded if $\frac{1}{2}$ or more of the groups is within the plot. Scattered pellet droppings will be counted as one group if more than $\frac{1}{2}$ of the normal dropping is determined to be within the plot. At a minimum plots will be read in the spring. Plots may be read during the fall or other times if additional or seasonal data is desired. Pellet groups can be dot-tallied by species and

reported by species and as groups/acre. Pellet groups do not need to be cleared nor reported as average animal days use. We are using this as an index of annual fecal deposition by species only.

| Pellet Group Count (Dot Tally) | | | | | | | | | | | | |
|--------------------------------|---|---|------|---|---|---|-----------|---|---|----|-----|------------|
| Transect ID | | | Date | | | | Observers | | | | | |
| Dot#/Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Sum | Group/Acre |
| Deer | | | | | | | | | | | | |
| Elk | | | | | | | | | | | | |
| Pronghorn | | | | | | | | | | | | |
| Cattle | | | | | | | | | | | | |
| | | | | | | | | | | | | |

Observations/Notes:

Minimum Standard Protocol for Monitoring Shrubs/Trees

Protocol for monitoring shrubs (currently used by the Laramie Region).

Reference Appendix B for data forms you will need for some measurements and transect photo examples.

Shrub Leader Production

Leader production measurements are used to gauge the production capabilities of a particular shrub stand and to monitor annual and long-term fluctuations in winter range browse forage production. The resulting data can be used to evaluate the effects of weather and climate and predict big game winter survival and fawn production. Measurements are taken in September or October after significant seasonal growth has ceased.

Multiple shrub species can be measured on each transect. However, if only one species is measured the productivity of the single species cannot then be used as production indices for the other species in the stand as they have different growth habits, forms, root systems, etc. In stands containing two or more forage shrubs, professional judgment is used to select the most important browse species, or you may select all of the species and sample separately.

The transect should be established in a "key area" or an "indicator area" to reflect what is happening on a larger area. Small, isolated areas of severe utilization should not be selected for monitoring. Conversely, areas that receive unrepresentative light use should be avoided. The key question to ask is: "Will the vegetation community show reaction to changes in population management?"

Cage exclosure setup: One permanent 4' x 4' hog wire cage fastened together with hog rings or strong wire should be placed over a representative key shrub or shrubs immediately adjacent to the starting point of the transect in the fall. The cage will be permanently set and wired to rebar or steel T-posts. If left in place over a long period of time, this small exclosure can provide a visual reference for long-term shrub growth potential for the site protected from browsing use. (Refer to previous discussion, too.)

Photopoints: Photopoints should be established at the cage and taken each fall and again each spring. A digital camera is preferred, but any camera available can be substituted. A close-up photo of the cage and shrub should be taken in the same direction as the transect line. This should include an 8 1/2" x 11" (minimum) transect name identification and the date the photo is taken (see Appendix B Figure 7). In addition, an aspect view photo should be taken down the transect line to include a landscape view of the shrub community and the overall condition of the habitat type (Appendix B, Figure 9). The aspect view should also include the transect name and date in the photo. These repeat photos (close-up and aspect views) should be taken annually in the fall and spring. (Refer to previous discussion, too.)

The technique for selecting the area of the plant to examine production is essentially the same as that used when measuring utilization as discussed below:

1. After the plant to be evaluated has been identified and recorded on the data form, note the position of the second hand on your watch.
2. Using your route of travel as the 12 o'clock and 6 o'clock go to the area of the plant that is indicated by the second hand on your watch. If the second hand of your watch is on the upper right side of the face (i.e. on or near 3) you will select an available branch from that location on the plant. Use the equivalent second reading if using a digital watch (i.e. 20 seconds represents the 4 o'clock position). Only examine leaders from an area of the plant that is available to browsing, generally the top or upper portion of the sides.
3. At least 5 leaders (you can measure 10 leaders) should be examined from a minimum of 50 plants. Measurements are taken in millimeters or centimeters and expressed as average leader length for the stand. If any are browsed at the time you are conducting production please record the number browsed and discuss in the comments or notes section.

Again, we recommend minimum of 50 plants be measured across the community. More plants can be examined if desirable. If five or ten leaders are not available on the first branch selected, an adjacent branch can also be used. In most cases, only leaders that appear to be available to be browsed are selected, however, in communities where leader production has been poor, any leaders that can be found may have to be used in order to get a total of five or ten. In stands where production has declined to that level, the situation should be described in the comment section of the reporting form. These situations are particularly common in stands of true mountain mahogany. **Note:** This is optional and does not substitute for minimum protocol.

Although individual plant selection using a standard pace interval is the standard protocol recommended since it is the least labor intensive, another option is to tag 50 individual shrubs with numbered aluminum tags at paced intervals. This allows you to visit the same plant each year and to track the health and fate of the individual plant. When a plant dies the tag is placed on an adjacent plant and the same number is used with alphabet letters added, for example plant 14 dies, an adjacent plant is then tagged with 14A, if it dies than 14B, and so on. This has been used on sagebrush in a number of areas. Another option used by some Regions and researchers is to twist a small piece of wire on the individual branch of the tagged plant and measure production and utilization on the stems above the twisted piece of wire. **Note:** This is optional and does not substitute for minimum protocol.

Recommended data recording form for shrub production:

SHRUB LEADER PRODUCTION

Transect Name _____

Date _____ **Observer(s)** _____

Shrub Species _____

Note this would be done for a minimum of 50 plants. Also record number of leaders measured/plant.

| <u>Plant #</u> | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|--|---|---|---|---|---|---|---|---|---|----|
| LL EE AN DG ET RH | | | | | | | | | | |
| | | | | | | | | | | |
| | | | | | | | | | | |
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| | | | | | | | | | | |
| | | | | | | | | | | |
| <u>TOTAL</u> | | | | | | | | | | |

Comments:

Recommended summary form for annual leader production:

| ANNUAL LEADER PRODUCTION | | | | |
|---------------------------------|----------------------|------------------------------|-----------------------------------|----------------|
| <u>SPECIES</u> | Sampling Date | # OF LEADERS MEASURED | AVERAGE LEADER LENGTH (cm) | Comment |
| | | | | |
| | | | | |
| | | | | |

Shrub Utilization (Mainly adapted from the extensive browse technique).

Leader utilization measurements are used to gauge the use occurring within particular shrub stands and to monitor annual and long-term fluctuations in winter range browse forage utilization. The resulting data can be used to evaluate the effects of weather and climate, predict future big game survival and fawn recruitment and to evaluate the influence of use on the shrub species or shrub community and the long-term viability of the community or need for treatment or more intensive management. Measurements are taken in late winter/early spring (March-May) after most significant use has occurred and animals have left and prior to the initiation of plant growth.

Transect location and plant selection will be determined using the standard techniques discussed above. We recommend sampling no fewer than 50 plants. Utilization surveys should be conducted in spring after big game herds have left the winter range and before the plants begin active growth. The plant species name and percent utilization will be recorded on the browse utilization form shown at the bottom of this section. Percent utilization will be determined as follows:

1. After the plant to be evaluated has been identified and recorded on the data form, note the position of the second hand on your watch or digital watch equivalent.
2. Using your route of travel as the 12 o'clock and 6 o'clock go to the area of the plant that is indicated by the second hand on your watch. If the second hand of your watch is on the upper right side of the face (i.e. on or near 3) you will select an available branch from that location on the plant (in this case upper right). Only examine leaders from an area of the plant that is available to browsing, generally the top or upper portion of the sides.
3. Randomly examine ten leaders of annual growth and determine the number of these leaders which show evidence of use. Convert this number to a percent (i.e. 2 leaders used of 10 leaders examined = 20%). Record the value by dot tally recorded in the appropriate column. Results will be summarized as average percent of leaders utilized by species. Additional notations should be made in each column to indicate when utilization has gone into the wood produced in the previous year.
4. Optional. An additional measure may be collected for various shrub/tree species as follows: at least 5 leaders (you can measure 10 leaders) should be examined from a minimum of 50 plants. Leader lengths are measured in millimeters or centimeters and expressed as average leader length remaining in the spring for the stand. This is occasionally being done on mountain mahogany, bitterbrush, willow and aspen. **Note:** This is optional and does not substitute for minimum protocol.

Recommended field data recording form for shrub utilization. Data can be expressed simply as a (%) utilization by species and does not need to be presented in tabular form:

| | | | | | | | | | | | |
|----------------------------|----------|-----------|-----------|-------------------|-----------|-------------|-----------|-----------|-----------|-----------|------------|
| Transect Name: | | | | | | UTM: | | | | | |
| Date: | | | | Observers: | | | | | | | |
| Percent Utilization | | | | | | | | | | | |
| Species | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| | | | | | | | | | | | |
| | | | | | | | | | | | |

Hedging Class (Adapted from the extensive browse utilization technique.) Hedging classification is an ocular estimation of current and historic plant utilization. The major shrub species in the stand are examined and placed in one of three classes. Plants in Class One – (Little or No Hedging) refer to plants that have received light use in the last 3 to 4 years. Plants placed in Class Two – (Moderate Hedging) have experienced use in the past 3 to 4 years that has caused much development of lateral branching and a more complex growth form. Those plants placed in Class Three – (Severely Hedged) have been subjected to heavy use in the past 3 to 4 years which has caused a clubbed or broomed appearance. The assumption is that the entire plant is available to be browsed. If this is not the case, then another plant should be examined. Results are recorded as a percent of the total number of plants examined (We recommend 100 plants and a minimum of 50) found in each form class. Hedging surveys can be conducted anytime during the year, however, the condition of deciduous plants is most evident following leaf drop.

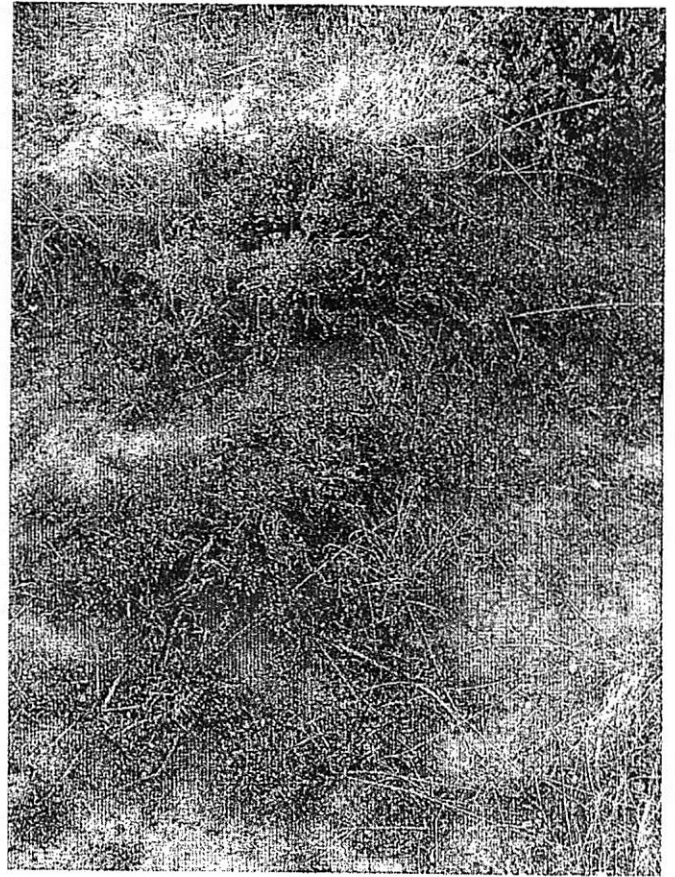


Figure 1. Severely hedged antelope bitterbrush.

Recommended summary and field data recording forms for shrub hedging:

HEDGING CLASSIFICATION
SAMPLING DATE:

| HEDGING CLASS | DESCRIPTION |
|---------------|--|
| 1 | Little or no hedging – Indicates light use in the past 3 to 4 years. |
| 2 | Moderate hedging – Use in past 3 to 4 years caused much development of lateral branching and more complex growth form. |
| 3 | Severely hedged – Heavy use in the past 3 to 4 years caused a very much clubbed or broomed appearance. |
| SHRUB SPECIES | HEDGING CLASS |
| | |
| | |

| | | | |
|-------------------|--------------------|-----------------------|---------------------|
| Location: | | Date: | |
| Observers: | | | |
| SPECIES | Form Class | | |
| | 1 Light | 2 Moderate | 3 Severe |
| | | | |
| | | | |
| | | | |

Hedging Class 1: Light or no hedging; 2-year-old wood is relatively long and unaltered or only slightly altered from the normal growth form. Less than 40 percent of the growing season leaders occur as extensions from lateral buds off of 2-year-old wood. Most of the 2 year old stems have current growing season leaders that extend directly from terminal bud apexes.

Hedging Class 2: Moderate hedging; 2-year-old wood is not strongly altered from the normal growth form. Between 40 percent and 70 percent of the current growing season leaders occur as extensions from lateral buds off 2-year-old wood. The remaining 30 percent to 60 percent of the 2-year-old stems have current growing season leaders that extend directly from terminal bud apices.

Hedging Class 3: Heavy hedging; 2-year-old wood is relatively short and strongly altered from the normal growth form. Recurrent use has resulted in the development of much lateral branching or a very "clubbed" or "broomed" appearance. More than 70 percent of the current growing season leaders occur as clumped lateral and/or adventitious sprouts. Less than 29 percent of the 2-year-old stems have current growing season leaders that

Fig. 2. Criteria used for hedging class determination.

Examples of hedging classes follow:

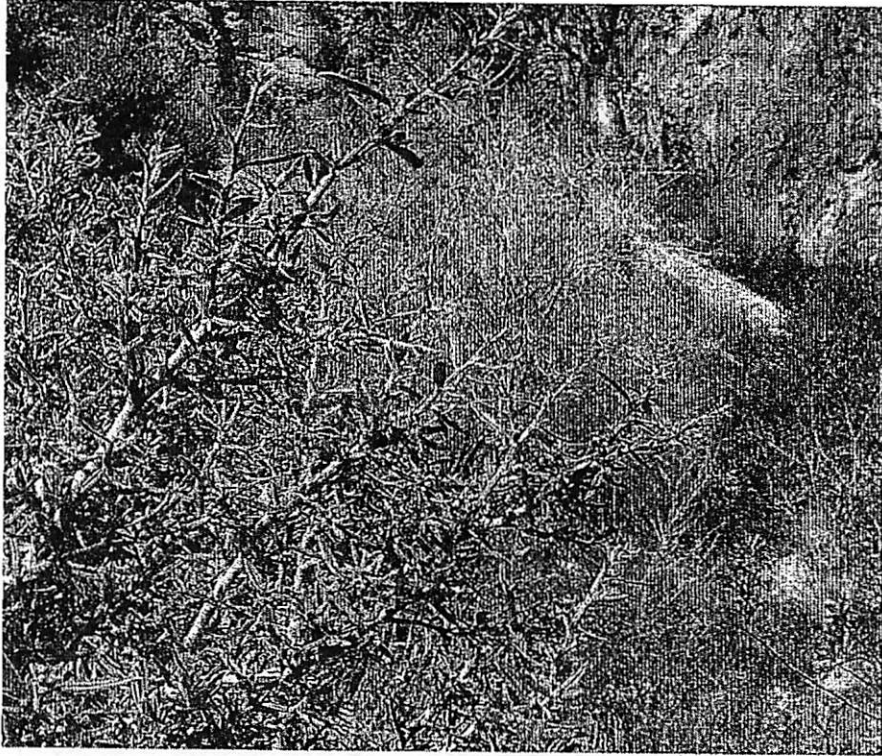


Fig. 3. Hedging Class 1.



Fig. 4. Hedging class 2.



Fig. 5. Hedging Class 3.

Stand Age Classification

Shrub stand age data is collected as it may be reflective of the health of the overall shrub community, individual shrub species health, interval between perturbations, natural range of variability, potential vigor, recruitment and replacement of shrubs and palatability to browsing animals. The following age classification techniques can be used with true mountain mahogany, bitterbrush, skunkbush sumac, sagebrush and other species as appropriate.

Data will be collected on the transects and for those shrub/tree species previously established and discussed above and re-discussed below. In general as previously noted: select a segment of the community that is a minimum of one-eighth to one-quarter mile long and set a metal "T" post at the established starting point, photo point stakes and 4'x4' cage. Plants are sampled at approximately three pace intervals, beginning at the starting point and progressing towards a distant land or vegetation feature. A compass should be used to determine the general line of travel and this information entered into the records for each transect. At the end of each three pace interval the observer should locate the browse plant nearest and within a 180° arc to the front of his lead toe. We recommend sampling no fewer than 50 plants. The number of species to be examined is up to the observers. Each procedure will be conducted at each transect every year.

Shrub Age Classification (Primarily from the extensive browse utilization technique):
 Shrub age classifications give a measure of the condition of the stand by providing a determination of the percent of the stand that is young, mature old, dying or dead. Age classifications also provide insight into whether or not the stand is replacing itself through recruitment. Use the standard technique to locate plants to be evaluated as previously discussed. The species name should be recorded and a dot count tally made in the appropriate column of the field data form. Plant age (or condition) determinations should be made using the following criteria:

- Young** – Basal stem diameter not over one quarter inch, simple branching on elongate growth.
- Mature** – Heavy growth, often gnarled stems, complex branching, crown made up of more than half living wood.
- Decadent** - Same as mature made up of more than one half dead wood.
 Note: Some researchers and managers define decadent when 25% or more of the plant is dead wood. You need to specify which % you will use.
- Dead** - The plant is dead with no signs it will regrow.

Age classifications should be conducted before leaf drop to ensure the greatest degree of accuracy in identifying dead and decadent deciduous shrubs.

A recommended data recording form for shrub age classification is shown below. The same form can be used for summarization by changing the headings to read % mature, young, decadent and dead and enter results after making calculations. Results are expressed as a percent of the total number of plants examined.

| Species | <u>Mature</u> Plants | <u>Young</u> Plants | <u>Decadent</u> Plants | <u>Dead</u> Plants |
|---------------------------|---------------------------------|--------------------------------|-----------------------------------|-------------------------------|
| | | | | |
| *Not Sampled by Age Class | | | | |

*Plant species whose age cannot be accurately determined (i.e. fringed sagewort).
 Specify which decadent % you use.

More detailed examples of permanent monitoring stations and data collection information and summarization for the Laramie Region is included in Appendix B.

Minimum Standard Protocol for Monitoring Herbaceous Vegetation

Recommended protocol for monitoring production/utilization of herbaceous vegetation (currently used by the Cody Region)

Purpose

This method is used to determine both production and utilization of herbaceous vegetation. All herbaceous species can be recorded or, if desired, only "key species". Please refer to Biological Techniques Manual.

Equipment

- Data sheets (see Techniques Manual pages 366 and 401 for general format)
- 4'X4' hog panel or horse panel steel cage
- Plot frames – see below for recommended sizes and material
- Clipping shears
- Paper sacks
- Spring scale (grams)
- GPS unit
- Digital camera or other camera
- Transect photo ID 8 ½" x 11" minimum to ID site location with transect name and date
- May or may not need welded wire cages as described in the Techniques Manual page 365

Establishment

The transect should be established in a "key area" or an "indicator area" to reflect what is happening on a larger area. Small, isolated areas of severe utilization should not be selected for monitoring. Conversely, areas that receive unrepresentative light use should be avoided. The key question to ask is: "Will this herbaceous community show reaction to changes in population management?" One permanent 4'X4' hog wire cage should be placed at each transect location and UTM's recorded with a GPS. If needed to differentiate growing season use from annual use, temporary welded fabric wire cages should be placed in the area within vegetation that is representative of the general area. If vegetation is not uniformly used and/or if both fall production and spring utilization estimates are desired, more than five cages may be desired or warranted. If cages are used, at least 2 plots should be clipped from within each cage and appropriate number outside each cage for a minimum of 10 plots depending on data needs.

Plot Frames

Plot frames can be either rectangular or circular. Rectangular frames can be easily made from ½" PVC. Old band saw blades with teeth ground off, cut to size and brazed together make excellent "hoop" frames. Frames may be sized so the mathematical

conversion from grams per plot to pounds per acre is simple. The following hoop sizes convert easily:

| Area of plot frame (ft ²) | Radius (inches) | Circumference (inches) | To convert grams/plot to pounds/acre multiply by |
|---------------------------------------|-----------------|------------------------|--|
| 0.96 | 6.64 | 41.67 | 100 |
| 1.92 | 9.38 | 58.93 | 50 |
| 2.40 | 10.49 | 65.88 | 40 |
| 4.80 | 14.84 | 93.17 | 20 |
| 9.60 | 20.98 | 131.77 | 10 |

Larger hoop sizes should be used in lower precipitation bunch grass communities or where vegetation is not uniform.

Production/Utilization

Sampling Procedure:

Monitoring for production should be done annually, ideally after full production and before environmental processes such as wind and snow removes or destroys standing plant material. Monitoring of utilization should occur after the use period. If utilization by wildlife on winter ranges is monitored, samples inside and outside cages should be clipped after wildlife leave the winter range. If only an estimation of utilization of previous years growth is desired, plots should be clipped before significant green-up occurs. After green-up, an effort to separate current and previous year's growth should be made. A minimum of 10 plots should be clipped during each sampling period. Sample as follows:

1. Take a close-up and an aspect photo with the cage in one half of the photo and part of the horizon or a prominent landmark in the background for reference. A photo board with date and location information should be stood up against a corner of the cage.
2. Remove wire cage to gain access to clip protected plots if temporary welded fabric wire cages are used or needed.
3. Place a plot frame inside the caged area and clip all herbaceous within the frame. If production and/or utilization of only key species are desired, clip only those species. Plants should be clipped between ¼ and ½ inches above the ground level surface to simulate what a 'normal' grazing animal could bite. Plot frame size will vary according to the density and uniformity of the vegetative community. If clipping is done in the summer/fall for production and utilization will be monitored the following spring, leave enough room in the cage for another plot to be clipped in the spring. If a larger plot size is required, however, more cages may be necessary. Place all clippings in a paper bag and label accordingly.
4. When utilization is monitored, randomly place the same plot frame outside the cage, clip and place clippings in a separate bag and label as unprotected plots. Place the plot frame at least 20 feet from the cage to avoid heavier use around the cage. If the vegetation is not uniform and utilization is uneven, clip additional

plots as determined to be needed by Region personnel. Make sure the number of plots clipped and plot frame size is clearly marked on bags.

5. Content of bags should be air dried before weighing with a gram scale and calculating production and utilization.

Calculations

Production is calculated by multiplying the weight of the protected plots by the appropriate conversion factor above.

Calculate the percent utilization as follows:

$$\% \text{ utilization} \quad \frac{\text{Total protected weight} - \text{Total unprotected weight}}{\text{Total protected weight}} \times 100$$

If an unequal number of protected and unprotected plots

$$\% \text{ utilization} \quad \frac{\text{Average weight for protected plots} - \text{Average weight for unprotected plots}}{\text{Average weight for protected plots}} \times 100$$

Appendix A

Aspen Treatment Stand/Clone Evaluations

Recommended protocol for monitoring aspen (currently used by the Jackson Region)

Sampling Methodology for Aspen

The following methodology has been used by habitat managers in NW Wyoming to assess stem densities within treated and untreated stands/clones. The following methodology was part of a paper presented at the Conference on Fire, Fuel Treatments and Restoration: Proper Place, Appropriate Time, April 16-18, 2002, Ft. Collins, CO. The paper was subsequently peer reviewed and published in the conference proceedings. The following sampling protocol has proven to be an efficient methodology in acquiring statistically reliable aspen stem densities. Managers felt sampling efficiency was acceptable for acquiring sample sizes necessary for predicting aspen stem densities with 80% confidence. In addition to density, height and annual leader growth are also collected. Once on site, a clone/stand can be sampled in 1 – 2 hours with two individuals.

Sampling steps

- Randomly establish a permanent photo point near the center of the clone/stand (five-foot steel post optional). Record GPS coordinates (including Datum).
- Take photos in one to all four cardinal directions.
- Select a random azimuth from the permanent photo point.
- Select a random pace distance.
- Select circular plot size. (Recommend 1/50 to 1/100 ac. for pre-treatment mature tree densities estimated at 150 – 250 trees/acre. Recommend 1/100 – 1/500 acre plots size for post-treatment densities of 4,000 – 15,000 stems/acre, respectively. Also, increase the plot size with increased stand/clone heterogeneity.
- Proceed along random azimuth sampling plots at the selected random pace interval. Record: a) number of stems per plot by height or dbh class (eg. <1, 1-2, 2-3.....>10 & <2"dbh). If stems are connected above the ground level, it is counted as one stem. If stems are connected below the ground it is counted as multiple stems.)
b) annual leader growth on 2 stems/plot).
- Stop proceeding along random azimuth when a different community type or ecotone is encountered.
- Select a new random azimuth that intercepts the stand/clone and proceed sampling with the same random pace interval and plot size as above.

- Continue the above procedure until the required sample size and statistical reliability is achieved using the following formula (eg. 80% reliability) .

$$N = (t)^2 * (s)^2 / (P * x)^2$$

N = required sample size

t = t table value for desired distribution (eg. 80% , 90% C.I.)

s = standard deviation

P = percent error (eg. 20% = 0.20)

x = mean # stems/plot

An example of our sampling methodology is illustrated in Figure 1. Bartos and Winward, (2000), recommend the following post-treatment conditions for successful aspen clone reestablishment; > 1,000 stems/acre, > 10 feet in height within 10 years post-treatment. They also suggest mean sucker height should increase by one foot/year post-treatment. The above recommendations are often transformed into objectives for aspen treatments.

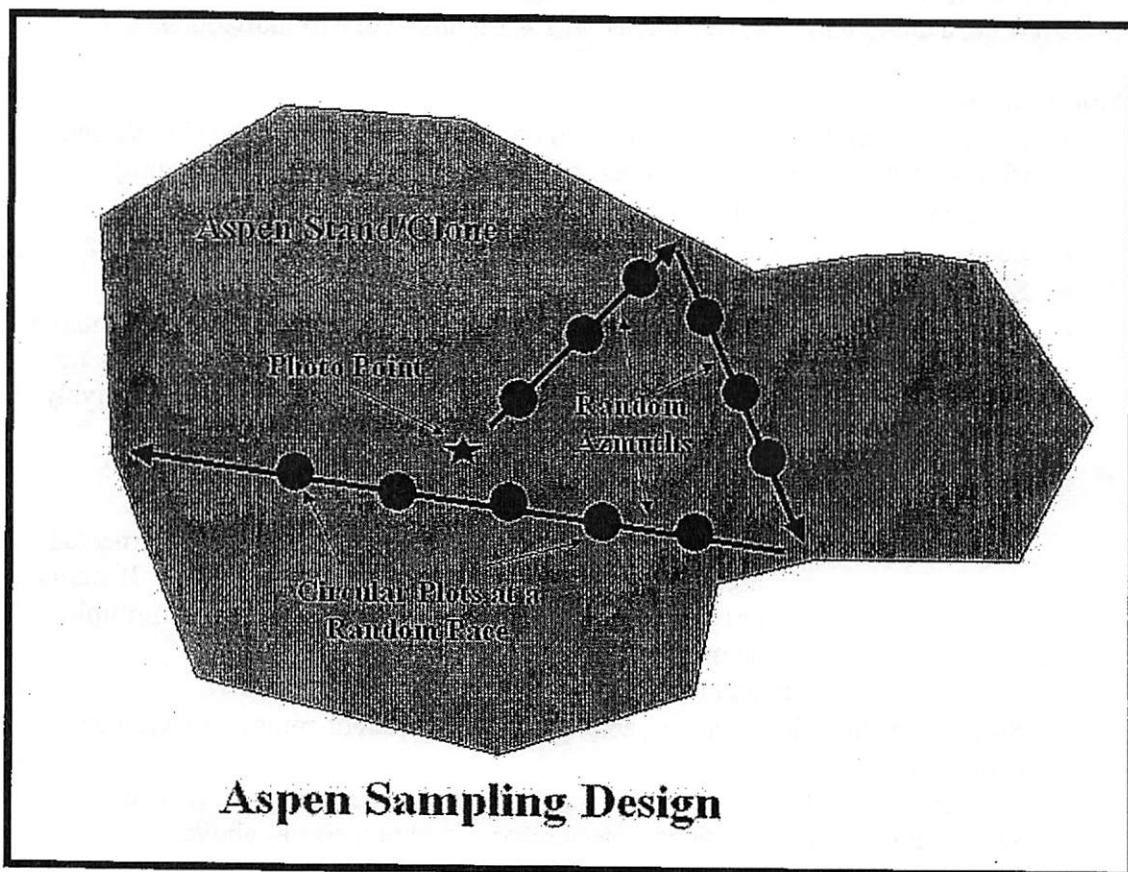


Figure 10. Sampling layout

ASPEN CIRCULAR PLOT DATA SHEET

SITE/NAME#: **DATE:** **PLOT SIZE:** **Other**
RECORDED BY: **PHOTO LOCATION:** E N NAD

COMMENTS:

| | | PLOT # | | | | | | | | | | | | | | | | | | | | | | |
|--------------|---------------------------------|--------|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|-----------------------|----------------|--|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Tot # | Stems/a cre | |
| Height Class | <1 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 1-2 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 2-3 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 3-4 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 4-5 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 5-6 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 6-7 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 7-8 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 8-9 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 9-10 | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | >10 & <2" | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | 2-4" dbh | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | >4" dbh | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | Annual leader growth of 2 stems | | | | | | | | | | | | | | | | | | | | | | 0 | |
| | Mean annual leader growth | ### | | | | | | | | | | | | | | | | | | | | | 0 | |
| | | | | | | | | | | | | | | | | | | | | | | Total Stems/ac | | |

Riparian/Willow Monitoring Evaluations

Suggested protocol for monitoring willows (currently used by the Jackson Region)

Sampling Methodology for Willows

The following methodology has been partly taken from "Monitoring the Vegetation Resources in Riparian Areas" by Alma Winward (USDA General Technical Report, April 2000). Additionally, these methods have been discussed between WGFD personnel and Alma Winward in field trips to NW Wyoming. Managers have determined this methodology to be an efficient way to get useful, repeatable data on long-term riparian transects. These transects should be read in the spring and fall in the same way except offtake will only be read in the spring.

Sampling steps

- Randomly establish 5 transects, perpendicular to the waterway. These transects should be randomly placed in such a way as to best represent the entire complex (use aerial photography when possible).
- The five transects should have beginning and ending points permanently marked with stakes. The stakes should be far enough back into the non-riparian area (usually several feet) to allow subsequent quantification in case the riparian area expands in size. At the beginning of each transect establish a permanent photopoint and record GPS coordinates (including Datum) at the start and end of the transects.
- A minimum of 50 sites will be sampled at predetermined pace intervals. Divide the approximate total length (ft.) of the five transects by 50 to determine the pace intervals at which you will sample. (Example: transect length is 1 mile (5,280 ft). $5,280/50 = 106$ ft. between sampling sites. The average pace (2 steps) is 6.5 ft. $106/6.5 = 16$ paces (32 steps) between sampling sites. At the end of each pace interval the following needs to be recorded on the closest willow plant:
 - 1) Plant species
 - 2) Plant age class (sprout, young, mature, dead)
 - 3) Plant height class (one-foot increments)
 - 4) Offtake percent of leaders hit (spring only)

Details on how to record the necessary information:

Species could be difficult to determine in the spring. If you are unable to identify the species in the spring, record the information as an unknown species. It will need to be collected and submitted to a taxonomist for identification.

Plant age classes are indicated as follows:

Clumped, multiple-stemmed species (most willows):

| <u>Number of stems at ground surface</u> | <u>Age class</u> |
|--|------------------|
| 1 | Sprout |
| 2-10 | Young |
| >10 | Mature |
| 0 stems alive | Dead |

Single-stemmed species:

For shrub and tree species that tend to grow more single stemmed, such as coyote and wolf willow, count each stem that occurs 12 inches or more from any other at ground level as a separate plant, and age them by pre-established categories. If other woody species are present and one wishes to monitor them such as birch (*Betula* spp.), alder (*Alnus* spp.), cottonwoods or quaking aspen (*Populus* spp.), do those in the same way. As a minimum, four categories—sprout, young, mature, and dead—should be developed based on a combination of both growth rings and unbrowsed height.

Example:

| <u>Growth rings</u> | <u>Height</u> | <u>Age class</u> |
|---------------------|---------------|------------------|
| 1-2 | <1/4 mature | sprout |
| 3-10 | <1/2 mature | young |
| >10 | bear full | mature |
| -- | -- | dead |

Plant Height should be recorded in one-foot increments and to the nearest foot in total height. Each one-foot increment should include the six inches before and after the foot mark (example: 6'3" would be recorded as 6' and 6'10" would be recorded as 7'). When the plant has an extensive number of stems, the plant should be randomly quartered using the second hand on the watch (seconds indicating quarters of a circle). Within this quarter, randomly sample 10 stems for height. When there are fewer than 10 stems within the quarter, use the whole plant for height measurements.

Offtake should be recorded in the same random way as plant height, using a random quarter of the willow clump when stems are numerous. When the 10 leaders are sampled for height, also record the number of hits and non-hits from the past winter's browsing. Be sure not to count 1+ yr.-old browsing.

Five Cross sections to monitor willows

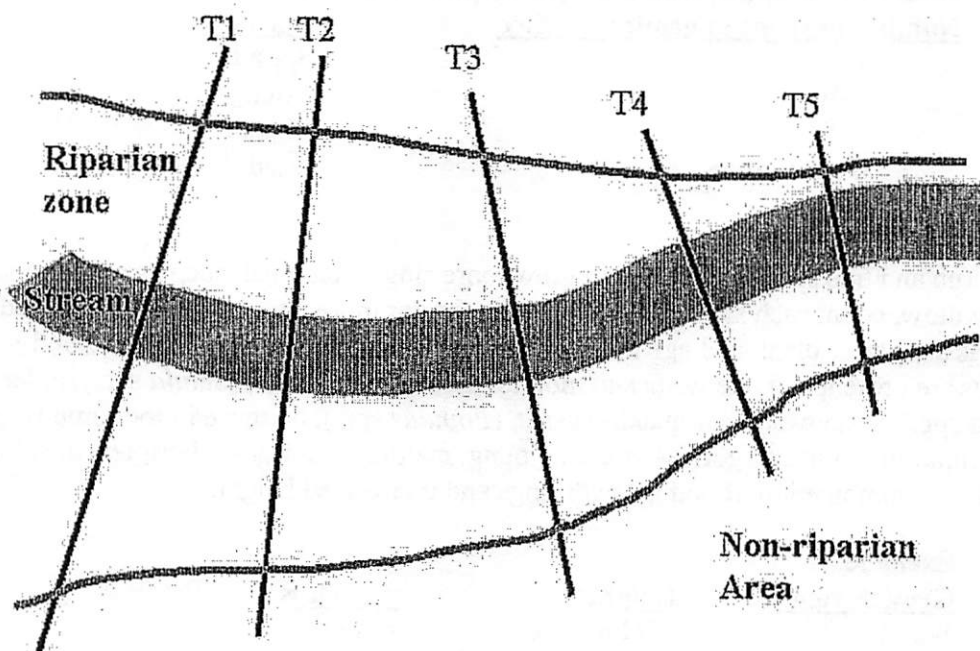


Figure 11. Willow monitoring cross sections.

Casper Shrub Production Sampling Design

Step transects are located in key or "heaviest used" areas of crucial winter ranges for big game species. The transects are permanently marked with T-posts, a GPS reading is recorded, and compass bearings are taken to determine the direction in which they run. We tag 25 (this should be increased to 50) shrubs occurring nearest the toe in a 180-degree arc in front of the observer at 3 pace intervals. We place a tag on each plant for ease of relocation, and the tags are numbered in sequential order. We tag only those plants that are available to big game species during the winter period. Big sagebrush production is estimated by measuring to the nearest millimeter 10 randomly located current annual leaders. A spot on each shrub is selected by noting the second hand on a wristwatch, moving to that position within the browsing zone, and measuring 5 leaders. Five additional leaders are assessed on the opposite side of the plant.

Mountain shrub (i.e., true mountain mahogany, curleaf mountain mahogany, antelope bitterbrush, etc.) production is estimated by measuring to the nearest millimeter, 10 current annual leaders located above a tag on a marked stem. This stem will be randomly selected by noting the second-hand on a wristwatch. The same current annual leaders measured for production will be used to estimate utilization (actual use).

All production data is collected during September.

Casper Shrub Utilization Sampling Design

Step transects are located in key or "heaviest used" areas of crucial winter ranges for big game species. The transects are permanently marked with T-posts, a GPS reading is recorded, and a compass bearing is taken to determine the direction in which they run. We tag 25 (this should be increased to 50) shrubs occurring nearest the toe in a 180-degree arc in front of the observer at 3 pace intervals. We place a tag on each plant for ease of relocation, and the tags are numbered in sequential order. We tag only those plants that are available to big game species during the winter period. Each shrub is assessed for utilization (percent leaders browsed) and characterized according to hedging and age class criterion. Big sagebrush utilization (percent leaders browsed) is estimated and recorded to the nearest 5 percent (+ or - 10 percent). Utilization is estimated by trying to mentally reconstruct the plant, as it would have appeared had it not been utilized because leader counts or measurements are not feasible with big sagebrush. Big sagebrush actual use is very difficult to measure, therefore we have instituted an ocular assessment, which is described previously in this paragraph.

Mountain shrub (i.e., true mountain mahogany, curleaf mountain mahogany, antelope bitterbrush, etc.) utilization (actual use) is determined by measuring 10 leaders on a marked stem. This stem is randomly selected by noting the second-hand on a wristwatch. In addition, all current annual leaders are measured to the nearest quarter inch above the tag. The tag is used for ease of location, and is numbered in sequential order. The same

leaders are re-measured the following spring to determine utilization (actual use). If the entire leader has been removed, a zero is recorded.

All utilization data is collected in late April through early May, prior to the shrubs initiating growth.

The criterion for hedging and age classifications are outlined below.

Hedging Class 1: Light or no hedging; 2 year old wood is relatively long and unaltered or only slightly altered from the normal growth form. Less than 40 percent of the growing season leaders occur as extensions from lateral buds off of 2-year-old wood. Most of the 2 year old stems have current growing season leaders that extend directly from terminal bud apices.

Hedging Class 2: Moderate hedging; 2-year-old wood is not strongly altered from the normal growth form. Between 40 percent and 70 percent of the current growing season leaders occur as extensions from lateral buds off 2-year-old wood. The remaining 30 percent to 60 percent of the 2 year old stems have current growing season leaders that extend directly from terminal bud apices.

Hedging Class 3: Heavy hedging; 2-year-old wood is relatively short and strongly altered from the normal growth form. Recurrent use has resulted in the development of much lateral branching or a very "clubbed" or "broomed" appearance. More than 70 percent of the current growing season leaders occur as clumped lateral and/or adventitious sprouts. Less than 29 percent of the 2-year-old stems have current growing season leaders that extend directly from terminal bud apices.

Young (Y): intermediate age plant between seedling and mature; exhibits more complex branching, more fibrous bark, and greater root development than a seedling, but the branching is still simple, on elongated growth, and the plant does not produce seed. The basal stem diameters for evergreen species are usually less than 1/4 inch, and for deciduous species usually less than 1/2 inch.

Mature (M): plant producing seed when healthy (vigorous), stems heavier and often gnarled, branching complex, and foliar crown made up of more than 50% living branches.

Decadent (D): plant in a state of decline that exhibits 50% or more dead branches regardless of age.

Dead (DE): plant that exhibits 100% dead branches.

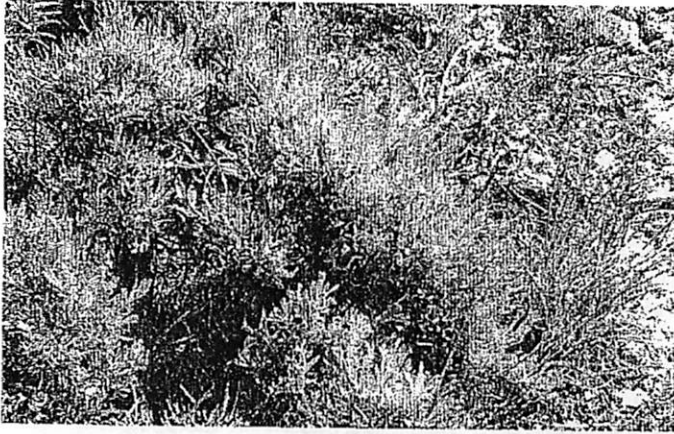


Figure 12. Hedge Class 2
Age Class - Mature



Figure 13. Hedge Class 3
Age Class - Mature

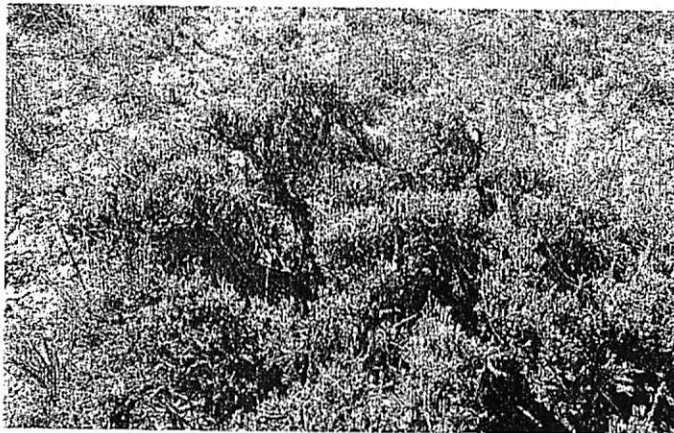


Figure 14. Hedge Class 3
Age Class - Mature

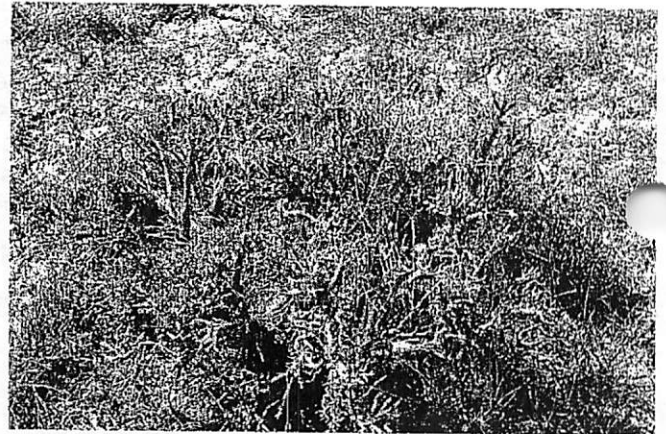


Figure 15. Hedge Class 3
Age Class - Decadent

The Casper Region uses the following methods for long-term monitoring.

Vegetative Plot Sampling Protocol

A 66-foot baseline is extended perpendicular to the slope from a marker (i.e., reinforcing bar, t-post, etc.), a GPS reading is recorded and a compass bearing is taken to determine which direction it lies. The zero footmark is placed to the left as you face upslope, or on the west end (west to east) on flat areas. A marker is placed approximately 50 feet from the end of each baseline to allow relocation for monitoring efforts. Subsequently, multiplying a random number generated on a calculator by 66 identifies five random

starting points along the baseline. The transects are placed perpendicular to the baseline (parallel to the slope) beginning at each starting point, and canopy coverage, ground coverage, nested-rooted frequency, and shrub density by age class is estimated along each transect.

Canopy coverage is estimated, as defined by Daubenmire (1959), for shrubs and trees using the line intercept technique. Canopy intercept is measured to the nearest inch along each transect. Canopy coverage for each graminoid and forb encountered in a microplot is ocularly assessed to the nearest percent. Microplots are 20-inch (50.8 cm. square) square quadrat frames. Five microplots are placed to the right of the transect line with the lower left corner of the microplot frame located at the 8, 16, 24, 32, 40, 48, 56 and 64 foot marks on each transect.

Ground (basal) coverage is estimated by point sampling at designated marks on the microplot frame. Eight points are sampled at each microplot location. The point intercept is recorded by vegetative life form class, or as rock, gravel, litter, or bare ground.

Nested-rooted frequency is estimated within each microplot. The microplot frame is sectioned into four quadrants of 20 x 20 inches (50.8 x 50.8 cm.), 20 x 10 inches (50.8 x 25.4 cm.), 10 x 10 inches (25.4 x 25.4 cm.), and 2 x 2 inches (5.08 x 5.08 cm.) to derive the estimate. Plants are recorded according to the smallest quadrant in the microplot they were rooted in.

Density of important shrubs within macroplots is estimated using 3.3 x 66 foot (1.02 x 20.12 m.) belt transects. Belt transects are established by carrying a 3 ft. 4 in. section of lath held parallel to the transect line along the left side. Should one belt transect overlap another, the right side of the adjacent transect is recorded instead. Each key shrub occurring in the belt transect is recorded according to the age class criteria outlined below.

Vegetative plot sampling is usually conducted from late May through June, dependent upon plant growth which aids in plant identification. This timeframe may change from year to year and location to location.

Appendix B

Following are examples of completed data forms and sheets used to summarize information from a shrub transect at Cedar Hills in the Laramie Region.

Laramie Region Field Report Summary Sheet

Transect Name: Cedar Hills

Date Established (m-d-y): 8/2/01

Established by: Rick Straw, Michele Turner

Herd Units Represented: Mule Deer 541 & Antelope 528

Witness Post GPS Location: 13T0357758 4581722

GPS Indicated Altitude: 7284

Community Type: ArTrWy, PuTr, ChVi

Estimated Slope: 30 degrees

Estimated Aspect (azimuth): 280 degrees

Animal Use: Mule deer, horse

Transect & Exclosure Photo Taken: No

Soil Sample Taken: No

Shrub Recruitment Belt Transect: Yes

Nutrient Sample Taken: Yes

Shrub Stems Taken for Age Determination: Yes

Exclosure Installed: Yes

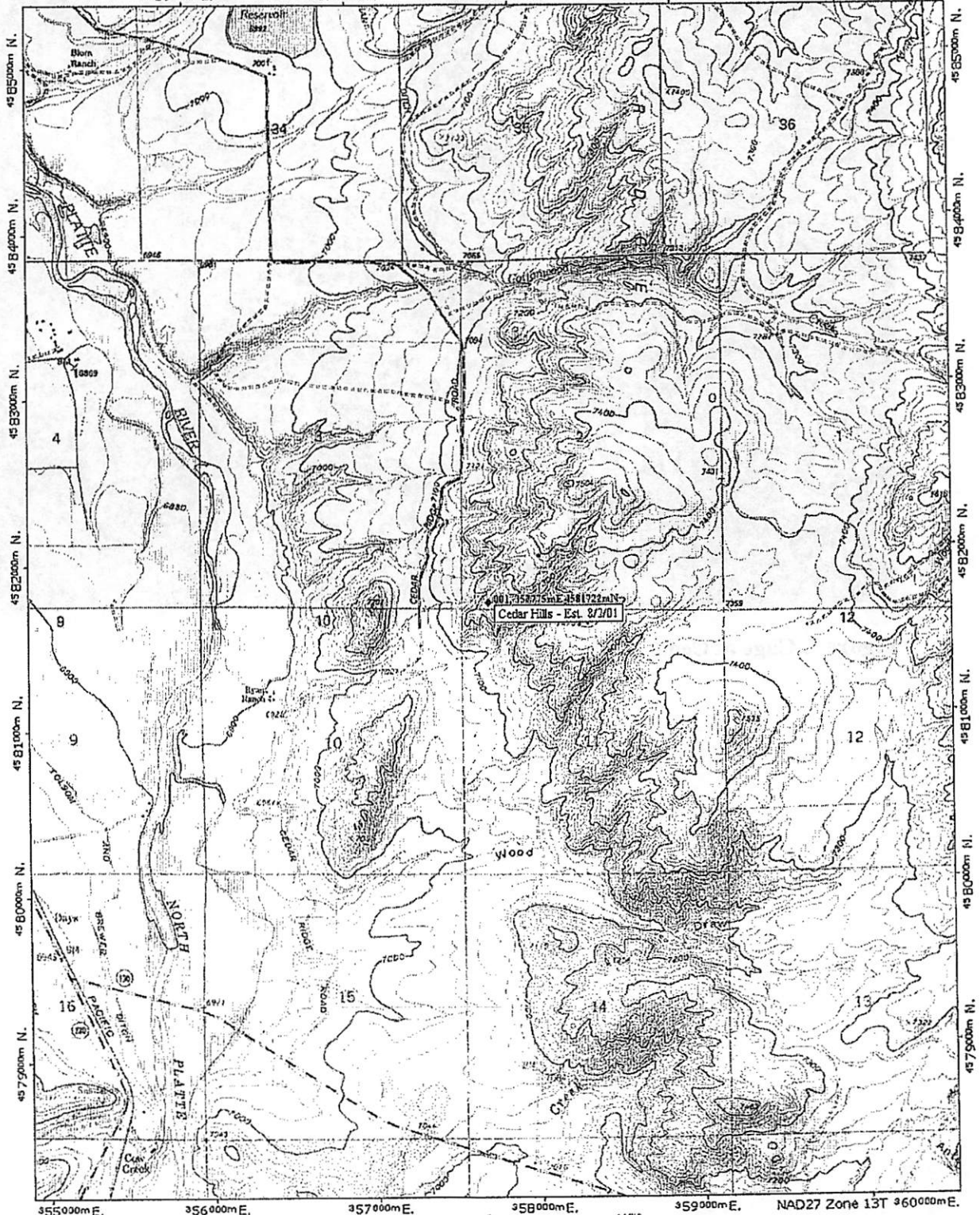
Fecal Sample Collected (species): Yes (Mule deer)

Field Observations

Area receives very high use during severe winters. Rocky mountain juniper present, many of which have been high lined.

TOPOI map printed on 04/09/02 from "Wyoming.tpo" and "Untitled.tpg"

356000m E. 357000m E. 358000m E. 359000m E. NAD27 Zone 13T 360000m E.



TH MN 11W

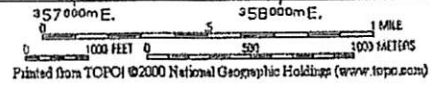




Figure 7. Cage at Cedar Hills. 7/29/03.

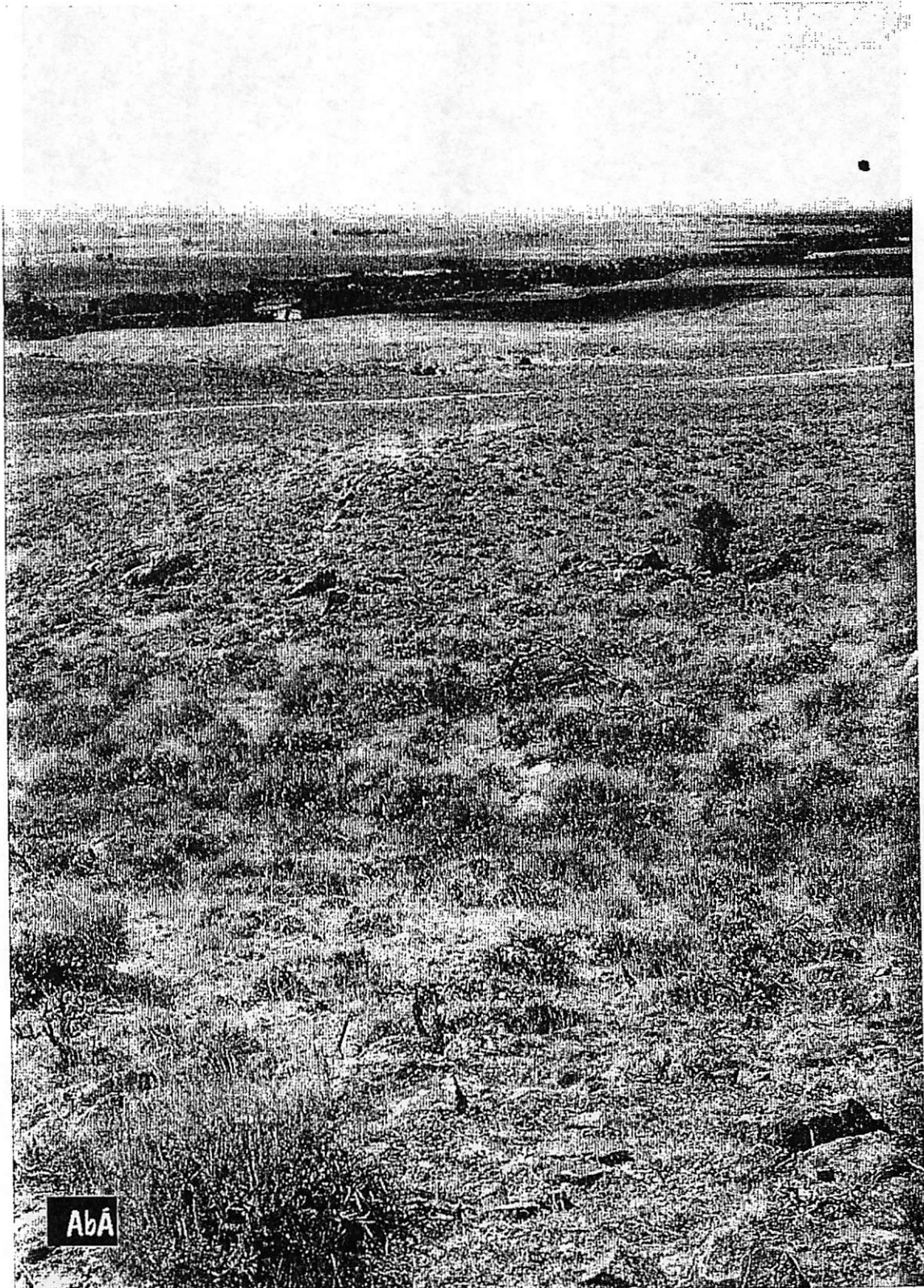


Figure 8. Landscape at monitoring station.



Figure 9. Transect line. 7/29/03.

| ANNUAL LEADER PRODUCTION | | | | |
|--------------------------|---------------|-----------------------|----------------------------|--|
| SPECIES | Sampling Date | # OF LEADERS MEASURED | AVERAGE LEADER LENGTH (cm) | Comment |
| ArtTriW | 9/27/01 | 100 | 4.00 | Good production on PurTri and ArtTriW. Both species producing smaller plants with many relatively long leaders. Bitterbrush disappears at the end of the transect and is "replaced" by ChVi. |
| ArtTriW | 2002 | 100 | 2.07 | |
| ArtTriW | 9/16/03 | 100 | 2.72 | |

| Plate Valley Mtn. Deer #10 | | | | | | |
|----------------------------|----------------------|--------------------|-----------|-----------|-----------|------------------------|
| TRANSECT NAME | SPECIES | AVG. % UTILIZATION | | | | SUGGESTED DUELS OR USE |
| | | 2003/2004 | 2004/2005 | 2005/2006 | 2006/2007 | |
| Prospect | Antelope Bitterbrush | 66.5 | | | | 60 - 65% |
| School Creek | Antelope Bitterbrush | 51.8 | | | | 60 - 65% |
| Cedar Hills | Mt. Big Sagebrush | 48.5 | | | | 45% |

Collection Date: 8/02/01

HEDGING CLASSIFICATION

SAMPLING DATE: 7/29/03

| HEDGING CLASS | DESCRIPTION |
|---------------|--|
| 1 | Little or no hedging - Indicates light use in the past 3 to 4 years. |
| 2 | Moderate hedging - Use in past 3 to 4 years caused much development of lateral branching and more complex growth form. |
| 3 | Severely hedged - Heavy use in the past 3 to 4 years caused a very much clubbed or broomed appearance. |
| SHRUB SPECIES | HEDGING CLASS |
| PurTri | 3 |
| ArtTriW | 3 |

POINT FRAME MEASUREMENTS

Relative Frequency = $\frac{\text{Total Number of Intercepts Per Category}}{\text{Total Number of Points Sampled}}$

Sampling Date: 8/2/01

| Intercept Category | Frequency (%) |
|---------------------------|----------------------|
| ArTrWy | 8 |
| ChVi | 4 |
| PuTr | 5 |
| Cushion Plant? | 7 |
| Sedge | 7 |
| Phlox | 1 |
| Rock | 15 |
| Litter | 17 |
| Bare Ground | 25 |

LIVE SHRUB CANOPY MEASUREMENTS*

Sampling Date – 7/29/03

| Species | Total Inches Intercepted | % Live Canopy Coverage |
|----------------|---------------------------------|-------------------------------|
| ArtTriV | 214 | 18% |
| PurTri | 19 | 2% |
| ChrVis | 44 | 4% |

*% Live Canopy Cover = $\frac{\text{Total Inches Live Canopy Intercepted/Species} \times 100}{\text{Total Inches in Transect (1200)}}$

SHRUB (STEM) DENSITY/RECRUITMENT PER ACRE

Sampling Date – 7/29/03

| Species | No. and % Mature Plants | No. and % Young Plants | No. and % Decadent Plants | No. and % Dead Plants | Total Plants Per Acre |
|----------------|--|---------------------------------------|--|--------------------------------------|--------------------------------------|
| ArtTriV | 58 – 43% | 6 – 4% | 64 – 47% | 7 – 5% | 4320 |
| PurTri | 5 – 23% | 0 | 15 – 68% | 2 – 9% | 702 |
| ArtFri | Not Sampled by Age Class | | | | 32 |
| ChrVis | Not Sampled by Age Class | | | | 1248 |

Comments: Very heavy BroTec infestation.

| SHRUB AGE CLASSIFICATION | | | | | |
|---------------------------------|------------|-----------|-----------|-----------|-----------|
| <u>Species</u> | <u>Age</u> | | | | |
| ArtTriW | 88 | 74 | 80 | 77 | 77 |
| PurTri | 48 | 52 | 32 | 44 | 37 |

Interpretation:

| FECAL ANALYSIS | | | | | | | | | | | | |
|--------------------------------|------------------|----------------|-------------|--------------|----------------------------------|-----------------|---------------|------------------|------------------|--------------------|----------------|--------------------|
| Species - Mule Deer | | | | | | | | | | | | |
| PLANT GENUS | Agropyron | Hordeum | Poa | Stipa | Artemisia tridentata type | Atriplex | Cactus | Composite | Juniperus | Lesquerella | Purshia | Sphaeralcea |
| Mean % Relative Density | 2.43 | 7.05 | 0.81 | 3.33 | 21.77 | 0.72 | 0.72 | 3.35 | 17.88 | 5.17 | 11.96 | 0.81 |

* Highest mean percent relative density in sample.

* Shrub and tree genus' found in sample.

| SHRUB NUTRIENT ANALYSIS | | | | | |
|--------------------------------|--|------------------------------------|---------------------------|--|--|
| | PLANT SPECIES | | | | |
| | Artemisia tridentata wyomingensis | Chrysothamnus viscidiflorus | Purshia tridentata | | |
| P% (Phosphorous) | 0.103 | 0.188 | 0.122 | | |
| Ca% (Calcium) | 0.828 | 1.371 | 0.698 | | |
| Fe ppm (Iron) | 136.9 | 386.1 | 163.5 | | |
| Cu ppm (Copper) | 12.20 | 18.3 | 4.0 | | |
| ADF% | 27.75 | 22.98 | 34.97 | | |
| Total C (Carbon) | 59.65 | 57.45 | 58.66 | | |
| Total N (Nitrogen) | 2.274 | 2.576 | 1.973 | | |
| CP% (Crude Protein) | 14.21 | 16.10 | 12.33 | | |

Collection Date:8/2/01

| PRECIPITATION DATA (Western Regional Climate Center) | | | | |
|--|--|---|--------------------------------------|--|
| Station Name | Recording Period-Precip. Mean | Station Elevation (Feet) | Station Location Lat/Long | Current Reading Previous 2 Yrs. |
| Saratoga 1. SSE | 1948 – 2000 – 9.76 Inches | 6790 | 4127 – 10648 | 2001 – 5.47 2002 – 5.94 |