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**Natural
Resources
Conservation
Service**

National Range and Pasture Handbook

Chapter 4 Inventorying and Monitoring Grazing Land Resources

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Chapter 4 Inventorying and Monitoring Grazing Land Resources

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Chapter 4 Inventorying and Monitoring Grazing Land Resources

Chapter 4 includes:

- procedures for vegetation inventory and monitoring on native grazing lands
- procedures for evaluating and rating ecological sites
- information on vegetation sampling techniques

The inventory and monitoring section describes methods of determining production, composition, and utilization. The evaluating and rating of ecological sites section gives procedures for determining trend and similarity index and evaluating rangeland health attributes on rangelands and forage value ratings on grazed forest lands. The Sampling Vegetation Attributes, Interagency Technical Reference, 1996, and Utilization Studies and Residual Measurements, Interagency Technical Reference, 1996, should be used for specific monitoring methods.

600.0400 General

Vegetation sampling is an important activity conducted by Natural Resources Conservation Service (NRCS) range management specialists and pasture management specialists. The data are used to develop inventories for planning, monitor ecological change, provide data to make management decisions for the development of rangeland ecological site descriptions, to obtain data for hydrologic models, for studies of treatment effects, and for many other purposes.

An inventory is defined as the collection, assemblage, interpretation, and analysis of natural resource data for planning or other purposes. Inventories are regularly completed to determine the present status of variables important to NRCS and decisionmakers. These inventories include physical structures, hydrologic features, rangeland ecological sites, animal resources, and other variables pertinent to the planning process. Biomass data collection, production, and composition by species are the standard techniques used by NRCS in characterizing rangeland ecological sites during the inventory process.

Several variables important to rangeland health and trend cannot be quantified using biomass data alone, so other techniques must be used to quantify characteristics of rangeland ecological sites. For instance, cover measurements can be used to quantify ground cover of litter, seedlings, microphytes (algae, lichen, and moss), and the condition of the soil surface. Cover is also important from a hydrologic perspective where the variables of interest might include basal cover of perennial and annual species, litter, coarse fragments, rills, and foliar and canopy cover above the soil surface.

Monitoring is used to quantify effects of management or environmental variation at a location, through time. Monitoring can be short term, for example, to quantify the amount of biomass used during a grazing event. It can also be long term such as to quantify trend in similarity index on a particular rangeland ecological site. Monitoring techniques are different from those used in inventory because monitoring uses the same location on a repetitive basis. Continued clipping at the same location may eventually impact the productivity of the location, and biomass data collection is labor intensive and time consuming. Therefore, monitoring environmental change using another technique, such as cover, or a combination of techniques, such as cover and density, is often more efficient. Data collections for ecological site descriptions are more involved than planning inventories. These data collections require collection of biomass and cover data, as well as a review of local history related to the historic climax plant community. Data are also collected for use in hydrology assessments. Development of hydrologic models is an important activity in NRCS that requires data collection from a unique set of variables.

Studies of treatment effects are limited in NRCS. These studies involve intensive use of statistical methods and should be done in cooperation with USDA Agricultural Research Service (ARS) or universities familiar with the particular type of study. Data collections for other purposes might include data for:

- coordinating grazing history, stocking rate, and animal performance records in determining guides to initial stocking rates
- preparing soil survey manuscripts and other publications
- analyzing wildlife habitat values
- planning watershed and river basin projects
- assisting and training landowners and operators in monitoring vegetation trends and the impact of applied conservation practices and programs
- exchanging information with research institutions and agencies
- preparing guides and specifications for recreation developments, beautification, natural landscaping, roadside planting, and other developments or practices

600.0401 Inventory

All production and composition data collected by NRCS are based on weight measurements. Weight is the most meaningful expression of the productivity of a plant community or an individual species. It has a direct relationship to feed units for grazing animals that other measurements do not have.

Production is determined by measuring the annual aboveground growth of vegetation. Some aboveground growth is used by insects and rodents, or it disappears because of weathering before production measurements are made. Therefore, these determinations represent a productivity index. They are valuable for comparing the production of different rangeland ecological sites, plant species composition, and similarity index. Production data must be obtained at a time of year when measurements are valid for comparison with similar data from other years, other sites, and various conditions being evaluated.

Comprehensive interpretation of plant production and composition determinations requires that data be representative of all species having measurable production. Rangeland and other grazing lands may be used or have potential for use by livestock and wildlife, as recreation areas, as a source of certain wood products, for scenic viewing, and for other soil and water conservation purposes. The value of plant species for domestic livestock often is not the same as that for wildlife, recreation, beautification, and watershed protection. Furthermore, the principles and concepts of rangeland ecological site, similarity index, and other interpretations are based on the total plant community. Therefore, interpretations of a plant community are not limited solely to species that have value for domestic livestock.

The procedures and techniques discussed in this section relate primarily to rangeland. Most of them, however, also apply to grazeable forest and native or naturalized pasture. Changes or modifications in procedures required for land other than rangeland are described.

(a) Total annual production

The total production of all plant species of a plant community during a single year is designated total annual production. For specific purposes, production of certain plants or groups of plants can be identified as herbage production for herbaceous species, woody-plant production for woody plants, and production of forage species for plants grazed by livestock. Annual production, approximate production, total production, and production are used interchangeably with total annual production throughout this section.

Total annual production includes the aboveground parts of all plants produced during a single growth year regardless of accessibility to grazing animals. An increase in the stem diameter of trees and shrubs, production from previous years, and underground growth are excluded.

(1) Total forage production

Total annual forage production is the annual production of plant species that are forage plants for the animals of concern. The same site may have different total annual forage production weights for cattle than that for deer. If total annual forage production is used as an inventoried item, then the animal of concern must be identified.

(2) Usable forage production

The usable forage production is that amount of total forage production to be allocated to or expected to be used by livestock or wildlife. When usable forage production is an inventoried item, the animal of concern and the desired use must be specified.

(b) Definition of production for various kinds of plants

(1) Herbaceous plants

These plants include grasses (except bamboos), grass-like plants, and forbs. Annual production includes all aboveground growth of leaves, stems, inflorescences, and fruits produced in a single year.

(2) Woody plants

(i) Deciduous trees, shrubs, half-shrubs, and woody vines—Annual production includes leaves, current twigs, inflorescences, vine elongation, and fruits produced in a single year.

(ii) Evergreen trees, shrubs, half-shrubs, and woody vines—Annual production includes current year leaves (or needles), current twigs, inflorescences, vine elongation, and fruits produced in a single year.

(iii) Yucca, agave, nolina, sotol, and saw palmetto—Annual production consists of new leaves, the amount of enlargement of old leaves, and fruiting stem and fruit produced in a single year. Until more specific data are available and if current growth is not readily distinguishable, consider current production as 15 percent of the total green-leaf weight plus the weight of current fruiting stems and fruit. Adjust this percentage in years of obviously high or low production.

(3) Cacti

(i) Pricklypear and other pad-forming cacti—Annual production consists of pads, fruit, and spines produced in a single year plus enlargement of old pads in that year. Until more specific data are available and if current growth is not readily distinguishable, consider current production as 10 percent of the total weight of pads plus current fruit production. Adjust this percentage for years of obviously high or low production.

(ii) Barrel-type cactus—Until specific data are available, consider annual production as 5 percent of the total weight of the plant, other than fruit, plus the weight of fruit produced in a single year.

(iii) Cholla-type cactus—Until specific data are available and if current growth is not readily distinguishable, consider annual production as 15 percent of the total weight of photosynthetically active tissue plus the weight of fruit produced in a single year.

(c) Methods of determining production and composition

Production and composition of a plant community are determined by estimating, by a combination of estimating and harvesting (double-sampling), or by harvesting. Some plants are on state lists of threatened, endangered, or otherwise protected species. Regulations concerning these species may conflict with harvesting procedures described. For example, barrel-type cactus in some states is a protected species, and harvesting is not allowed.

The weight of such plants is to be estimated unless special permission for harvesting can be obtained. Conservationists determining production should be aware of such plant lists and regulations. Environment Memorandum-1 (rev.) states NRCS policy on activities involving Federal- and state-designated threatened and endangered species.

(1) Estimating (by weight units)

The relationship of weight to volume is not constant; therefore, production and composition determinations are based on weight estimates, not on comparison of relative volumes. The weight unit method is an efficient means of estimating production and lends itself readily to self-training. This method is based on the following:

- A weight unit is established for each plant species occurring on the area being examined.
- A weight unit can consist of part of a plant, an entire plant, or a group of plants (see exhibit 4–1).
- The size and weight of a unit vary according to the kind of plant. For example, a unit of 5 to 10 grams is suitable for small grass or forb species. Weight units for large plants may be several
- pounds or kilograms
- other considerations:
  — length, width, thickness, and number of stems, and leaves

  — ratio of leaves to stems

  — growth form and relative compactness of species

The following procedure can be used to establish a weight unit for a species.

Step 1. Decide on a weight unit (in pounds or grams) that is appropriate for the species.

Step 2. Visually select part of a plant, an entire plant, or a group of plants that will most likely equal this weight.

Step 3. Harvest and weigh the plant material to determine actual weight.

Step 4. Repeat this process until the desired weight unit can be estimated with reasonable accuracy.

Step 5. Maintain proficiency in estimating by periodically harvesting and weighing to check estimates of production.

The procedure for estimating production and composition of a single plot is:

Step 1. Estimate production by counting the weight units of each species in the plot.

Step 2. Convert weight units for each species to grams or pounds.

Step 3. Harvest and weigh each species to check estimates of production.

Step 4. Compute composition on the basis of actual weights to check composition estimates.

Step 5. Repeat the process until proficiency in estimating is attained.

Step 6. Periodically repeat the process to maintain proficiency in estimating.

Step 7. Keep the harvested materials, when necessary, for air-drying and weighing to convert from field (green) weight to air-dry weight.

(2) Estimating and harvesting (double sampling)

The double-sampling method is to be used in making most production and composition determinations. The procedure is:

Step 1. Select a study area consisting of one soil taxonomic unit. This should be a benchmark soil or taxonomic unit that is an important component of a rangeland ecological site or forest land ecological site.

Step 2. Select plots to be examined at random.

Step 3. The number of plots selected depends on the purpose for which the estimates are to be used, uniformity of the vegetation, and other factors. A minimum of 10 plots should be selected for all data to be used in determining rangeland ecological sites or other interpretive groupings and for data for use in the Ecological Site Information System. If vegetation distribution is very irregular and 10 plots will not give an adequate sampling, 20 plots can be selected. Fewer than 10 plots can be used if data are to be used for planning or application work with landowners, but the data should not be entered in the Ecological Site Information System.

Step 4. Adapt size and shape of plots to the kind of plant cover to be sampled. Plots can be circular, square, or rectangular. The area of a plot can be expressed in square feet, acres, or square meters.

If vegetation is relatively short and plot markers can be easily placed, 1.92-, 2.40-, 4.80-, and 9.60-square foot plots are well suited to use in determining production in pounds per acre. The 9.6-square foot plot is generally used in areas where vegetation density and production are relatively light. The smaller plots, especially the 1.92-square foot plot, are satisfactory in areas of homogeneous, relatively dense vegetation like that occurring in meadows and throughout the plains and prairie regions. Plots larger than 9.6 square feet should be used where vegetation is very sparse and heterogeneous.

If the vegetation consists of trees or large shrubs, larger plots must be used. If the tree or shrub cover is uniform, a 66- by 66-foot plot of 0.1 acre is suitable. If vegetation is unevenly spaced, a more accurate sample can be obtained by using a 0.1-acre plot, 4.356 feet wide and 1,000 feet long. For statistical analyses, 10 plots of 0.01 acre are superior to a single 0.1 acre plot. If vegetation is mixed, two sizes of plots generally are needed. A series of 10 square or rectangular plots of 0.01 acre and a smaller plot, such as the 9.6-square foot plot nested in a designated corner of each larger plot, is suitable. The 0.01-acre plot is used for trees or large shrubs, and the smaller plot for lower growing plants. Weights of the vegetation from both plots are then converted to pounds per acre.

Plots with area expressed in square meters are used if production is to be determined in kilograms per hectare. If the plots are nested, production from both plots must be recorded in the same units of measure. For example, a plot 20 meters by 20 meters (or other dimensions that equal 400 meters) can be used for measuring the tree and shrub vegetation and a 1-meter plot nested in a designated corner can be used for measuring the low-growing plants. Determine the production from both in grams and convert the grams to kilograms per hectare. Plots of 0.25, 1, 10, 100, and 400 square meters are commonly used.

After plots are selected, estimate and record the weight of each species in each plot using the weight-unit method. When estimating or harvesting plants, include all parts of plants whose stems originate in the plot, including all aboveground parts that extend beyond a plot boundary. Exclude all parts of herbaceous plants and shrubs whose stems originate outside a plot, even though their foliage may overlap into the plot.

After weights have been estimated on all plots, select the plots to be harvested. The plots selected should include all or most of the species in the estimated plots. If an important species occurs on some of the estimated plots, but not on the harvested plots, it can be clipped individually on one or more plots. The number of plots harvested depends on the number estimated. To adequately correct the estimates, research indicates at least one plot should be harvested for each seven estimated. At least 2 plots are to be harvested if 10 are estimated, and 3 are to be harvested if 20 are estimated.

Harvest, weigh, and record the weight of each species in the plots selected for harvesting. Harvest all herbaceous plants originating in the plot at ground level. Harvest all current leaf, twig, and fruit production of woody plants originating in the plots. If harvesting forage production only, then harvest to a height of 4.5 feet above the ground on forest land sites.

Correct estimated weights by dividing the harvested weight of each species by the estimated weight for the corresponding species on the harvested plots. This factor is used to correct the estimates for that species in each plot. A factor of more than 1.0 indicates that the estimate is too low. A factor lower than 1.0 indicates that the estimate is too high.

After plots are estimated and harvested and correction factors for estimates computed, air-dry percentages are determined by air-drying the harvested materials or by selecting the appropriate factor from an air-dry percentage table (see exhibit 4–2). Values for each species are then corrected to air-dry pounds per acre or kilograms per hectare for all plots. Average weight and percentage composition can then be computed for the sample area.

(3) Harvesting

This method is similar to the double-sampling method except that all plots are harvested. The double-sampling procedures for estimating weight by species and the subsequent correction of estimates do not apply. If the harvesting method is used, selection and harvest of plots and conversion of harvested weight to air-dry pounds per acre or kilograms per hectare are performed according to the procedures described for double sampling.

(4) Units of production and conversion factors

All production data are to be expressed as air-dry weight in pounds per acre (lb/a) or in kilograms per hectare (kg/ha). The field weight must be converted to air-dry weight. This may require drying or the use of locally developed conversion tables.

(i) Converting weight to pounds per acre or kilograms per hectare—The weight of vegetation on plots measured in square feet or in acres can be estimated and harvested in grams or in pounds, but weight is generally expressed in grams. To convert grams per plot to pounds per acre, use the following conversions:

1.92-square foot plots—multiply grams by 50

2.40-square foot plots—multiply grams by 40

4.80-square foot plots—multiply grams by 20

9.60-square foot plots—multiply grams by 10

96.0-square foot plots—multiply grams by 1

In the metric system, a square-meter plot (or multiple thereof) is used. Weight on these plots is estimated or harvested in grams and converted to kilograms per hectare. A hectare equals 10,000 square meters. A kilogram equals 1,000 grams. To convert grams per plot to kilograms per hectare, use the following conversions:

0.25-square meter plots—multiply grams by 40

1-square meter plots—multiply grams by 10

10-square meter plots—multiply grams by 1

100-square meter plots—multiply grams by 0.10

400-square meter plots—multiply grams by 0.025

When assisting landowners and operators in determining approximate production, express data in pounds per acre. Use the following factors to convert from one system to another:

To convert	To	Multiply by
Metric units:		
Kilograms per hectare	Pounds per acre	0.891
Kilograms	Pounds	2.2046
Hectares	Acres	2.471
English units:		
Pounds per acre	Kilograms per hectare	1.12
Pounds	Kilograms	0.4536
Acres	Hectares	0.4047

(ii) Converting green weight to air-dry weight—If exact production figures are needed or if air-dry weight percentage figures have not been previously determined and included in tables, retain and dry enough samples or harvested material to determine air-dry weight percentages. The percentage of total weight that is air-dry weight for various types of plants at different stages of growth is provided in exhibit 4–2. These percentages are based on currently available data and are intended for interim use. As additional data from research and field evaluations become available, these figures will be revised. Air-dry weight percentages listed in the exhibit can be used for other species having growth characteristics similar to those of the species listed in the exhibit. States that have prepared their own tables of air-dry percentages on the basis of actual field experience can substitute them for the tables in exhibit 4–2. Local conservationists are encouraged to develop these tables for local conditions and species. Some interpolation must be done in the field to determine air-dry percentages for growth stages other than those listed.

The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shading, time since last rain, and unseasonable dry periods. Several samples of plant material should be harvested and air-dried each season to verify the factors shown or to establish factors for local use.

(d) Methods for determining production and composition for specific situations

The intended use of the data being collected determines the method, or variation thereof, that is selected. Unless specifically stated otherwise, composition is always determined by computing the percent from the weight, either estimated or weighed. Several activities require knowledge of production, but in varying degrees of detail. The methods or variations that apply to several of these situations are described in this section.

(1) Collecting production and composition data for documentation

Data to be used for preparing rangeland ecological site descriptions grouping soils into rangeland ecological sites, and other guides, and processing in the Ecological Site Information System are to be obtained by the double-sampling procedure. All documentary production and composition data are to be recorded on form NRCS–RANGE–417. Production determinations are made as follows:

- Tabulate production data by estimating and harvesting plots of the potential plant community for one or more soil taxonomic units associated with the site or group.
- Obtain production data from vegetation that has not been grazed since the beginning of the current growing season.
- Make determinations near or shortly after the end of the growing season of the major species. Give due consideration to species that mature early in the growing season. If plant communities consist of a mixture of warm- and cool-season species, at least two determinations may be needed during a single production year. The following procedure should then be used:
  - — Select two periods that will yield the best estimate of the growth of most of the important species.
  - — At the first determination, estimate and harvest only the species that are mature or nearly mature.
  - — At the second determination, select a new set of plots for estimating and harvesting all other species, but record the data on the same form NRCS–RANGE–417 used for the first determination.
  - — At the second determination, harvest the plots having numbers corresponding to those harvested at the first determination. For example, if plots number two and four were harvested the first time, plots number two and four are harvested the second time. Correction of sampling errors, as well as moisture data can then be made. Any species not included in these plots can be harvested individually.
  - — If two determinations are made, record the date of the second determination in the Remarks space of form NRCS–RANGE–417.
- Repeat production determinations in different years to reflect year-to-year variations.
- Analyze production data from soil taxonomic units to determine the soils that should be tentatively grouped into specific rangeland ecological sites or other interpretive groupings and also to obtain data for inclusion in published soil surveys. Soils are not grouped based on production alone. The species composition by weight is also used.

The procedures discussed above are also to be used in obtaining data for the various status ratings for rangeland ecological sites and for different forage value ratings on those sites. To accomplish this, collect data from areas that represent specific similarity index or forage value ratings for the rangeland ecological site in a single production year. This procedure will be used for all kinds and uses of grazing lands.

(2) Estimating production and composition of an area

Use the following procedure to estimate similarity index of a rangeland ecological site, areas of different similarity indices within a rangeland ecological site, and forage value rating of a forestland ecological site or a native pasture group:

- Estimate production, in pounds per acre or kilograms per hectare, of individual species in the area.

- Compute composition, by weight, of the area from estimated production data. Sample the production on a series of random plots.
- Compute average production of the plots in terms of pounds per acre or kilograms per hectare, to further check these estimates for the area as a whole, harvest or double sample.
- Using these average figures, compute average composition. Although by using this procedure some species of minor importance may be missed, the procedure provides a useful check on estimates.
- Repeat this procedure until proficiency is attained. To gain proficiency, double sample within a range of similarity indices in several rangeland ecological sites each year.

(3) Inventorying composition for conservation planning

During conservation planning, it is often necessary to determine plant composition when plant growth is not ideal for making such determinations. Some grazing units are grazed at the time of planning. In places, estimates must be made at different stages of plant growth or when plant vigor varies from grazing unit to grazing unit. In some years production is obviously much higher or much lower than normal because of weather extremes. In making production estimates, therefore, it is often necessary to mentally reconstruct plant growth as it would most likely appear if undisturbed at the end of an average growing season. Adjustments or reconstruction must be made for percent of growth made during the year, percent of growth grazed or otherwise lost, and for air dry percentages.

(4) Determining production of tree or large shrub vegetation on rangeland

Rangeland ecological site descriptions are to include composition, by weight, of trees that are part of the climax plant community. Determining production of trees and large shrubs by harvesting portions of stands is time consuming and impractical for regular field conservation planning procedures. Research scientists are devising methods for calculating current production of some species on the basis of measurements of such factors as crown width or height and basal area.

These data are to be used in estimating the annual production of trees and large shrubs. Range management specialists, pasture specialists, and foresters work together to prepare production guides for various kinds of understory and tree stands for use by field office personnel. Range management specialists are to use the following procedures in preparing guides for rangeland:

- Select a few sample trees for each species. Samples should reflect variations in tree size, form, and spacing.
- Determine current production of sample trees.
- Determine production through a combination of estimating and harvesting. For estimates, establish appropriate weight units. These units can be an entire small tree or a branch or cluster of branches from large trees (see exhibit 4–1). Determinations from sample trees should include all components of current production except bark and wood of other than current twigs. Current leaf and twig production can be easily identified for some species. For these species, current leaf growth can be collected. Field determinations of production can be based on current leaf production only if data are available to indicate the percentage that various components contribute to total production. For example, Utah research shows that current production of balsam fir and Utah juniper is about 30 percent of the total foliage. Current production of these two species can be calculated by determining the total foliage present, then multiplying by 0.30 and adding to this figure the current fruit (cone) production. For species requiring 2 years for fruit maturity, half the weight of mature fruit represents the current production of fruit.
- Expand estimates to plots 0.1 acre or larger. Record production for each tree or large shrub. If the 0.1- or 0.01-acre or the 400-square meter plots are used in stands of trees, the likelihood of the plot boundary hitting the bole of a tree is high. If this happens exclude the first hit tree and include the second hit and so on or vice versa. Also describe the appearance and aspect of the plot. List component species, tree size, growth forms, number of trees, and density of the canopy.
- Repeat this process for stands of various kinds of trees or large shrubs. On the basis of data

thus collected, prepare guides that list the approximate annual production of stands of various kinds of trees or large shrubs (see exhibit 4–4).

(e) Methods for determining utilization of key species

The main purpose for determining utilization is to consider whether adjustments are needed in grazing management or stocking rate. Determining the actual use of key grazing areas is only one of the factors considered in assessing the status of plant communities. Other factors, such as trend, similarity index, and the status of rangeland health attributes, must be considered. The degree of use of one or more plant species in a key grazing area does not measure the total amount of forage that grazing animals can consume. If the key species and key grazing areas are correctly selected, it is an index of the degree of grazing use for the total plant community. Use the following methods to determine forage utilization.

(1) Weight comparisons of grazed versus ungrazed plants

Ungrazed plants of the key species occurring within movable enclosures, located in key grazing areas at the beginning of the grazing season, are cut and weighed. The weight of these plants is then compared with that of grazed plants of the key species clipped near the enclosures. As an alternative, the clipped weight of grazed plants can be compared with that of ungrazed plants of the key species selected at random in the key grazing area. If ungrazed plants of the species are not available, ungrazed plants from the nearest comparable location can be used.

(2) Determining percentage of grazed versus ungrazed plants

This method applies where evaluations relating the percentage of grazed versus ungrazed plants of a species to the percentage removal by weight have been determined locally. After the percentage of grazed versus ungrazed plants of the key species in the key grazing area is determined, the percentage removal is determined using charts and graphs prepared during previous evaluations.

(3) Use of grazed-class photo guides

In some locations, series of photographs illustrating various degrees of grazing use, expressed in percentage by weight, are available for some plant species. Guides based on actual clipping and weighing of plants of the key species provide a relatively simple and rapid means of determining approximate grazing use. Such guides should be used only in the locality where they are prepared and only for the plant species specifically appraised. The procedure is to visually compare a series of plants of the key species with photographs illustrating various degrees of plant use and to tally the number of plants occurring in each grazed class. Extremes in growing condition must be considered when using photo guides.

(4) Ocular estimates of percentage grazed

Qualified conservationists who are trained and experienced in making actual weight comparisons of grazed versus ungrazed plants can make ocular estimates of the percentage removal of key species in a key grazing area. If this method is used, it is important to demonstrate the actual weight procedure to the cooperator on one or more grazing units.

(5) Determining utilization of browse plants

Even though the degree of utilization of current growth of browse plants is an important factor, it does not provide all the information needed for properly planning and managing rangeland for use by wildlife or livestock. Moreover, it is impractical to make current utilization estimates at such times as during the early part of the growing season or before current use has taken place on seasonal range. In addition to the degree of utilization of current growth, several other indicators are of value in appraising the general trend in production of a stand of browse plants. These indicators often reveal more about the stand than current utilization alone. Also, they can be observed and interpreted at any time of the year. These indicators include:

- **Age classes of key plant species**—Age class is probably the most important single factor in judging trend in a stand of browse plants. If all plants are mature, the stand is not maintaining itself and will thin out as older plants die. The presence of adequate numbers of seedlings and young plants of the key species is indicative of a healthy, self-perpetuating stand. Browse plants generally do not reproduce every year, but at least several age classes should be represented in a healthy stand. Animals usually prefer seedlings and young plants; consequently, a degree of use that may be proper for mature plants often results in overutilization of younger plants.

- **Evidence of hedging of the key plant species**—The degree of hedging reflects past use and also the productive ability of browse plants. Moderate hedging may be desirable for some species because it stimulates growth and keeps plants from growing out of reach of animals. Severe hedging results in the death of many branches and if continued for a long time may cause death of entire plants. If only a single year's growth extends beyond old hedged contours, recent use has been heavy. Parts of two or more years' growth beyond old hedged contours suggest that browsing pressure has recently been reduced and that trend is upward.
- **Use of plant growth more than 1 year old**—Generally, when overall utilization is heavy, browsing animals often consume parts of plants that are older than the current growth. Continued use of older growth results in rapid decline and death of plants.
- **Evidence of browse lines**—If a browse line is readily apparent, plant growth within reach of animals has declined. Very distinct browse lines indicate that plants have already grown beyond the reach of animals. Such plants may be vigorous and productive because of unused growth above reach of animals, but they produce little or no available forage.
- **Presence of dead twigs and branches**—Some mortality of plant parts is normal, but excessive amounts of dead or weak limbs, branches, twigs, or even entire plants indicate that past use was too heavy and that the stand is deteriorating.
- **Relative size of plant parts**—Light pruning or browsing often stimulates growth of leaves and sprouts to more than normal size. Continued heavy use, however, results in small and weak leaves, twigs, and fruiting stems. Repeated heavy use of sprouts gradually reduces their size. If properly used, species of root-sprouting ability produce sprouts following fire or other disturbances; however, weakened plants do not. Overutilization reduces or eliminates fruit and seed production.
- **Significant use of low-preference species**—Plants of low preference are ordinarily lightly used unless species of higher preference are not available or have been too heavily used. If significant use is made of a species that animals ordinarily use sparingly or not at all, the key species is being abused.
- **Amount of reproduction of low-preference species**—Excessive reproduction of a low preference species generally indicates that the key species has declined to the extent that it is unable to compete with other plants.
- **Condition of animals**—The physical condition and reproductive ability of game animals or livestock reflect the amount and quality of plants available for forage. This indicator is not infallible because animals may remain in good condition for a while, even on seriously abused ranges, as long as succulent growth is available. Also, supplemental feeding of livestock often masks the effect of inadequate natural forage supplies.

None of the indicators, by itself, is a completely reliable indicator of the overall utilization of the plant community. All evidence must be carefully evaluated as a basis for determining needed adjustments in management or stocking and for determining needed harvest of game animals using the range.

The Browse Resource Evaluation worksheet (see exhibit 4–5) can be used for judging composition, trend, and utilization of the browse plant resource. Examples 4–1 and 4–2 illustrate how to use the worksheet. Example 4–1 records the determination of trend in June 1994 and records utilization during the next three fall and winter seasons. Example 4–2 illustrates the same location in July 1997 following a prescribed burn. The change in trend is recorded, and utilization will be recorded at the appropriate time.

Example 4–1 Completed Browse Resource Evaluation worksheet showing trend and utilization

Example - Browse Resource Evaluation

Cooperator: B.J. Smith
Ecological site: Low Stony Hill
Pasture: Lower Canyon
Location in pasture: 3/4 mile N of spring
Kinds of browsing animals: Goats, deer
Examiner: L. Jones
Goals for browse resource: Recovery of preferred species; Reduction in juniper

Date of initial evaluation: 6 / 12 / 94

	Browse composition			Browse trend					
	Occurrence			Hedging or browse line			Reproduction		
	Abundant	Common	Scarce	Not evident	Moderate	Severe	Abundant	Adequate	Not adequate
Preferred species									
Mt. mahogany		X				X		X	
Spanish oak		X				X			X
Hackberry		X				X			X
Redbud		X				X		X	
Desirable species									
Shin oak	X				X			X	
Evergreen sumac	X				X			X	
Non-preferred species									
Juniper	X			X			X		
Persimmon		X			X		X		

Browse composition

Judge composition and trend based on majority of evidence

- X Good
- Fair
- Poor

Browse trend

- Upward
- Stable or not apparent
- X Downward

Note: Goats removed Dec. 94; Deer only in 95; Presburn Feb. 96; Goats in summer 96.

Utilization of current year's growth

Key species	Season of use	Planned use percent	Actual use percent — Years: 94	95	96					
Mt. mahogany	Sp-fall	50	80+	70	60					
Hackberry	Sp-fall	50	80+	60	60					
Shin oak	Sp-fall	50	65	20	35					
EG sumac	Yearlong	50	50	20	35					
Date observed			12-4	10-9	11-6					

Example 4–2 Completed Browse Resource Evaluation worksheet showing change in trend at same site as used in example 4–1

Example - Browse Resource Evaluation

Cooperator: B.J. Smith
Ecological site: Low Stony Hill
Pasture: Lower Canyon
Location in pasture: 3/4 mile N of spring
Kinds of browsing animals: Goats, deer
Examiner: L. Jones
Goals for browse resource: Continue recovery of preferred species

Date of initial evaluation: 7 / 30 / 97

	Browse composition			Browse trend					
	Occurrence			Hedging or browse line			Reproduction		
	Abundant	Common	Scarce	Not evident	Moderate	Severe	Abundant	Adequate	Not adequate
Preferred species									
Mt. mahogany			X			X		X	
Spanish oak		X			X			X	
Hackberry		X			X			X	
Redbud		X			X		X		
Desirable species									
Shin oak	X			X			X		
Evergreen sumac	X			X			X		
Flameleaf sumac			X		X		X		
Non-preferred species									
Juniper			X	X					X
Persimmon		X		X				X	

Browse composition

Judge composition and trend based on majority of evidence

	Browse composition	Browse trend
Stippled (X)	Good	Upward
White	Fair	Stable or not apparent
Gray	Poor	Downward

Note: Fire killed much mahogany; Fire killed all juniper; Sumacs invigorated by fire.

Utilization of current year's growth

Key species	Season of use	Planned use percent	Actual use percent (Years)							
Mt. mahogany	Sp-fall	50								
Hackberry	Sp-fall	50								
Shin oak	Sp-fall	50								
EG sumac	Yearlong	50								
		Date observed								

Many other factors should be considered in determining utilization of rangeland. Following are some that should be considered when working with the landowner:

- Although the degree of use or the lack of use of each plant species in a grazing unit is of interest and affects the nature of plant communities in the grazing unit, determining the use of each species is neither practical nor essential.

  — Averaging the degree of use of many species having widely different degrees of use and grazing preference values does not provide a meaningful answer to utilization or to the impact of such utilization on the plant community.

  — Nonuse or light use of a species of negligible grazing preference does not compensate for heavy use of a species having high grazing preference.

  — To determine the use status of a grazing unit, the acreage that is properly used and overused must be determined. The intent of grazing management is to prevent excessive use of grazing areas, or at least to reduce the excessively used acreage to a reasonable minimum. Most grazing units have small areas of natural livestock concentration, such as those immediately adjacent to water. These areas often are excessively used even when the entire grazing unit is properly grazed. If areas of excessive use do not exceed 3 to 5 percent of the grazing unit, the grazing unit may be considered properly used.

- To determine the degree of grazing use of key species, make the determination at or near the end of the planned grazing period.

  — For grazing units grazed on a continuous yearlong basis, make the final determination shortly before the beginning of a new growing season.

  — For grazing units grazed early every spring, rested in summer, and grazed again in fall, determine the degree of use at or near the end of each grazing period.

  — For grazing units in some type of planned grazing rotation, determine use near or at the end of the planned grazing period of each grazing unit. If grazing units are grazed more than once during the year, make the determination near the end of the last grazing period preceding the beginning of a new growth season.

- A determination of degree of use at or near the end of the grazing period serves to indicate the final utilization of grazing units. This is too late, however, to permit needed adjustments in grazing during the current season and is, in effect, a postmortem determination.

Conservationists should help cooperators make forage production and utilization determinations and trend observations well before the end of the scheduled grazing period, preferably before two-thirds of the period has passed. If determinations are made this early, enough time remains to adjust animal numbers or the length of the grazing period to avoid overuse of plants during years of poor production or to take advantage of extra forage in more favorable years.

600.0402 Evaluating and rating ecological sites

Ecological sites are evaluated with the landowner during the inventory phase of the planning process so that a greater level of understanding of the rangeland resource can be achieved by both the NRCS employee and the landowner. The inventory process and evaluations of ecological sites provide the opportunity to work with the landowner to identify resource problems and concerns, as well as opportunities to maintain or improve the resource, and increase the knowledge level of the landowner.

An ecological site may be evaluated in at least three distinct, but associated ways. Although these three methods are associated, they are not interchangeable. These evaluations and ratings cannot be extrapolated from one to the other.

The first method of rating is **trend**. Trend determines the direction of change occurring on a site. It provides information necessary for an operational level of management to ensure the direction of change will enhance the site and meet the manager's objectives.

Similarity index is another method to evaluate an ecological site. This method compares the present plant community to the historic climax plant community for that site or to a desired plant community that is one of the site's potential vegetation states. The similarity index to the historic climax plant community is the percentage, by weight, of historic climax vegetation present on the site. Likewise, a similarity index to a desired plant community is the percentage, by weight, of the desired plant community present on the site. As the name implies, this method assesses the similarity of the plant community to the historic climax or desired plant community. This can provide an indication of past disturbances, as well as future management or treatment, or both, needed to achieve the client's objectives.

Rangeland health provides a third way to assess ecological sites. Qualitative assessments of rangeland health provide land managers and technical specialist with a good communication tool for evaluating ecological processes and can assist to identify potential areas at risk of degradation.

Conservation planning assistance to rangeland owners and managers includes the following:

- Trend assessments (rangeland trend or planned trend) will be made, provided the appropriate plant communities are known and described in the ecological site descriptions, on the predominant rangeland ecological sites and key areas within their operating unit.
- Similarity index to the historic climax plant community or desired plant community will be determined.
- If appropriate, rangeland health ecological attributes evaluations will also be made.
- Professional judgment, based on experience and knowledge of the rangeland ecosystems, will be required to decide which rating techniques should be used on an individual rangeland unit.

(a) Trend

Trend is a rating of the direction of change that may be occurring on a site. The plant community and the associated components of the ecosystem may be either moving toward or away from the historic climax plant community or some other desired plant community or vegetation state (rangeland trend or planned trend). At times, it can be difficult to determine the direction of change.

The kind of trend (rangeland trend or planned trend) being evaluated must be determined. This rating indicates the direction of change in the plant community on a site. It provides information necessary for the operational level of management to ensure that the direction of change will enhance the site and meet the objectives of the manager. The present plant community is a result of a sustained trend over a period of time.

Trend is an important and required part of a rangeland resource inventory in the NRCS planning process. It is significant when planning the use, management, and treatment needed to maintain or improve the resource. The trend should be considered when making adjustments in grazing management.

(1) Rangeland trend

Rangeland trend is defined as the direction of change in an existing plant community relative to the historic climax plant community. **It is only applicable on rangelands that have ecological site descriptions identifying the historic climax plant community.** It can be determined as apparent trend or measured trend. *Apparent trend* is a point in time determination of the direction of change. *Measured trend* requires measurements of the trend indicators over a period of time. Rangeland trend is monitored on all rangeland ecological sites. It is described as:

Toward—moving towards the historic climax plant community

Not apparent—no change detectable

Away from—moving away from the historic climax plant community

(2) Planned trend

Planned trend is defined as the change in plant composition within an ecological site from one plant community type to another relative to management objectives and to protecting the soil, water, air, plant, and animal resources (SWAPA). It is described as:

Positive—moving towards the desired plant community or objective.

Not apparent—change not detectable.

Negative—moving away from the desired plant community or objective.

Planned trend provides feedback to the manager and grazing land specialist about how well the management plan and prescribed grazing are working on a site-by-site basis. It can provide an early opportunity to make adjustments to the grazing duration and stocking levels in the conservation plan. **Planned trend is monitored on all native and naturalized grazing land plant communities. It may be determined on any ecological site where a plant community other than the historic climax plant community is the desired objective.**

(3) Attributes for determining trend

Exhibit 4–6 is a worksheet for determining range and planned trend. The relative importance of the trend factors described vary in accordance with differences in vegetation, soils, and climate. Evaluating any one of these factors on an ecological site may indicate whether the plant community is improving or declining. A more accurate evaluation of trend, however, can be ascertained if all or several of the factors are considered in their proper relation to each other.

(i) Composition changes—Native plant communities evolve within their environment and slowly change over time as environmental factors change. Major short-term changes in the plant composition, however, do not normally occur unless induced by significant disturbances. Disturbances, such as continued close grazing by livestock, severe or prolonged drought, abnormally high precipitation, exotic species invasion, or unnatural burning frequencies, can cause major changes in plant communities.

If the plant community is changing as a result of prolonged grazing, the perennial species most sensitive to damage by grazing decrease. This may lead to a relative increase in species of lower forage value or successional stages, or both. When improved management has occurred in areas where the plant cover has been severely depleted, increases in low-quality plants may indicate improvement since these plants may be the first to respond.

When disturbances that caused a decline in plant community are removed, the present plant community may react in one of several ways. It may appear to remain in a steady or static state while it moves along one of several transition pathways leading to one of several identifiable plant communities including the historic climax plant community.

Original species that have declined in amount because of past misuse will often increase over time. For this to occur, seed or vegetative parts must still be available, growing conditions be similar (soil profile, hydrologic characteristics, microclimate), and space for re-establishment must be available and must not have been displaced by other species, for example, exotic annual and perennial grasses, forbs, shrubs, or trees.

Once established, certain woody and some other long-lived perennial plants may persist and may require high energy expenditures, such as prescribed burning, herbicide application, mechanical treatment, or other applications of supporting practices if the decision-maker desires to remove them.

The invasion of plants on the site indicates a major change in the present plant community. Some invaders, particularly annuals, may flourish temporarily in favorable years, even when existing plant community is moving towards management objectives. A significant, though temporary, increase in annuals and short-lived perennials may also occur during a series of wet years even though general trend is toward objectives.

Changes in plant composition from one plant community type to another generally follow a pattern. Although all changes in amounts of species on a site are not always predictable, general successional patterns for specific sites, plant species, climates, and rangeland uses often can be predicted. These successional changes in plant composition are generally not linear and vary because of localized climatic history and past use patterns.

(ii) Abundance of seedlings and young plants—Changes in a plant community depend mainly on successful reproduction of the individual species within the community. This reproduction is evidenced by young seedlings, plants of various ages, and tillers, rhizomes, and stolons. The extent to which any of these types of reproduction occurs varies according to the growth habits of the individual species, site characteristics, current growing conditions, and use to which the plant is subjected. In some plant communities, reproduction is often largely vegetative so the mere absence of seedlings does not always indicate a change in plant community. A significant number of seedlings and young plants of species indigenous to the site, however, usually indicates a positive trend. Variations in seedling recruitment resulting from abnormal weather patterns should be recognized.

(iii) Plant residue—The extent to which plant residue accumulates depends primarily on the production level of the plant community; the amount of plant growth removed by grazing, haying, fire, insects, wind, or water; and the decomposition rate of the plant biomass on the site. In hot and humid climates, the rate of decomposition of plant residue may be so great that little or no net accumulation occurs. Conversely, in cold climates decomposition is generally slow. When using plant residue to judge trend in plant community, careful consideration should be given to the level of accumulation that can be expected for the specific ecological site, plant species, and climate.

Excessive grazing, below-normal production, recent fires, and abnormal losses caused by wind or water erosion may result in an accumulation of plant residue below that considered reasonable for the site. In the absence of these factors, progressive accumulation of plant residue generally indicates positive changes in the plant community. Residue may accumulate rapidly for some kinds of plants, especially woody species or annuals. When the amount characteristic for the historic climax plant community is exceeded, such accumulations of residue are not necessarily an indication of an improving plant community.

(iv) Plant vigor—Plant vigor is reflected primarily by the size of a plant and its parts in relation to its age and the environment in which it is growing. Many plants that form bunches or tufts when vigorous may assume a sod form if their vigor is reduced. Length of rhizomes or stolons is also a good indication of the vigor of a parent plant; these parts are usually fewer and shorter if a plant is in a weakened status. Periodic drought is common in many rangeland environments and will lower the apparent vigor and annual productivity of ecological sites while often retaining their current plant community.

Cryptogams develop new growth during growing periods that adds to the total structure and biomass of the plant. When considerable amounts of live cryptogamic material are destroyed, several years may be required for these plants to fully replace lost tissue.

(v) Condition of the soil surface—Unfavorable conditions of the soil surface may significantly affect trend. Compaction, splash erosion, and crusting may occur if plants or plant residue are lacking on the soil surface.

Compaction and crusting impede water intake, inhibit seedling establishment and vegetation propagation, and induce higher soil surface temperature. These conditions often increase rates of water runoff and soil loss, reduce effective soil moisture, and generally result in unfavorable plant, soil, and water relationships. Improvement in the plant cover following good management is delayed if such soil conditions exist. Bare ground, soil crusting, stone cover, compaction from trampling, plant hummocking, or soil movement may indicate a negative trend in a plant community.

These soil indicators, however, are sometimes misleading. They can occur naturally under certain circumstances. For example, plant hummocking is natural—on silty soil sites that are subject to frost heaving.

Other sites do not support a complete plant cover. Bare ground crusting, stones on the soil surface, and localized soil movement may be completely natural. Even when induced by misuse, the soil surface trend indicators are not nearly as sensitive as those changes in the plant cover.

(b) Similarity index

The present plant community on an ecological site can be compared to the various common vegetation states that can exist on the site. To make the comparison, these vegetation states or plant communities must be described in sufficient detail in the ecological site description. This comparison can be expressed through a similarity index, which is the present state of vegetation on an ecological site in relation to the kinds, proportions, and amounts of plants in another vegetation state possible on the site. A similarity index is expressed as the percentage of a vegetation state plant community that is presently on the site. When determining a similarity index, the vegetation state or plant community that the present plant community is being compared to must be identified as the reference plant community.

Similarity index to historic climax plant community is defined as the present state of vegetation on an ecological site in relation to the historic climax plant community for the site. It is expressed as the percentage, by weight, of the historic climax plant community present on the site. The similarity index to historic climax provides a measurement of change that has taken place on a site. The similarity index to historic climax is the result of how climate and management activities have affected the plant community on a site.

(1) Purpose for determining similarity index

The purpose for determining similarity index to historic climax is to provide a basis for describing the extent and direction of changes that have taken place and predicting those that can take place in the plant community because of a specific treatment or management. The ecological site description indicates the historic climax plant community for the site; similarity index to historic climax represents the percent of the historic climax plant community present on the site. These evaluations provide the manager with the starting point for establishing objectives and developing management goals. These goals can result in a change in the present plant community toward a community desired by the decisionmaker that meets the needs of the soil, water, air, plant, and animal resources, as well as those of the manager.

As ecological site descriptions are revised and further developed, they are to include descriptions of other common vegetation states that can exist on the site. A similarity index to each of these or any of these will also indicate the present state of the site.

(2) Determining similarity index to historic climax plant community

The similarity index to historic climax plant community for areas within an ecological site is determined by comparing the present plant community with that of the historic climax plant community, as indicated by the ecological site description.

The existing plant community must be inventoried by recording the actual weight, in pounds, of each species present. The production of each species must be reconstructed to reflect total annual production. See exhibit 4–7 for reconstruction procedure. The reconstructed total production by species of the existing plant community is compared to the production of individual species in the historic climax plant community. For the similarity index determination, the allowable production of a species in the existing plant community cannot exceed the production of the species in the historic climax plant community. If plant groups are used, the present reconstructed production of a group cannot exceed the production of the group in the historic climax plant community. All allowable production is then added together. This total weight represents the amount of the historic climax plant community present on the site.

The relative similarity index to the historic climax plant community is calculated by dividing this total weight of allowable production by the total annual production in historic climax shown in the site description for the normal year. This evaluation expresses the percentage of the historic climax plant community present on the site.

Example 4–3 Determination of similarity index of historic climax

Example - Determination of similarity index to historic climax

Cooperator Rockin' Raindrop Ranch
Ecological Site Loamy Upland 12-16 PZ
Reference Plant Community Native midgrass (HCPC)
Conservationist Someone's name
Location Center of Horse Pasture
Date 8/30/96

A Plant group	BC Species name	C Pounds/acre in reference plant community (from ecological site description)	D Annual production in lb/a (Actual or reconstructed)	E Pounds allowable
1	Sideoats grama and			
	others from Group 1	450	25	25
2	Blue grama and			
	others from Group 2	200	25	25
3	Threeawn species	75	40	40
4	Bush muhley and	75	25	25
	others from Group 4			
5	Curly mesquite and			
	others from Group 5	30	20	20
6	Fall witchgrass and			
	others from Group 6	30	30	30
7	Six weeks threeawn &			
	others from Group 7	30	15	15
8	Wild daisy and others			
	from Group 8	125	5	5
9	Tansy mustard and			
	others from Group 9	10	5	5
10	Range ratany and			
	others from Group 10	75	50	50
11	Jumping cholla and			
	others from Group 11	30	160	30
12	Mesquite and others			
	from Group 12	15	600	15
TOTALS		1,145	1,000	285

SIMILARITY INDEX to Mesquite-Short Grass Community = 25 %
(Total of E divided by total of C)

Example 4–3 illustrates how the similarity index to historic climax is determined on a loamy upland 12–16 PZ ecological site. (Refer to chapter 3, exhibit 3–3 for the site description.) Note: This example shows only one plant from each group of plants described in the ecological site description. This is for illustrative purposes to show the calculation of the similarity index. In actual practice, it is desirable to list each plant found in the sample transect. This example assumes the current plant community has been reconstructed to actual annual production. (See exhibit 4–7 for this procedure.) Some areas of the United States have plant communities where, because of landscape position and climatic factors, vegetative composition is greatly influenced by episodic events. For example, in desert areas of the Southwest, many watersheds are composed of very shallow soils or very little soil and considerable exposed bedrock. Intense summer thunderstorm events create high volume catastrophic runoff that flows in confined drainage ways through low-lying landscapes. Although these rainfall events may occur relatively infrequently, these high intensity, concentrated flows can and do totally remove all vegetation occurring within drainage ways and cause severe disruption of the normal plant community dynamics. In these situations, ratings of similarity index to historic climax generally are not appropriate. Secondary succession is constantly in progress with a stable plant community seldom being obtained because of the episodic nature of catastrophic events.

Similarity index to historic climax is not appropriate on sites that have been planted to single species forage plants.

(3) Determining similarity index to other vegetation states or desired plant community

In the inventory phase, determining the similarity index to one or more of the possible vegetation states in the site description may be desirable. After the landowner has identified goals, a particular vegetation state may be identified as the desired plant community.

Once a desired plant community has been identified, it is appropriate to determine the similarity index to the desired plant community during follow-up monitoring.

To determine the present plant community's similarity index to a specific plant community, the specific plant community must be adequately described as a common vegetation state in the ecological site description. It must be described by species and the expected production by weight of species or by groups of species, as well as the expected normal total annual production.

The similarity index to other vegetation states for areas within an ecological site is determined by comparing the present plant community with that of the other vegetation state plant community, as indicated in the ecological site description.

The existing plant community must be inventoried by recording the actual weight, in pounds, of each species present. The production of each species must be reconstructed to reflect total annual production. The reconstructed annual production by species of the existing plant community is compared to the production of individual species in the specific vegetation state plant community. For the similarity index determination, the allowable production of a species in the existing plant community cannot exceed the production of the species in the specific vegetation state plant community. If plant groups are used, the existing production of a group cannot exceed the production of the group in the specific vegetation state plant community. All allowable production is then added together. This total weight represents the amount of the specific vegetation state plant community present on the site.

The relative similarity index to the specific vegetation state plant community is calculated by dividing this total weight of allowable production by the total annual production in vegetation state shown in the site description for the type year (above average, average, below average). This evaluation expresses the percentage of the vegetation state plant community present on the site.

Examples 4–4, 4–5, and 4–6 show similarity index determinations to some of the other vegetation states described in the loamy upland 12 –16 PZ. These determinations use the same transect data used in example 4–3. (Refer to chapter 3, exhibit 3–3, for the site description.) **Note:** This example shows only one plant from each group of plants described in the ecological site description. This is for illustrative purposes to show the calculation of the similarity index. In actual practice, it is desirable to list each plant found in the sample transect. This example assumes the current plant community has been reconstructed to actual annual production. (See exhibit 4–7 for this procedure.)

Example 4–4 Determination of similarity index to the mesquite-short grass vegetation state

Example - Determination of similarity index to the mesquite-short grass vegetation state on loamy upland 12-16 PZ site

Cooperator Rockin' Raindrop Ranch
Ecological Site Loamy Upland 12-16 PZ
Reference Plant Community Mesquite-Short Grass
Conservationist Someone's name
Location Center of Horse Pasture
Date 8/30/96

A	BC	C	D	E
Plant group	Species name	Pounds/acre in reference plant community (from ecological site description)	Annual production in lb/a (Actual or reconstructed)	Pounds allowable
1	Sideoats grama and			
	others from Group 1	35	25	25
2	Blue grama and			
	others from Group 2	350	25	25
3	Threeawn species	35	40	35
4	Bush muhley and	0	25	0
	others from Group 4			
5	Curly mesquite and			
	others from Group 5	75	20	20
6	Fall witchgrass and			
	others from Group 6	0	30	0
7	Six weeks threeawn &			
	others from Group 7	0	15	0
8	Wild daisy and others			
	from Group 8	35	5	5
9	Tansy mustard and			
	others from Group 9	0	5	0
10	Range ratany and			
	others from Group 10	35	50	35
11	Jumping cholla and			
	others from Group 11	0	160	0
12	Mesquite and others			
	from Group 12	100	600	100
TOTALS		665	1,000	245

SIMILARITY INDEX to Mesquite-Short Grass Community = 37 %
(Total of E divided by total of C)

Example 4–5 Determination of similarity index to native-short grass vegetation state

Example - Determination of similarity index to the native-short grass vegetation state on loamy upland 12-16 PZ site

Cooperator Rockin' Raindrop Ranch
Ecological Site Loamy Upland 12-16 PZ
Reference Plant Community Native-Short Grass
Conservationist Someone's name
Location Center of Horse Pasture
Date 8/30/96

A	BC	C	D	E
Plant group	Species name	Pounds/acre in reference plant community (from ecological site description)	Annual production in lb/a (Actual or reconstructed)	Pounds allowable
1	Sideoats grama and			
	others from Group 1	35	25	25
2	Blue grama and			
	others from Group 2	350	25	25
3	Threeawn species	35	40	35
4	Bush muhley and	0	25	0
	others from Group 4			
5	Curly mesquite and			
	others from Group 5	100	20	20
6	Fall witchgrass and			
	others from Group 6	0	30	0
7	Six weeks threeawn &			
	others from Group 7	0	15	0
8	Wild daisy and others			
	from Group 8	35	5	5
9	Tansy mustard and			
	others from Group 9	0	5	0
10	Range ratany and			
	others from Group 10	75	50	50
11	Jumping cholla and			
	others from Group 11	trace	160	0
12	Mesquite and others			
	from Group 12	trace	600	0
TOTALS		630	1,000	160

SIMILARITY INDEX to Native-Short Grass Community = 25 %
(Total of E divided by total of C)

Example 4–6 Determination of similarity index to dense mesquite vegetation state

Example - Determination of similarity index to the dense mesquite vegetation state on loamy upland 12-16 PZ site

Cooperator Rockin' Raindrop Ranch
Ecological Site Loamy Upland 12-16 PZ
Reference Plant Community Dense Mesquite
Conservationist Someone's name
Location Center of Horse Pasture
Date 8/30/96

A Plant group	BC Species name	C Pounds/acre in reference plant community (from ecological site description)	D Annual production in lb/a (Actual or reconstructed)	E Pounds allowable
1	Sideoats grama and			
	others from Group 1	0	25	0
2	Blue grama and			
	others from Group 2	0	25	0
3	Threeawn species	35	40	35
4	Bush muhley and	35	25	25
	others from Group 4			
5	Curly mesquite and			
	others from Group 5	0	20	0
6	Fall witchgrass and			
	others from Group 6	0	30	0
7	Six weeks threeawn &			
	others from Group 7	0	15	0
8	Wild daisy and others			
	from Group 8	0	5	0
9	Tansy mustard and			
	others from Group 9	0	5	0
10	Range ratany and			
	others from Group 10	0	50	0
11	Jumping cholla and			
	others from Group 11	0	160	0
12	Mesquite and others			
	from Group 12	550	600	550
TOTALS		620	1,000	610

SIMILARITY INDEX to Dense Mesquite Community = 98 %
(Total of E divided by total of C)

(4) Reconstructing the present plant community

The existing plant community at the time of evaluation must be reconstructed to the total normal annual air-dry production before it can be compared with the reference vegetation state plant community. The reconstruction must consider physical, physiological, and climatological factors that affect the amount of biomass measured (weighed or estimated) for a species at a specific point in time. The present plant community is reconstructed by multiplying the measured weight of each species by a reconstruction factor. The reconstruction factor formula is :

$$\text{Reconstruction factor} = \frac{C}{(D)(E)(F)}$$

where:
C = percent of air-dry weight
D = percent of plant biomass of each species that has not been removed
E = percent of growth of each species that has occurred for the current growing season
F = percent of growth of each species that has occurred relative to normal growing conditions

Use the worksheet shown as exhibit 4–7 in the exhibits section to determine this factor.

(5) Worksheet for use in determining similarity index

Exhibit 4–7 is an example of a similarity index worksheet. Conservationists should determine similarity index of a site with the decisionmaker. If this is not possible, conservationists should review the similarity index inventory with the decisionmaker in enough detail to assure that it is fully understood. A worksheet for this purpose helps the decisionmaker to evaluate the plant communities and also serves as a record. Completed copies can be left with the decisionmaker or placed in his or her conservation plan folder. Completed worksheets are of value in monitoring changes or evaluating the effectiveness of management practices during subsequent evaluations of the same area.

(c) Rangeland health

Rangeland Health has been defined by an interagency committee as:

> *The degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the rangeland ecosystem are balanced and sustained. They defined integrity to mean maintenance of the functional attributes characteristic of a locale, including normal variability.*

(1) Purpose

Rangeland health assessment is designed to:

- be used only by knowledgeable, experienced people
- provide a preliminary evaluation of soil/site stability, hydrologic function, and integrity of the biotic community (at the ecological site level)
- help landowners identify areas that are potentially at risk of degradation
- provide early warnings of potential problems and opportunities
- be used to communicate fundamental ecological concepts to a wide variety of audiences in the field
- improve communication among interested groups by focusing discussion on critical ecosystem properties and processes
- select monitoring sites in the development of monitoring programs
- help understand and communicate rangeland health issues

Rangeland health assessment is not to be used to:

- identify the cause(s) of resource problems
- make grazing and other management decisions
- monitor land or determine trend
- independently generate national or regional assessments of rangeland health

The rangeland health assessment procedure was developed for use by experienced, knowledgeable rangeland professionals. It is not intended that this assessment procedure be used by individuals that do not have experience or knowledge of the rangeland ecological sites they are evaluating. This procedure requires a good understanding of ecological processes, vegetation, and soils for each of the sites to which it is applied. It relies on the use of a qualitative (nonmeasurement) procedure to assess the functional status of each indicator.

This current information incorporates concepts and materials from previous monitoring and inventory procedures, as well as from the National Research Council's book on Rangeland Health, and the Society for Range Management's Task Group on Unity in Concepts and Terminology (1995). Earlier versions of this procedure were developed concurrently by an interagency technical team led by the Bureau of Land Management and the Natural Resources Conservation Service as published in the National Range and Pasture Handbook (USDA 1997). An interagency team melded these concepts and protocols with the results from numerous field tests and numerous other comments to arrive at the process described herein. Along the way, this procedure has been termed rapid assessment, qualitative assessment of rangeland health, and visualization of rangeland health. The current version will be revised in the future as science and experience provides additional information on indicators of rangeland health and their assessment.

Relationship to similarity index and trend—The similarity index and trend studies have long been used to assess the conditions of rangeland. The similarity index is an index of where the current plant community is in relation to the historic climax plant community, or to a desired plant community that is one of the site's potential vegetation states. Trend is a determination of the direction of change in the current plant community and associated soils in relation to the historic climax plant community or some other desired plant community.

The rangeland health assessment is an attempt to look at how the ecological processes on a site are functioning. These three assessment tools (similarity index, trend, and rangeland health assessment) evaluate the rangeland site from different perspectives and are not necessarily correlated.

(2) Evaluating rangeland health ecological attributes

Ecological processes include the **water cycle** (the capture, storage, and safe release of precipitation), **energy flow** (conversion of sunlight to plant then animal matter), and **nutrient cycle** (the cycle of nutrients, such as nitrogen and carbon through the physical and biotic components of the environment).

Ecological processes functioning within a normal range of variation will support specific plant and animal communities. Direct measures of site integrity and status of ecological processes are difficult or expensive to measure because of the complexity of the processes and their interrelationships. Therefore, biological and physical attributes are often used as indicators of the functional status of ecological processes and site integrity.

The product of this qualitative assessment is not a single rating of rangeland health, but an assessment of three components, called attributes (table 4–1).

Definitions of the three interrelated attributes are:

Soil/Site Stability—The capacity of the site to limit redistribution and loss of soil resources (including nutrients and organic matter) by wind and water.

Hydrologic Function—The capacity of the site to capture, store, and safely release water from rainfall, run-on, and snowmelt (where relevant) to resist a reduction in this capacity and to recover this capacity when a reduction does occur.

Integrity of the Biotic Community—The capacity of the biotic community to support ecological processes within the normal range of variability expected for the site, to resist a loss in the capacity to support these

Table 4–1 The three attributes of rangeland health and the rating categories for each attribute

Soil/Site Stability	Hydrologic Function	Integrity of the Biotic Community

Attribute ratings are based upon departure from ecological site description in these categories:

Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight

processes, and to recover this capacity when losses do occur. The biotic community includes plants, animals, and microorganisms occurring both above and below the ground.

Based upon a *preponderance of evidence* approach for the applicable indicators, each of the three attributes of rangeland health are summarized at the end of the Rangeland Health Evaluation Sheet (exhibit 4–9). To reiterate, the process described here will produce three ratings, one for each attribute.

(3) Indicators

Unfortunately, ecological processes are difficult to observe or measure in the field because most rangeland ecosystems are complex. Indicators are components of a system whose characteristics (presence or absence, quantity, distribution) are used as an index of an attribute (rangeland health attribute) that is too difficult, inconvenient, or expensive to measure. Just as the Dow Jones Index is used to gauge the strength of the stock market, different combinations of the 17 indicators are used to gauge soil/site stability, hydrologic function, and biotic integrity. For each indicator, five descriptors are developed which reflect the range of departure from what is expected for the site: None to Slight, Slight to Moderate, Moderate, Moderate to Extreme, and Extreme to Total.

Indicators have historically been used in rangeland resource inventories. These indicators focused on vegetation (production, composition, density, and other such characteristics) or soil stability as indicators of rangeland condition or livestock carrying capacity. Such single indicator assessments are inadequate to determine rangeland health because they do not reflect nor assess the complexity of the ecological processes. There is no one indicator of ecosystem health; instead, a suite of key indicators should be used for an assessment.

Rangeland health evaluations provide information on the functioning of the ecological site. This evaluation provides information that is not available with other methods of evaluation. It gives an indication of the status of the three attributes chosen to represent the health of the area of interest (the area where the evaluation of the rangeland health attributes takes place). This interest may be due to concern about current condition, lack of information on condition, or public perceptions on the condition of the area of interest.

Evaluation area—The rangeland health evaluation is site specific using the rangeland ecological site description as the standard for comparison. The evaluation area (area of interest) should be large enough to include the natural variability associated with each ecological site being assessed. Upon arrival at the location, the evaluator(s) should identify the boundaries of the area of interest and walk 1 to 2 acres of the ecological site. This enables the evaluator(s) to become familiar with the plant species, soil surface features, and the variability of the area of interest.

Surrounding features that may affect ecological processes within the area should also be noted. The topographic position, adjacent roads, trails, watering points, gullies, timber harvests, and other disturbances can all affect onsite processes. The topographic position should be carefully described with documentation of off-site influences. There is significant variability in the potential of different sites associated with relatively minor differences in landscape position and soils (differences in aspect or location at the top vs. bottom of a slope).

Development of the ecological site reference sheet—The reference sheet describes the status of each indicator for the reference state (exhibit 4 –8). It serves as the primary reference for the evaluation. The reference sheet describes a range for each indicator based on expected spatial and temporal variability within each ecological site. The reference sheet becomes the standard for the evaluation of each of the indicators. The development of the reference sheet is an important process that must be accomplished prior to any rangeland health assessments. Reference sheet are being included in the ecological site description format and development. It is not possible to conduct a rangeland health assessment without a reference sheet. The development of the reference sheet requires at least as much expertise as the assessment process and is a five-step process:

Step 1. Assemble a diverse group of experts with extensive knowledge of the ecological site. Individuals should include those who have long-term knowledge of the variability and dynamics of the site, in addition to rangeland professionals who understand soil-climate-vegetation relationships.

Step 2. Provide group with all available sources of information. Sources of information include relevant scientific literature and ecological site descriptions. Data obtained in support of the development of site descriptions and monitoring and inventory data from the ecological site.

Step 3. Define functional and structural groups on the site. The discussion of the functional and structural groups on the site provides an opportunity to discuss the functioning of the site from an ecological process standpoint and gets all involved in the same mindset. Functional and structural groups are defined by such attributes (but not limited to) as the photosynthetic pathways, lifeform, nitrogen fixation ability, rooting structure, above ground structure.

Step 4. Visit reference areas and other examples of the variability of the ecological site.

Step 5. Describe the status of each indicator in the reference state for the ecological site. This description should be quantitative where possible and include ranges based on the natural range of variability for the reference state of the ecological site.

Review/modify descriptors of indicators for the rangeland ecological site—Ideally, each ecological site will have a unique set of descriptors (narrative under the five categories) for each indicator. In lieu of this, a set of standard or generic descriptors (called default descriptors) has been developed for each indicator, and each descriptor is listed in the Rangeland Health Evaluation Matrix (exhibit 4–10). These descriptors are used in the evaluation if they fit the observations on the indicators on the Rangeland Ecological Site Description. If the default descriptor does not fit an indicator, the evaluator(s) should modify the descriptor in the revised descriptor space that is below the default descriptor.

This Rangeland Health Evaluation Matrix with the revised descriptors should be used on subsequent evaluations on that same rangeland ecological site. Therefore, it is important to fill out the site documentation information at the top of this matrix if any of the descriptors are revised.

These modifications in the descriptors will aid in the ongoing development of rangeland ecological site specific indicators and descriptors. Copies of the Rangeland Health Evaluation Matrix with the modified descriptors should be forwarded to the person responsible for maintaining rangeland ecological site descriptions in the state (usually the NRCS state rangeland management specialist) for approval Rangeland Health Evaluation Matrix will be developed for each rangeland ecological site and any modification must be approved by the NRCS state rangeland management specialist or other designated individual.

Soil/site stability indicators are more likely to require these changes because of the inherently higher erosion potential on certain ecological sites. Example 4–7 shows changes in the descriptor narrative for the bare ground indicator.

Rate the 17 indicators—The evaluator(s) selects the category descriptor (narrative) that most closely describes the site for each indicator on the Rangeland Health Evaluation Matrix and records it on the Rangeland Health Evaluation Sheet. The rating for each indicator in the area of interest is based on that indicator's degree of departure from the rangeland ecological site description.

Narrative descriptions in the Rangeland Health Evaluation Matrix are intended to aid in the determination of the degree of departure. The narrative descriptors for each indicator form a relative scale from Extreme to Total to None to Slight. Not all indicator descriptors will match what is observed requiring a "best fit" approach in making the ratings. The rating for each indicator should be supported by comments in the space provided under each indicator rating. In some instances there may be no evidence of the indicator in the area of interest, thus it will be rated None to Slight.

The revised descriptor for an indicator is used to rate indicators if the default description on the Rangeland Health Evaluation Matrix did not adequately represent the range and status of an indicator in the ecological site description.

When making an assessment, the effects of natural disturbances (drought, fire) should be considered. For example, if a fire occurred 5 years ago in the area being assessed, reduced shrub (sagebrush) cover is not an indication of lack of biotic integrity if the natural processes alone are sufficient to allow recovery of the original plant community.

Example 4–7 Revised descriptor for the bare ground indicator

Indicator	Degree of departure from the reference state for the ecological site				
	Extreme to Total	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
4. (Revised descriptor)	Greater than 75% bare ground with entire area connected. Only occasional areas where ground cover is contiguous, mostly patchy and sparse	60–75% bare ground. Bare patches are large (>24-inch diameter) and connected. Surface disturbance areas becoming connected to one another. Connectivity of bare ground broken occasionally by continuous ground cover	40–60% bare ground with much connectivity especially associated with surface disturbance. Individual bare spaces are large and dominate the area	30–45% bare ground; bare spaces greater than 12-inch diameter and rarely connected. Bare areas associated with surface dis-turbance are larger (>15 inch) and may be connected to other bare areas	20–30% bare ground; bare patches should be less than 8 to 10-inches in diameter and not be connected; occasional 12 inches patches associated w/ shrubs. Larger bare patches also associated with ant mounds and small mammal disturbances
4. Bare ground (default description)	Much higher than expected for the site. Bare areas are large and generally connected	Moderately higher than expected for the site. Bare areas are large and occasionally connected	Moderately to slightly higher than expected for the site. Bare areas are of moderate size and sporadically connected	Slightly higher than expected for the site. Bare areas are small and rarely connected	Amount and size of bare areas matches that expected for the site

1. Rills—Rills are small, erosional rivulets that are generally linear and do not necessarily follow the microtopography as flow patterns do. They are formed through complex interactions between raindrops, overland flow, and the characteristics of the soil surface. The potential for rills increases as the degree of disturbance (loss of cover) and slope increases. Some soils have a greater potential for rill formation than others do. Therefore, the degree of natural versus accelerated rill formation should be established by interpretations made from the soil survey, the rangeland ecological site description and the reference sheet for the area. Generally, concentrated flow erosional processes are accelerated when the distance between rills decreases and depth and width of rills increase.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
1. Rills	Rill formation is severe and well defined throughout most of the area	Rill formation is moderately active and well defined throughout most of the area	Active rill formation is slight at infrequent intervals, mostly in exposed areas	No recent formation of rills; old rills have blunted or muted features	Current or past formation of rills as expected for the site

2. Water flow patterns—Flow patterns are the path that water takes (accumulates) as it moves across the soil surface during overland flow. Overland flow occurs during rainstorms or snowmelt when a surface crust impedes water infiltration, or the infiltration capacity is exceeded. These patterns are generally evidenced by litter, soil or gravel redistribution, or pedestalling of vegetation or stones that break the flow of water. Interrill erosion caused by overland flow has been identified as the dominant sediment transport mechanism on rangelands. Water flow patterns are controlled in length and coverage by the number and kinds of obstructions to water flow provided by basal intercepts of living or dead plants, biological crust, persistent litter, or rocks. They are rarely continuous, and appear and disappear as the slope and microtopography of the slope changes. Shorter flow patterns facilitate infiltration by helping to pond water in depressional areas, thus increasing the time for water to soak into the soil. Generally, as slope increases and ground cover decreases, flow patterns increase. Soils with inherently low infiltration capacity may have a large number of natural flow patterns.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
2. Water flow patterns	Extensive and numerous; unstable with active erosion; usually connected	More numerous than expected; deposition and cut areas common; occasionally connected	Nearly matches what is expected for the site; erosion is minor with some instability and deposition	Matches what is expected for the site; some evidence of minor erosion. Flow patterns are stable and short	Matches what is expected for the site; minimal evidence of past or current soil deposition or erosion

3. Pedestals and/or terracettes—Pedestals and terracettes are important indicators of the movement of soil by water and by wind (pedestals only). Pedestals are rocks or plants that appear elevated because of soil loss by wind or water erosion.

Pedestals can also be caused by nonerosional processes, such as frost heaving or through soil or litter deposition on and around plants. Because of this, it is important to distinguish and not include this type of pedestalling as an indication of erosional processes.

Terracettes are benches of soil deposition behind obstacles caused by water movement (not wind). As the degree of soil movement by water increases, terracettes become higher and more numerous and the area of soil deposition becomes larger. Terracettes caused by livestock or wildlife movements on hillsides are not considered erosional terracettes, thus they are not assessed in this protocol. However, these terracettes can increase erosion by concentrating water flow and/or reducing infiltration. These effects are recorded with the appropriate indicators (waterflow patterns, compaction layer, and soil surface loss and degradation).

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
3. Pedestals and/or terracettes (wind and water)	Abundant active-pedestalling and numerous terracettes. Many rocks and plants are pedestalled; exposed plant roots are common	Moderate active pedestalling; terracettes common. Some rocks and plants are pedestalled with occasional exposed roots	Slight active pedestalling; most pedestals are in flow paths and interspaces and/or on exposed slopes. Occasional terracettes present	Active pedestalling or terracette formation is rare; some evidence of past pedestal formation, especially in water flow patterns and on exposed slopes	Current or past evidence of pedestalled plants or rocks as expected for the site. Terracettes absent or uncommon

4. Bare ground—Bare ground is exposed mineral or organic soil that is available for raindrop splash erosion, the initial form of most water-related erosion. It is the remaining ground cover after accounting for ground surface covered by vegetation (basal and canopy (foliar)), litter, standing dead vegetation, gravel/rock, and visible biological crust (lichen, mosses, algae). The amount and distribution of bare ground is one of the most important contributors to site stability relative to the site potential; therefore, it is a direct indication of site susceptibility to accelerated wind or water erosion. In general, a site with bare soil present in a few large patches is less stable than a site with the same ground cover percentage in which the bare soil is distributed in many small patches, especially if these patches are unconnected. The determination of adequacy of ground cover is made by comparing the expected ground cover for a site as determined by the rangeland ecological site description. The amount of bare ground can vary seasonally depending on impacts on vegetation canopy cover (herbivore utilization) and litter amount (trampling loss), and annually relative to weather (drought, above average precipitation). Current and past climate must be considered in determining the adequacy of current cover in protecting the site against the potential for accelerated erosion.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
4. Bare ground	Much higher than expected for the site. Bare areas are large and generally connected	Moderate to much higher than expected for the site. Bare areas are large and occasionally connected	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected	Slight to moderately higher than expected for the site. Bare areas are small and rarely connected	Amount and size of bare areas match that expected for the site

5. Gullies —A gully is a channel that has been cut into the soil by moving water. Gullies generally follow the natural drainages and are caused by accelerated water flow and the resulting downcutting of soil. Gullies are a natural feature of some landscapes while on others management actions (excessive grazing, recreation vehicles, or road drainages) may cause gullies to form or expand. In gullies, water flow is concentrated but intermittent. Gullies can be caused by resource problems offsite (document this on the Rangeland Health Evaluation Sheet), but still affect the site function on the evaluation area.

Gullies may be assessed by observing the numbers of gullies in an area and/or assessing the severity of erosion on individual gullies. Generally, signs of active erosion; that is, incised sides along a gully, are indicative of a current erosional problem while a healing gully is characterized by rounded banks, vegetation growing in the bottom and on the sides, and a reduction in gully depth. Active headcuts may be a sign of accelerated erosion in a gully even if the rest of the gully is showing signs of healing.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
5. Gullies	Common with indications of active erosion and downcutting; vegetation is infrequent on slopes and/or bed. Nickpoints and headcuts are numerous and active	Moderate to common with indications of active erosion; vegetation is intermittent on slopes and/or bed. Headcuts are active; downcutting is not apparent	Moderately in number with indications of active erosion; vegetation is intermittent on slopes and/or bed. Occasional headcuts may be present	Uncommon with vegetation stabilizing in bed and slopes; no signs of active headcuts, nickpoints, or bed erosion	Drainages are represented as natural stable channels, no signs of erosion with vegetation common

6. Wind-scoured, blowout, and/or depositional areas—Accelerated wind erosion on an otherwise stable soil increases as the surface crust, either physical, chemical, or biological crust, is worn by disturbance or abrasion. Physical crusts are extremely important in protecting the soil surface from wind erosion on many rangelands with low canopy (foliar) cover. The exposed soil beneath the crust is often weakly consolidated and vulnerable to movement via wind. As wind velocity increases, soil particles begin bouncing against each other in the saltation process. This abrasion leads to suspension of fine particles into the windstream where they may be transported off the site. Wind erosion is reflected by wind-scoured or blowout areas where the finer particles of the top soil have blown away, sometimes leaving residual gravel, rock, or exposed roots on the soil surface. They are generally found in interspace areas with a close correlation between soil cover/bare patch size, soil texture, and degree of accelerated erosion. Deposition of suspended soil particles is often associated with vegetation that provides roughness to slow the wind velocity and allows soil particles to settle from the wind stream. The taller the vegetation, the greater the deposition rate, thus shrubs and trees in rangeland ecosystems are likely sinks for deposition (mesquite dunes). The soil removed from wind-scoured depressions is redistributed to accumulation areas (eolian deposits) that increase in size and area of coverage as the degree of wind erosion increases.

Like water erosion, wind-deposited soil particles can originate from offsite, but affect the function of the site by modifying soil surface texture. The changes in texture influence the site's hydrologic function. Even when soil particles originate from offsite, they can have detrimental effects on plants at the depositional site.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
6. Wind-scoured, blowout, and/or depositional areas	Extensive	Common	Occasionally present	Infrequent and few	Current or past evidence of pedestalled plants or rocks as expected for the site. Terracettes absent or uncommon

7. Litter movement—The degree and amount of litter (dead plant material that is in contact with the soil surface) movement (redistribution) is an indicator of the degree of wind and/or water erosion. The redistribution of litter within a small area on a site is indicative of less erosion, whereas the movement of litter off-site by wind or water is indicative of more severe erosion. In a study in the Edwards Plateau in Texas, litter accumulation was shown to be the variable most closely correlated with interrill erosion. The same study showed that litter of bunchgrasses represented significant obstructions to runoff, thereby causing sediment transport capacity to be reduced and a portion of the sediment to be deposited.

The inherent capacity for litter movement on a soil is a function of its slope and geomorphic stability. For example, alluvial fans and flood plains are active surfaces over which water and sediment are moved in response to major storm events. The amount of litter movement varies from large to small depending on the amount of bare space typical of the plant community and the intensity of the storm.

The size of litter moved by wind or water is also an indicator of degree of litter redistribution. In general, the greater distance that litter is moved from its point of origin and the larger the size and/or amount of litter moved, the more the site is being influenced by erosional processes.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
7. Litter movement (wind or water)	Extreme; concentrated around obstructions. Most size classes of litter have been displaced	Moderate to extreme; loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced	Moderate movement of smaller size classes in scattered concentrations around obstructions and in depressions	Slightly to moderately more than expected for the site with on small size classes of litter being displaced	Matches that expected for the size with a fairly uniform distribution of litter

8. Soil surface resistance to erosion—This indicator assesses the resistance of the surface of the soil to erosion. The stability of the soil surface is key to this indicator. The soil surface may be stabilized by soil organic matter that has been fully incorporated into aggregates at the soil surface, adhesion of decomposing organic matter to the soil surface, and biological crusts. The presence of one or more of these factors is a good indicator of soil surface resistance to erosion. Where soil surface resistance is high, soil erosion may be minimal even under rainfall intensities of over 5 inches per hour generating high runoff rates on plots from which all cover has been removed. Conversely, the presence of highly erodible materials at the soil surface can dramatically increase soil erosion by water even when there is high vegetative cover and by wind when vegetative cover is removed.

Another good indicator is the resistance of soil surface fragments to breakdown when placed in water. For a simple test, remove several small (1/4-in diameter by 1/8-in deep) fragments from the soil surface and place them in a bottle cap filled with water. Fragments with low stability appear to lose their structure or melt within 30 seconds. Fragments with extremely low stability melt immediately upon contact with the water and the water becomes cloudy as the soil particles disperse. Fragments with moderate stability appear to retain their integrity until the water in the bottle cap is agitated or gently swirled. Highly stable aggregates retain their shape, even when agitated indefinitely. This indicator is most highly correlated with water erosion. Susceptibility to wind erosion also declines with increases in soil organic matter.

Biological crusts consist of microorganisms (lichens, algae, cyanobacteria, microfungi) and nonvascular plants (mosses, lichens) that grow on or just below the soil surface. Soil physical and chemical characteristics, along with seasonal precipitation patterns, largely determine the dominant organisms comprising the crust. Biological crusts are primarily important as cover and in stabilizing the soil surface. In some areas, depending on soil characteristics, they may increase or reduce the infiltration of water through the soil surface or enhance the retention of soil water (acting as living mulch). In general, the relative importance of biological crusts increases as annual precipitation and potential vascular plant cover decreases.

Physical crusts are thin surface layers induced by the impact of raindrops on bare soil causing the soil surface to seal and absorb less water. Physical and chemical crusts tend to have very low organic matter content or have only relatively inert organic matter that is associated with relatively little biological activity. As this physical crust becomes more extensive, infiltration rates are reduced and overland water flow increases. Also, water can pond in flat crusted areas and is more likely to evaporate than infiltrate into the soil. Physical soil crusts are identified by lifting the soil surface with a pen or other sharp object and looking for cohesive layers at the soil surface which are not perforated by pores or fissures and in which there is no apparent binding by strands of organic material, such as cyanobacteria. Physical crusts are more common on silty, clayey, and loamy soils and relatively thin if at all present in sandy soils.

Chemical crusts rarely form in rangelands except on soils formed from particular parent materials; that is, salt desert shrub communities and in abandoned irrigated agricultural fields. Where they do occur, they can reduce infiltration and increase overland water flow similar to physical crusts. They are usually identified by a white color on the soil surface. Physical crusts also include vesicular crusts that have numerous small air pockets or spaces similar to a sponge, but resistant to infiltration.

Special cases: erosion pavement and open water. This indicator is not applicable to areas in which no soil is present at the surface because of the presence of an extensive erosion pavement (nearly 100% surface cover by stones) or where there is continuous open water (marshes in the Southeast). In this case the rating should be None to Slight.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
8. Soil surface resistance to erosion*	Resistance of soil surface to erosion extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent	Resistance of soil surface to erosion significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches	Resistance of soil surface to erosion significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site	Some reduction in soil surface stability in plant interspaces or slight reduction throughout the site. Stabilizing agents reduced below expected	Resistance of soil surface to erosion matches that expected for the site. Surface soil is stabilized by organic matter decomposition products or a biological crust

* Stability can also be assessed by placing a small (0.24 in) soil surface fragment in water. Relatively stable fragments maintain their shape, and the water remains clear, while unstable soils appear to melt. Very stable fragments maintain their shape even after being agitated. Extremely unstable fragments disperse immediately upon insertion into the water, making it cloudy.

9. Soil surface loss or degradation—The loss or degradation of part or all of the soil surface layer or horizon is an indicator of a loss in site potential. In most sites, the soil at and near the surface has the highest organic matter and nutrient content. This generally controls the maximum rate of water infiltration into the soil and is essential for successful seedling establishment. As erosion increases, the potential for loss of soil surface organic matter increases, resulting in further degradation of soil structure. Historic soil erosion may result in complete loss of this layer. In areas with limited slope where wind erosion does not occur, the soil may remain in place, but all characteristics that distinguish the surface from the subsurface layers are lost. Except in soils with a clearly defined horizon immediately below the surface (argillic), it is often difficult to distinguish between the loss and degradation of the soil surface. For the purposes of this indicator, this distinction is unnecessary—the objective is to determine to what extent the functional characteristics of the surface layer have been degraded. Note also that visible soil erosion is covered in description of indicator 3, pedestals and terracettes, and subsurface degradation in Indicator 11, Compaction layer.

The two primary indicators used to make this evaluation are the organic matter content and structure of the surface layer or horizon. Soil organic matter content is frequently reflected in a darker color of the soil, although high amounts of oxidized iron (common in humid climates) can obscure the organic matter. In arid soils where organic matter content is low, this accumulation can be quite faint. The use of a mister to wet the soil profile can help make these layers more visible. Soil structural degradation is reflected in the loss of clearly defined structural units or aggregates at one or more scales from less than an eighth inch to 3 to 4 inches. In soils with good structure, pores of various sizes are visible within the aggregates. Structural degradation is reflected in a more massive, homogeneous surface horizon and is associated with a reduction in infiltration rates. Comparisons to intact soil profiles at reference sites can also be used although in cases of severe degradation, the removal of part or all of the A horizon or of one or more textural components may make identification of appropriate reference areas difficult.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
9. Soil surface loss or degradation	Soil surface horizon absent. Soil structure near surface is similar to, or more degraded, than that in subsurface horizons. No distinguishable difference in subsurface organic matter content	Soil loss or degradation severe throughout site. Minimal difference in soil organic matter content and structure of surface and subsurface layers	Moderate soil loss or degradation in interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced	Some soil loss has occurred and/or soil structure shows signs of degradation, especially in plant interspaces	Soil surface horizon intact. Soil structure and organic matter content match that expected for site

10. Plant community composition and distribution relative to infiltration and runoff—Vegetation growth form is an important determinant of infiltration rate and interrill erosion.

Vegetation is the primary factor influencing the spatial and temporal variability of surface soil processes controlling infiltration and interrill erosion rates on semiarid rangelands. The distribution of the amount and type of vegetation is an important factor controlling spatial and temporal variations in infiltration and interrill erosion rates on rangelands in Nevada, Idaho, and Texas.

Changes in plant community composition and the distribution of species can influence (positive or negative) the ability of a site to capture and store precipitation. Plant rooting patterns, litter production and associated decomposition processes, basal area, and spatial distribution can all affect infiltration, runoff, or both. In the Edwards Plateau in Texas, shifts in plant composition between bunchgrass and short grasses over time have the greatest potential to influence infiltration and soil erosion. An example of a composition change that reduces infiltration and increases water runoff is the conversion of desert grasslands to shrub dominated communities. However, infiltration and runoff are also affected when sagebrush steppe rangeland is converted to a monoculture of annual grasses. These annual grasses provide excellent watershed protection although they adversely affect the ecological processes in many other ways.

Care must be exercised in interpreting this indicator in different ecosystems, as the same species may have different effects.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
10. Plant community composition and distribution relative to infiltration and runoff	Infiltration is severely decreased due to adverse changes in plant community composition and/ or distribution. Adverse plant cover changes have occurred	Infiltration is greatly decreased due to adverse changes in plant community composition and/ or distribution. Detrimental plant cover changes have occurred	Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. Plant cover changes negatively affect infiltration	Infiltration is slightly to moderately affected by minor changes in plant community composition and/or distribution. Plant cover changes have only a minor effect on infiltration	Infiltration and runoff are equal to that expected for the site. Plant cover (distribution and amount) adequate for site protection

11. Compaction layer—A compaction layer is a near surface layer of dense soil caused by the repeated impact on or disturbance of the soil surface. Compaction becomes a problem when it begins to limit plant growth, water infiltration, or nutrient cycling processes. Farm machinery, herbivore trampling, recreational and military vehicles, foot traffic, or any other activity that repeatedly causes an impact on the soil surface can cause a compaction layer. Moist soil is more easily compacted than dry or saturated soil. Recovery processes, such as earthworm activity and frost heaving, are generally sufficient to limit compaction by livestock in many upland systems.

A compaction layer is a structural change, not a textural change as described in a soil survey. Compacted layers in rangelands are generally less than 6 inches below the soil surface. They are detected by digging a small hole (generally less than 1 foot deep) with the determination of a compaction layer (a soil structure change) done by a person with soils experience. These layers may be detected in some soils with the use of a penetrometer or by simply probing the soil with a sharp rod or shovel and “feeling” for the compaction layer. However, any potential compaction layer should be confirmed using multiple indicators, including direct observation of physical features. Those physical features include such things as platy or blocky, dense soil structure over less dense soil layers and horizontal root growth, and increased density (measured by weighing a known volume of oven-dry soil). Increased resistance to a probe can be simply due to lower soil moisture or higher clay content.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
11. Compaction layer (below soil surface	Extensive; severely restricts water movement and root penetration	Widespread; greatly restricts water movement and root penetration	Moderately widespread, moderately restricts water movement and root penetration	Rarely present or is thin and weakly restrictive to water movement and root penetration	None to minimal, not restrictive to water movement and root penetration

12. Functional/structural groups—Functional/structural groups are a suite of species that are grouped together, on an ecological site basis, because of similar shoot (height and volume) or root (fiberous versus tap) structure, photosynthetic pathways, nitrogen fixing ability, or life cycle. Functional composition and functional diversity are the principal factors explaining plant productivity, plant percent nitrogen, plant total nitrogen, and light penetration. The study by Tilman, et al. (1997) showed that functional composition has a large impact on ecosystem processes. This and related studies have demonstrated that factors that change ecosystem composition, such as invasion by novel organisms, nitrogen deposition, disturbance frequency, fragmentation, predator decimation, species removal, and alternative management practices, can have a strong affect on ecosystem processes.

Relative dominance is based upon the relative annual production, or biomass that each functional group collectively contributes to the total. The recommended protocol to use for grouping species is composition by annual production. If the evaluator(s) doesn't have experience in estimating composition by annual production, then composition by cover may be used if appropriate reference data are available. The potential for Functional/Structural groups is derived by placing species into the appropriate groups from information found in the Reference Sheet. The list and ranking of functional/structural groups should reflect all of the plant (including biological crust) communities in the reference state, under the natural disturbance regime, and in the context of normal climax variability. The comparison should be to communities in the reference state (in the state and transition model for the ecological site).

The number of species in each functional group is also considered when selecting the appropriate rating category on the Rangeland Health Evaluation Sheet. If the number of species in many of the functional/structural plant groups has been greatly reduced, this may indicate loss of biotic integrity. Both the presence of functional groups and the number of species within the groups significantly affect on ecosystem processes. Example 4–8 shows functional/structural groups for a prairie ecological site, and example 4–9 shows them from a Great Basin desert site. Nonvascular plants (biological crusts) are included in example 4–9 because they are an important component of this Great Basin ecological site. Biological crusts are components of many ecosystems and should be included in this evaluation when appropriate.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
12. Functional/ structural groups (F/S groups)	Number of F/S groups greatly reduced and/or Relative dominance of F/S groups has been dramatically altered and/or Number of species within F/S groups significantly reduced	Number of F/S groups reduced and/or One dominant group and/or One or more subdominant group replaced by F/S groups not expected for the site and/or Number of species within F/S groups significantly reduced	Number of F/S groups moderately reduced and/or One or more subdominant F/S groups replaced by F/S groups not expected for the site and/or Number of species with F/S groups moderately reduced	Number of F/S groups slightly reduced and/or Relative dominance of F/S groups has been modified from that expected for the site and/or Number of species within F/S slightly reduced	F/S groups and number of species in each group closely match that expected for the site

Example 4–8 Functional/structural groups for a prairie ecological site

Warm-season tall grasses	Warm-season midgrasses	Cool-season midgrasses	Warm-season shortgrass	Perennial forbs	Leguminous shrubs
Big bluestem	Sideoats grama	Western wheatgrass	Buffalograss	Dotted gayfeather	Leadplant
Indiangrass	Little bluestem	Green needlegrass	Blue grama	Prairie coneflower	

Example 4–9 Functional/structural groups from a Great Basin desert site

Tall shrubs (deep rooted)	Half shrub	Warm-season bunchgrass	Cool-season short bunch-grass	Cool-season mid bunch-grass	Perennial forbs, N fixers	Perennial forbs, not N fixers	Biological crust
Wyoming big sagebrush	Broom snakeweed	Sand drop-seed	Sandberg bluegrass	Squirreltail	Astragalus	Phlox	Moss
Bitterbrush		Red three-awn		Thurbers needlegrass	Lupine	Arrowleaf balsamroot	Lichens
				Indian Ricegrass		Biscuitroot	

13. Plant mortality/decadence—The proportion of dead or decadent (moribund, dying) to young or mature plants in the community relative to that expected for the site, under normal disturbance regimes, is an indicator of the population dynamics of the stand. If recruitment is not occurring and existing plants are either dying or dead, the integrity of the stand would be expected to decline and other undesirable plants (weeds or invasives) may increase. A healthy range has a mixture of many age classes of plants relative to site potential and climatic conditions.

Only plants native to the site (or seeded plants if in a seeding) are assessed for plant mortality. Plant mortality may vary considerably on the landscape depending on disturbance events (fire, drought, insect infestation, and disease).

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
13. Plant mortality/ decadence	Dead and/or decadent plants are common	Dead plants and/or decadent plants are somewhat common	Some dead and/or decadent plants are present	Slight plant mortality and/or decadence	Plant mortality and decadence match those expected for the site

14. Litter amount—Litter is any dead plant material (from both native and exotic plants) that is detached from the base of the plant. The portion of the litter that is in contact with the soil surface (as opposed to standing dead vegetation) provides a source of soil organic material and the raw material for onsite nutrient cycling. All litter helps to moderate the soil microclimate and provides food for microorganisms. The amount of litter present can play a role in enhancing the ability of the site to resist erosion. Litter helps to dissipate the energy of raindrops and overland flow, thereby reducing the potential detachment and transport of soil. Litter biomass represents a significant obstruction to runoff.

The amount of litter (herbaceous and woody) is compared to the amount that would be expected for the same type of growing conditions in the reference state per the Reference Sheet. Litter is directly related to weather and to the degree of utilization of biomass each year. Therefore, climatic influences (drought, wet years) must be carefully considered in determining the rating for the amount of litter. Do not confuse standing-dead plants with litter during this evaluation.

Some plant communities have increased litter quantities relative to the site potential and current weather conditions. An example is the increased accumulation of litter in exotic grass communities (cheatgrass) compared to native shrub steppe plant communities. In this case, litter amount above what is expected results in a downgraded rating for the site. Note in the comments section on the evaluation sheet for this indicator if the litter is undergoing decomposition (darker color) or oxidation (whitish color which may also be an indication of fungal growth). In addition to amount, litter size may also be important because larger litter tends to decompose slower and is more resistant to runoff. If litter size is considered as a part of an indicator, it should be noted in the reference sheet.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
14. Litter amount	Largely absent or dominant relative to site potential and weather	Greatly reduced or increased relative to site potential and weather	Moderately more or less relative to site potential and weather	Slightly more or less relative to site potential and weather	Amount is what is expected for the site potential and weather

15. Annual production—Annual production, as used in this document, is the net quantity of aboveground vascular plant material produced within a year. It is an indicator of the energy captured by plants and its availability for secondary consumers in an ecosystem given current weather conditions. Production potential will change with communities or ecological sites, biological diversity, and with latitude. Annual production of the evaluation area is compared to the site potential (total annual production) as described in the reference sheet.

Comparisons to the reference sheet are based on peak aboveground standing crop, no matter when the site is assessed. If utilization of vegetation has occurred or plants are in early stages of growth, the evaluator(s) is required to estimate the annual production removed or expected and include this amount when making the total site biomass estimate. Do not include standing dead vegetation or live tissue (woody stems) not produced in the current year as annual production.

All species (native, seeded, and weeds) alive (annual production only) are included in the determination of total aboveground site biomass. Therefore, the type of vegetation (native or introduced) is not the issue. For example, Rickard and Vaughan (1988) found that conversion of a sagebrush steppe plant community to an exotic annual grassland greatly affected vegetation structure and function, but not aboveground biomass production.

As with the other indicators, it is important to consider all other local and landscape level explanations for differences in production (runoff/run-on because of landscape position, weather, regional location, or different soils within an ecological site) before attributing production differences to differences in other site characteristics.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
15. Annual production	Less than 20% of potential production	20–40% of potential production	40–60% of potential production	60–80% of potential production	Exceeds 80% of potential production

16. Invasive plants—Invasive plants are plants that are not part of (if exotic), or are a minor component of (if native), the original plant community or communities that have the potential to become a dominant or co-dominant species on the site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years (short-term response to drought or wildfire) are not invasive plants. This indicator deals with plants that are invasive to the evaluation area. These plants may or may not be noxious and may or may not be exotic.

Invasives can include noxious plants (plants listed by a state because of their unfavorable economic or ecological impacts), non-native plants, and native plants. Native invasive plants (pinyon pine or juniper into sagebrush steppe) must be assessed by comparing current status with potential status described in the Reference Sheet. Historical accounts and photographs also provide information on the historical distribution of invasive native plants.

Invasive plants may impact an ecosystem's type and abundance of species, their interrelationship, and the processes which energy and nutrients move through the ecosystem. These impacts can influence both biological organisms and physical properties of the site. The impacts may range from slight to catastrophic depending on the species involved and their degree of dominance. Invasive species may adversely affect a site by increased water usage (salt cedar (tamarish) in riparian areas) or rapid nutrient depletion (high nitrogen use by cheatgrass).

Some invasive plants (knapweeds) are capable of invading undisturbed, climax bunchgrass communities, further emphasizing their use as an indicator of a new ecosystem stress. Even highly diverse, species rich plant communities are susceptible to exotic species invasion.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
16. Invasive plants	Dominate the site	Common throughout the site	Scattered throughout the site	Occasionally present on the site	Rarely present on the site

17. Reproductive capability of perennial plants— Adequate seed production is essential to maintain populations of plants when sexual reproduction is the primary mechanism of individual plant replacement at a site. However, annual seed production of perennial plants is highly variable. Since reproductive growth occurs in a modular fashion similar to the remainder of the plant, inflorescence production (seedstalks) becomes a basic measure of reproductive potential for sexually reproducing plants and clonal production (tillers) for vegetatively reproducing plants. Since reproductive capability of perennial plants is greatly influenced by weather, it is important to determine departure from the expected value in the reference sheet by evaluating management effects on this indicator.

Seed production can be assessed by comparing the number of seedstalks and/or number of seeds per seedstalk of native or seeded plants (not including invasives) in the evaluation area with what is expected as documented on the Reference Sheet. Mueggler (1975) recommended comparison of seedstalk numbers/culm length on grazed and ungrazed bluebunch wheatgrass plants as a measure of plant recruitment potential. Seed production is related to plant vigor since healthy plants are better able to produce adequate quantities of viable seed than are plants that are stressed or decadent.

For plants that reproduce vegetatively, the number and distribution of tillers or rhizomes is assessed relative to the expected production of these reproductive structures as documented in the reference sheet.

Recruitment is not assessed as a part of this indicator because plant recruitment from seed is an episodic event in many rangeland ecological sites. Therefore, evidence of recruitment (seedlings or vegetative spread) of perennial, native, or seeded plants is recorded in the comment section of the Evaluation Sheet, but is not considered in rating the reproductive capabilities of perennial plants.

This indicator considers only perennial plants. Evaluation areas that have no perennial plants would be rated Extreme to Total for this indicator because they no longer have the capacity to reproduce perennial plants.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
17. Reproductive capability of perennial plants (native or seeded)	Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions	Capability to produce seed or vegetative tillers is greatly reduced relative to recent climatic conditions	Capability to produce seed or vegetative tillers is somewhat limited relative to recent climatic conditions	Capability to produce seed or vegetative tillers is only slightly limited relative to recent climatic conditions	Capability to produce seed or vegetative tillers is not limited relative to recent climatic conditions

18. Optional indicators—The 17 indicators described previously represent the baseline indicators that must be assessed on all sites. Other indicators and descriptors may be developed to meet local needs. The only restriction on the development of optional indicators and their use is that they must be ecologically, not management, related. They should also significantly increase the quality of the evaluation. For example, an indicator of suitability for livestock, wildlife, or special status species are not appropriate indicators to determine the health of a land unit. They may be important in the allotment or ranch evaluation, but are not included in the determination of the status of soil/site stability, hydrologic function, or biotic integrity.

An example of optional indicators and descriptors for Biological Crusts and Vertical Vegetation follows:

Both are partially addressed by indicator 12 (functional/structural groups); however, many users find that this indicator often becomes heavily focused on plant community composition. Both optional indicators are also partially reflected by indicator 4 (bare ground). Soil stabilized by visible biological crust (lichens, mosses, and algae) is not considered bare ground. Because the bare ground indicator includes the special distribution of bare areas, it also provides some indication of the horizontal vegetation distribution.

The biological crust indicator might be applied where these crust play particularly important biological or physical role (for nitrogen fixation or soil stabilization). The vegetation structure indicator is useful where variability in vertical vegetation structure within functional/structural groups affects wind erosion or the integrity of animal populations. This variability may be due to species differences within functional/structural groups, in the age class distribution, or to disturbances such as fire and grazing that affect growth form.

The indicators included in these sheets are not intended to be all inclusive for all rangelands. Additional indicators may be added to the sheets to improve sensitivity in detecting changes in soil/site stability, hydrologic function, and biotic integrity. As with the modification of the descriptor narratives, any additional indicators will be site specific and need approval from the state rangeland management specialist or another person responsible for maintaining the quality of the ecological site descriptions.

	Degree of departure from the reference state for the ecological site				
Indicator	**Extreme to Total**	**Moderate to Extreme**	**Moderate**	**Slight to Moderate**	**None to Slight**
Biological crusts	Found only in protected areas, very limited suite of functional groups	Largely absent, occurring mostly in protected areas	In protected areas and with a minor component in interspaces	Evident throughout the site, but continuity is broken	Largely intact and nearly matches site capability
Vertical vegetation structure	Number of height classes greatly reduced and/or most height classes lost and/or dramatic increase in number of height classes expected for site and/or dramatic reduction in the number or density of individuals across several height classes	Number of height classes significantly reduced and/or more than one height class lost and/or addition of more than one height class not expected for site and/or significant reduction in the number or density of individuals across several height classes	Number of height classes moderately reduced and/or one height class lost and/or addition of height class not expected for site and/or moderate reduction in the number or density of individuals across several height classes	Number of height classes slightly reduced and/or slight reduction in the number or density of individuals across several height classes	Number and type of height classes and the number and density of individuals in each height class closely match that expected for the site

(4) Determining the functional status of the three rangeland health attributes

The interpretation process is the critical link between observations of indicators and determining the degree of departure from the reference sheet for each health attribute in an evaluation area. The interpretation of the indicators and the selection of the degree of departure of the rangeland health attributes (soil/site stability, hydrologic function, and biotic integrity) are made at the bottom of page 2 of the evaluation sheet. (exhibit 4–9). Table 4–2 is the grouping of indicators into the three attributes of rangeland health.

The summary rating is made by reviewing the indicator ratings and comments to arrive at a single degree of departure from the Reference Sheet for each attribute.

A preponderance of evidence approach is used to select the appropriate departure category for each attribute. This decision is based, in part, on where the majority of the indicators for each attribute fall under the five categories. For example, if four of the soil/site stability indicators are in the Moderate and six are in the Slight to Moderate departure from the ecological site description, the Soil/Site Stability attribute departure would be rated as Slight to Moderate assuming that the evaluator(s) interpretation of other information and local ecological knowledge supported this rating. However, if one of the four indicators in the Moderate category is particularly important for the site (bare ground), a rating of Moderate can be supported.

Once an evaluation is made for each attribute, managers may use the attribute evaluation to identify where more information (monitoring and/or inventory data) is required. This information should be reviewed if available, or if not available, the information should be collected. Therefore, these areas (moderate departure) are often ideal for the implementation of monitoring studies since they should be the most responsive to management activities. However, additional monitoring may be useful regardless of the departure rating, dependant upon future change in uses or management of the area.

This procedure relies upon the collective experience and knowledge of the evaluator(s) to classify each indicator and then to interpret the collective rating for the indicators into one summary rating of departure for each attribute. The rating of each indicator and the interpretation into a collective rating for each attribute are not apprentice-level work. This procedure has been developed for use by experienced, knowledgeable evaluator(s). It is not intended that this assessment procedure be used by new and/or inexperienced employees, without training and assistance by more experienced and knowledgeable employees.

(d) Communicating ratings of ecological sites

Communicating ratings of ecological sites on rangeland is important to decisionmakers, users, rangeland management professionals, other agency personnel, and the general public. Ratings on ecological sites can be reported in the three ways described in the preceding paragraphs: trend (rangeland trend or planned trend), similarity index, and rangeland health. Many times all three methods of evaluation may be useful and needed to fully inventory and describe the ratings of ecological sites on the land.

(e) Evaluating rangelands occupied by naturalized plant communities

As stated in chapter 3, ecological site descriptions are to be developed for all identified ecological sites on rangeland. These site descriptions are to identify and describe the historic climax plant community along with other vegetation states commonly found on the site. In some locations the historic climax plant community has been destroyed, and the plant community cannot be reconstructed with any degree of reliability. In these areas site descriptions will be developed using naturalized plant communities for the site instead of the historic climax plant community. The use of this option for ecological site descriptions is for areas where the historic climax plant community is unknown and cannot be reconstructed with any degree of reliability. An example of the areas within the United States where this may be used is the State of Hawaii, the Caribbean Area, and the annual grasslands of California. Approval to describe ecological sites in this manner in other regions must be obtained from the national program leader for range and pasture. Evaluation of these sites may include rangeland health, planned trend, and similarity index to a desired plant community. It will not include similarity index to historic climax because there is no way to know the historic climax plant community for these sites.

Table 4–2 Grouping of the indicators of rangeland health into ecological attributes

Indicator/attribute	Soil/site stability	Hydrologic function	Biotic integrity
1. Rills	X	X	
2. Water flow patterns	X	X	
3. Pedestals and/or terracettes	X	X	
4. Bare ground	X	X	
5. Gullies	X	X	
6. Wind-scoured, blowout, and/or deposition areas	X		
7. Litter movement	X		
8. Soil surface resistance to erosion	X	X	X
9. Soil surface loss or degradation	X	X	X
10. Plant community composition and distribution relative to infiltration and runoff		X	
11. Compaction layer	X	X	X
12. Plant functional/structural groups			X
13. Plant mortality/decadence			X
14. Litter amount		X	X
15. Annual production			X
16. Invasive plants			X
17. Reproductive capability of perennial plants			X

600.0403 Evaluating grazed forest lands

Grazed forest lands will be evaluated by utilizing planned trend and forage value ratings.

(a) Planned trend

Planned trend is defined as the change in plant composition within an ecological site from one plant community type to another relative to management objectives and to protecting the soil, water, air, plant, and animal resources. Planned trend is described as:

Positive—Moving towards the desired plant community

Not apparent—Change not detectable

Negative—Moving away from the desired plant community

Planned trend provides feedback to the manager and grazing land specialist about how well the management plan and prescribed grazing are working on a grazing unit by grazing unit basis. It can provide an early opportunity to make adjustments to the grazing duration and stocking levels in the conservation plan. Planned trend is monitored on all native and naturalized grazing land plant communities.

(b) Forage value rating

Forage value is a utilitarian classification indicating the grazing value of important plant species for specific kinds of livestock or wildlife. The classification is based on palatability or preference of the animal for a species in relation to other species, the relative length of the period that the plant is available for grazing, and normal relative abundance of the plant. Five forage value categories are recognized.

Preferred plants—These plants are abundant and furnish useful forage for a reasonably long grazing period. They are preferred by grazing animals. Preferred plants are generally more sensitive to grazing misuse than other plants, and they decline under continued heavy grazing.

Desirable plants—These plants are useful forage plants, although not highly preferred by grazing animals. They either provide forage for a relatively short period, or they are not generally abundant in the stand. Some of these plants increase, at least in percentage, if the more highly preferred plants decline.

Undesirable plants—These plants are relatively unpalatable to grazing animals, or they are available for only a very short period. They generally occur in insignificant amounts, but may become abundant if more highly preferred species are removed.

Nonconsumed plants—These plants are unpalatable to grazing animals, or they are unavailable for use because of structural or chemical adaptations. They may become abundant if more highly preferred species are removed.

Toxic plants—These plants are poisonous to grazing animals. They have various palatability ratings and may or may not be consumed. Toxic plants may become abundant if unpalatable and the more highly preferred species are removed.

600.0404 Vegetation sampling techniques

Vegetation sampling techniques are used in inventory and trend monitoring transects to assess utilization, cover, density, and frequency. In all cases techniques specific to the type of data needed should be used. Biomass data should be generated by clipping plots, not by trying to convert density or frequency data to weight. Frequency data should be generated from frequency techniques, not from biomass data. Photo points should be included in all monitoring programs to provide a visual record.

(a) Selecting techniques

Sampling Vegetation Attributes, an interagency technical reference released in 1996, is a good reference to use when evaluating sampling techniques. It includes examples of methods and data sheets, and can be used to plan, design, and layout for monitoring.

The technique or techniques used in monitoring depends on the vegetation attribute being monitored. For instance, a utilization technique should be used to monitor utilization to the needed level of precision within cost constraints. Because repeated clipping at a permanent monitoring location can reduce productivity, biomass is not recommended as a monitoring technique.

Indicators of environmental change, such as frequency or cover of certain species, may be the best variables to measure. For long-term monitoring, cover may be the best variable to measure. Basal cover of perennial grasses and canopy cover of woody plants typically change slowly over time. These attributes are not strongly affected by co-variates, such as climatic variation, yet they would be expected to change under different types of management. Permanent line transects established at random locations with photo points down the line are an excellent technique for monitoring environmental change.

(1) Monitoring scheme example

Range management specialists in Arizona, as well as other states, are monitoring trend using techniques similar to those described in this chapter. The following example scheme, from southern Arizona, involves a pace frequency monitoring technique to sample plant frequency and cover for overall trend.

Monitoring sites are established in key areas. Key areas are within the predominant site in the grazing unit that has potential for improvement under management and that has an adequate representation of key species. Four transects are established within the key area and marked so they can be relocated. Along each transect, 50 quadrates, 40-centimeter by 40-centimeter frequency, are read at one pace intervals. A single point on the quadrate is read for ground cover. Grasses and forbs rooted within the quadrate are recorded for presence (frequency), and trees or shrubs rooted within or overhanging the plot are recorded for presence. The data are tabulated and summarized on a summary sheet for use in discussions of trend by the rancher and range management specialist. Ancillary data noted or collected include the direction of the transect (consistent yearly), similarity index rating to a specific plant community, number of animals, season of use, utilization, production, and precipitation.

(b) Studies of treatment effects

The literature related to methods used in research, inventory, and monitoring is extensive. In many cases the conservationist will be well advised to seek advice from other professionals who may have more experience with a particular type of data need. The process of selecting an appropriate technique involves several simple questions:

Is this information really needed or is it already known? If the information has already been documented then data collection is probably not needed. However, if the information is not documented or the results in the literature are contrary to what has been observed, then data collection is needed.

Is the information needed related to a specific vegetation attribute, such as biomass, cover, density, frequency, or utilization or some combination? This is often the most difficult question to answer. If the answer is not known, biomass and cover data are the best data to collect. For example, if a difference in use has been noted between sites for a particular grass species, then the first thought might be a utilization study. A utilization study would provide the data needed to show a difference in use, but would not indicate why there is a difference in use. A chemical analysis of randomly selected plants from both sites might indicate a difference in palatability. A frequency study would indicate the presence of a more palatable plant on the site where the species is not used. A biomass study with selected materials from both sites put through a chemical analysis would also provide the needed information.

Which technique or combination of techniques will quantify the observed phenomenon? The best technique or combination of techniques will obtain the information within time and cost constraints and at the needed level of precision or will provide the best tradeoff of time and precision. An initial plot size and shape study provides this information.

Once these questions are answered, the study can be designed and completed with some likelihood of determining differences.

Exhibits

Exhibit 4–1 Examples of weight units

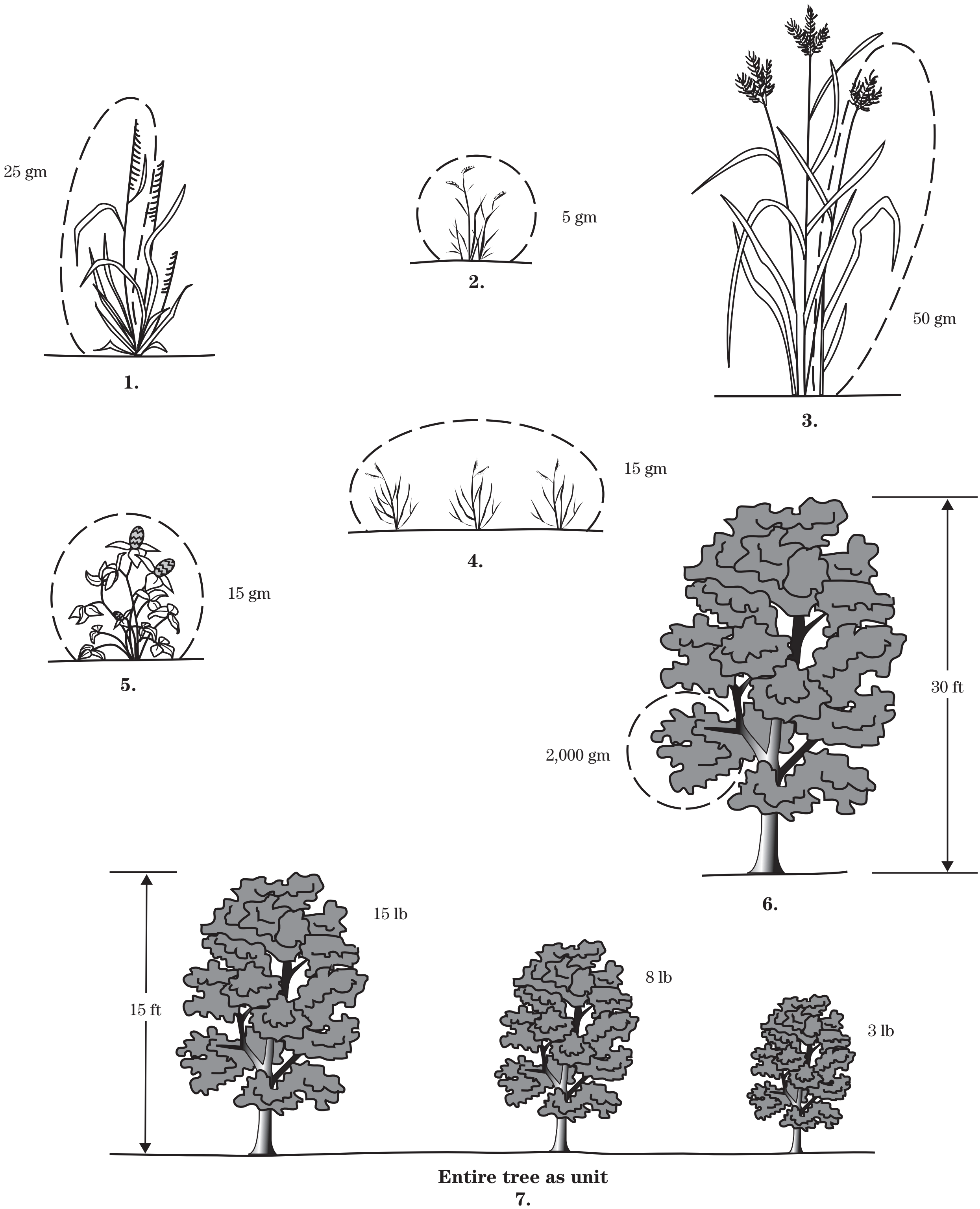

Exhibit 4–2 Percentage of air-dry matter in harvested plant material at various stages of growth

Grasses	Before heading; initial growth to boot stage (%)	Headed out; boot stage to flowering (%)	Seed ripe; leaf tips drying (%)	Leaves dry; stems partly dry (%)	Apparent dormancy (%)
Cool-season wheatgrasses perennial bromes bluegrasses prairie junegrass	35	45	60	85	95
Warm-season tall grasses bluestems indiangrass switchgrass	30	45	60	85	95
Midgrasses sideoats grama tobosa galleta	40	55	65	90	95
Short grasses blue grama buffalograss short three-awns	45	60	80	90	95

Trees	New leaf and twig growth until leaves	Older and full-size green leaves (%)	Green fruit (%)	Dry fruit (%)
Evergreen coniferous ponderosa pine, slash pine-longleaf pine Utah juniper Rocky Mountain juniper spruce	45	55	35	85
Live oak	40	55	40	80
Deciduous blackjack oak post oak hickory	40	50	35	85

Exhibit 4–2 Percentage of air-dry matter in harvested plant material at various stages of growth—Continued

Shrubs	New leaf and twig growth until leaves are full size (%)	Older and full-size green leaves (%)	Green fruit (%)	Dry fruit (%)
Evergreen big sagebrush bitterbrush ephedra algerita gallberry	55	65	35	85
Deciduous snowberry rabbitbrush snakeweed Gambel oak mesquite	35	50	30	85
Yucca and yucca-like plants yucca sotol saw-palmetto	55	65	35	85

Forbs	Initial growth to flowering (%)	Flowering to seed maturity (%)	Seed ripe; leaf tips dry (%)	Leaves dry; stems drying (%)	Dry (%)
Succulent violet waterleaf buttercup bluebells onion, lilies	15	35	60	90	100
Leafy lupine lespedeza compassplant balsamroot tickclover	20	40	60	90	100
Fibrous leaves or mat phlox mat eriogonum pussytoes	30	50	75	90	100

Succulents	New growth pads and fruits (%)	Older pads (%)	Old growth in dry years (%)
Pricklypear and barrel cactus	10	10	15+
Cholla cactus	20	25	30+

Exhibit 4–3 NRCS RANGE 414, Proper grazing use

Proper Grazing Use

Cooperator______________________________

							Actual percent or pounds remaining				
Grazing unit	Acres	Species of grazing animal	Season of Use	Location of Key Grazing Area	Key Plant(s) for Judging Proper Grazing Use	Minimum Percent of Key Species at End of Grazing Period (or Pounds per Acre)	19___	19___	19___	19___	19___
						Initials of Conservationist Assisting with Application					
						Dates of Application Checks					

Conservationist Assisting with Planning

____

Name and Date

Proper Grazing Use

Grazing Unit: Enter in this column the name of the pasture or field used by the cooperator or the number from the conservation plan map.

Acres: Enter in this column the acreage of the grazing unit.

Species of Grazing Animal: Enter in this column the species and class of livestock being grazed such as: dry cows, cow-calves, ewes and lambs, yearling cattle, 2-year steers, yearling sheep, goats, deer, horses, elk, etc.

Season of Use: Enter in this column the season that unit will be grazed such as: fall, winter, spring, summer, or by months: Sept. - Oct, Nov. - Mar, May- Jul, etc.

Location of Key Grazing Area: Enter in this column a description of the key grazing area. This may be an ecological site, it may be a portion of a site, or it might be a particular location within the grazing unit such as: S-W portion of grazing unit starting about 200 yards from pond to fence.

Key Plant(s) for Judging Proper Grazing Use: Enter in this column the species by common name on which you and the cooperator decide proper grazing use will be judged. There may be occasion when you will select two species, in this case enter the name of both species.

Minimum Percent of Key Species at End of Grazing Period: Enter in this column, the percent by weight, of the current year's growth of the key species that should be left ungrazed at the end of the grazing season. Where specifications call for a certain number of pounds of forage to be left ungrazed per acre of the key species, then the specified pounds per acre should be entered in this column.

Actual Percent or Pounds Remaining: Enter in this column, by calendar year, the percent, by by weight, or pounds remaining of the selected key species in the grazing unit. This measurement should be based on the key species on the key grazing area, at or near the end of the grazing call for use in percent of current year's growth, enter percentage of growth ungrazed. If use is specified in amount of forage to be left ungrazed in pounds per acre, then enter pounds per acre left ungrazed.

Exhibit 4–4 Foliage denseness classes

Dense

Medium

Sparse

Instructions for use of exhibit 4–4 tables:

Determine yields of juniper and pinyon pine by:

1. On 1/10- or 1/100-acre plots selected by random, tally crown diameter per tree and foliage denseness (sparse, medium, and dense) on each tree. From the tables, find yield per tree for each tree by crown diameter and foliage denseness from the proper table (range site), and record this opposite each tree. Add this column of weights. Multiply by 10 on 1/10-acre plots and by 100 on 1/100-acre plots. This figure is pounds per acre annual yield.
2. On 1/10- or 1/100-acre plots selected by random, tally crown diameter and foliage denseness for each tree. Average the crown diameter for the dense foliage trees; likewise, for the medium and sparse separately. Find the weight per tree in the proper tables opposite for average crown diameter and multiply this figure by the number of trees in the foliage class. Do this for each foliage class. Add the three figures. Multiply by 10 on 1/10-acre plots and by 100 on the 1/100-acre plots to get yield per acre.

Guide for Determining Current Yield of Utah Juniper in Utah Upland Stony Loam (Juniper) Site
Current Yield Air Dry Pounds

Crown diameter ft)	Weight per tree	10 trees	50 trees	100 trees	200 trees	300 trees	400 trees	500 trees
Sparse foliage								
1	0.1	1	5	10	20	30	40	50
2	0.3	3	15	30	60	90	120	150
3	0.6	6	30	60	120	180	240	300
4	1.0	10	50	100	200	300	400	500
5	1.3	13	65	130	260	390	520	650
6	1.6	16	80	160	320	480	640	800
7	1.9	19	95	190	380	570	760	950
8	2.3	23	115	230	460	690	920	1150
9	2.6	26	130	260	520	780	1040	1300
10	2.9	29	145	290	580	870	1160	1450
11	3.3	33	165	330	660	990	1320	1650
12	3.6	36	180	360	720	1080	1440	1800
13	4.0	40	200	400	800	1200	1600	2000
14	4.4	44	220	440	880	1320	1760	2200
15	4.7	47	235	470	940	1410	1880	2350
16	5.1	51	255	510	1020	1530	2040	2550
17	5.5	55	275	550	1100	1650	2200	
18	5.8	58	290	580	1160	1740	2320	
19	6.2	62	310	620	1240	1860	2480	
20	6.6	66	330	660	1320	1980	2640	
Medium foliage								
1	0.1	1	5	10	20	30	40	50
2	0.3	3	15	30	60	90	120	150
3	0.6	6	30	60	120	180	240	300
4	1.0	10	50	100	200	300	400	500
5	1.4	14	70	140	280	420	560	700
6	1.9	19	95	190	380	570	760	950
7	2.5	25	125	250	500	750	1000	1250
8	3.1	31	155	310	620	930	1240	1550
9	3.8	38	190	380	760	1140	1520	1900
10	4.6	46	230	460	920	1380	1840	2300
11	5.4	54	270	540	1080	1620	2160	2700
12	6.2	62	310	620	1240	1860	2480	
13	7.2	72	360	720	1440	2160		
14	8.1	81	405	810	1620	2430		
15	9.1	91	455	910	1820	2730		
16	10.2	102	510	1020	2040			
17	11.3	113	565	1130	2260			
18	12.4	124	620	1240	2480			
19	13.6	136	680	1360				
20	14.8	148	740	1480				
Dense foliage								
1	0.1	1	5	10	20	30	40	50
2	0.3	3	15	30	60	90	120	150
3	0.7	7	35	70	140	210	280	350
4	1.2	12	60	120	240	360	480	600
5	1.9	19	95	190	380	570	760	950
6	2.7	27	135	270	540	810	1080	1350
7	3.6	36	180	360	720	1080	1440	1800
8	4.7	47	235	470	940	1410	1880	2350
9	5.9	59	295	590	1180	1770	2360	
10	7.2	72	360	720	1440	2160		
11	8.6	86	430	860	1720	2580		
12	10.2	102	510	1020	2040			
13	11.9	119	595	1190	2380			
14	13.7	137	685	1370	2740			
15	15.6	156	780	1560				
16	17.7	177	885	1770				
17	19.9	199	995	1990				
18	22.2	222	1110	2220				
19	24.6	246	1230	2460				
20	27.2	272	1360	2720				

Annual Foliage and Fruit Production per Juniper Tree on Different Sites and for Different Foliage Classes

Crown diameter	Site Upland loam foliage and fruit sparse/medium/dense			Upland stony loam foliage and fruit sparse/medium/dense			Upland gravelly loam foliage and fruit sparse/medium/dense			Upland shallow loam foliage and fruit sparse/medium/dense			Upland shallow hardpan foliage and fruit sparse/medium/dense		
1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
2	0.2	0.3	0.4	0.4	0.3	0.3	0.4	0.4	0.5	0.2	0.2	0.5	0.3	0.4	0.5
3	0.4	0.6	0.9	0.7	0.6	0.7	0.6	0.7	0.9	0.4	0.5	1.0	0.7	0.9	1.4
4	0.6	1.1	1.5	1.0	1.0	1.2	1.0	1.1	1.5	0.7	0.8	1.6	1.2	1.6	2.4
5	0.9	1.6	2.1	1.3	1.4	1.9	1.3	1.6	2.1	1.0	1.3	2.2	1.8	2.6	3.8
6	1.3	2.1	3.1	1.6	1.9	2.7	1.7	2.1	2.7	1.4	1.8	2.9	2.7	3.7	5.4
7	1.6	2.8	4.0	1.9	2.5	3.6	2.1	2.6	3.5	1.7	2.4	3.8	3.6	5.0	7.4
8	2.0	3.5	5.1	2.3	3.1	4.7	2.6	3.2	4.3	2.2	3.1	4.6	4.7	6.5	9.6
9	2.5	4.3	6.3	2.6	3.8	5.9	3.1	3.9	5.1	2.6	3.8	5.6	6.0	8.2	12.2
10	3.0	5.2	7.6	2.9	4.6	7.2	3.6	4.6	6.0	3.1	4.6	6.6	7.4	10.1	15.1
11	3.5	6.2	9.0	3.3	5.4	8.6	4.1	5.3	7.0	3.6	5.5	7.6	9.0	12.1	18.2
12	4.0	7.2	10.5	3.6	6.2	10.2	4.7	6.1	8.0	4.2	6.5	8.8	10.7	14.4	21.7
13	4.6	8.3	12.1	4.0	7.2	11.9	5.2	6.9	9.1	4.7	7.6	9.9	12.6	16.9	25.5
14	5.2	9.4	13.9	4.4	8.1	13.7	5.8	7.8	10.2	5.3	8.7	11.2	14.6	19.5	29.6
15	5.9	10.6	15.6	4.7	9.1	15.6	6.5	8.7	11.3	6.0	9.9	12.4	16.7	22.4	33.9
16	6.5	11.9	17.5	5.1	10.2	17.7	7.1	9.6	12.5	6.6	11.1	13.8	19.0	25.5	38.6
17	7.2	13.2	19.4	5.5	11.3	19.9	7.8	10.5	13.7	7.3	12.4	15.1	21.5	28.7	43.6
18	8.0	14.6	21.5	5.8	12.4	22.2	8.4	11.5	15.0	8.0	13.8	16.6	24.1	32.1	48.9
19	8.7	16.1	23.7	6.2	13.6	24.6	9.1	12.5	16.3	8.7	15.3	18.0	26.9	35.5	54.5
20	9.5	17.6	26.0	6.6	14.8	27.2	9.8	13.6	17.6	9.5	16.8	19.6	29.8	39.5	60.4

General Soil Features Associated with Sites Named in "Guides for Determining Current Yield of PIMO and JUOS in Utah"

Site name	Precipitation zone (in)	Range in slope (%)	Soil depth	Coarse fragments in profile	Range in AWC (in)
Upland stony loam	12–16	5–30	Deep to very deep over bedrock	50% (45 60% at soil surface)	2–4 (6)
Semidesert stony loam	8–12	5–30	50 in over bedrock	50% (45-60% at soil surface)	2–4
Upland gravely loam	12–16	4–15	35–40 in	35–65%	2–3
Upland loam	12–16	3–20	40 in to bedrock	35–60% (in upper profile	3–6
Upland shallow hardpan	12–16	5–20	6–20 in over hardpan	15–60% (often nonskeletal)	1.5–3
Upland shallow loam	12–16	8–60	14–20 in (15 in) to bedrock	75%	0.5–1.5

Browse Resource Evaluation

Cooperator: ____________________ Ecological site: ____________________

Pasture: ____________________ Location in pasture: ____________________

Kinds of browsing animals: ____________________ Examiner: ____________________

Goals for browse resource: ____

Date of initial evaluation: ____/____/____

	Browse composition			Browse trend					
	Occurrence			Hedging or browse line			Reproduction		
	Abundant	Common	Scarce	Not evident	Moderate	Severe	Abundant	Adequate	Not adequate
Preferred species									
Desirable species									
Non-preferred species									

Browse composition / **Browse trend**

Judge composition and trend based on majority of evidence

Browse composition	Browse trend
Good	Upward
Fair	Stable or not apparent
Poor	Downward

Note: ____

____

Utilization of current year's growth

Key species	Season of use	Planned use percent	Actual use percent – Years							
			Date observed							

Instructions for Browse Resource Evaluation Worksheet

The worksheet can assist managers evaluate the composition and trend of the browse resource, as well as document the actual use of key browse species over time. This information is used to identify problems, formulate alternatives, and measure progress in attaining browse management goals.

Browse composition evaluates the occurrence of browse species according to preference categories. Species are designated as preferred, desirable, or non-preferred based on the species of browsing animal and the appropriate ecological site descriptions.

Occurrence: After a thorough observation of the area, determine the occurrence of each listed species and place a checkmark or an x in the appropriate block as defined.

Abundant The species dominates or characterizes the area observed; it makes up greater than 5% canopy and often greater than 20%.
Common The species is easily found, but is not present in abundance; it usually makes up 1–5% canopy.
Scarce Insignificant amounts of the species is present and may be difficult to find; it usually makes up far less than 1% canopy.

Browse composition is judged as good, fair, or poor based on the preponderance of entries in the shaded boxes. For example, if there were four entries in the fair blocks, one in the good blocks, and 2 in the poor blocks, the overall browse composition would be judged as fair.

Browse trend evaluates the health and vigor of the browse resource based on signs of past use and on reproduction. Hedging and browse lines are distinctive growth forms that occur on shrubs or trees subjected to long term heavy use. After a thorough examination of the selected species in the area, determine the level of hedging or browse line and status of reproduction and place a check mark or x in the appropriate block as defined below.

Hedging or browse line: Hedging is evaluated on short shrubs which are entirely or mostly within reach of browsing animals. Browse line is evaluated on taller shrubs and trees where a portion of the plant is above browsing height.

Not evident On shorter plants, there is little or no evidence of hedging. On taller plants, there is little or no reduction of lower growth. Production of lower branches and twigs is similar to those above the reach of animals.
Moderate On shorter plants, most recent year's twigs have been browsed, resulting in branching and rebranching from lateral buds; growth form is somewhat compact. On taller plants, there is a visible thinning of growth up to browsing height; lower branches and twigs are considerably less productive than those beyond reach of the animals.
Severe Shorter plants are very compact or have a stunted appearance; may be characterized by very short twigs, stubby branches, small leaves, low production or excessive number of dead branches. On taller plants, a browse line is strikingly evident; there is little or no production on twigs within reach of animals; most lower branches are absent.

Browse trend is judged as upward, stable (or not apparent), or downward based upon the preponderance of entries in the shaded boxes.

Reproduction: A reproduction evaluation is made to determine the future potential of a species in the community. The presence of young seedlings is only one measure of reproduction. The survival of new plants for the first 1 to 5 years is often the limiting factor, even though new seedlings or root sprouts may be present in some abundance in some years. A good distribution of various age plants from young to fully mature is a better indicator of successful reproduction.

Abundant The population of a species is increasing in the community; more young plants are present than are old plants.
Adequate Sufficient seedlings and young plants are present to approximately maintain the appropriate population status of the species in the community; plants that are decadent or dying are being replaced by new plants.
Inadequate Few or no seedlings or young plants are present; population is either declining or stagnated with mature plants.

Utilization of current year's growth—This section is used to record the actual degree of use on key species in the same area over a period of years. Browse use is usually determined sometime between late fall and late winter. Degree of use is expressed as the percentage, by weight, of the current year's twig and leaf production within reach of browsing animals that has been consumed. Use is most easily estimated by comparing accessible twigs to twigs which are inaccessible to browsing animals. Determinations should be made by observing many twigs on a number of different plants. Current year's twig growth is distinguished from older twigs by color, texture, and size.

Trend Determinations

Ecological Site____
Reference Plant Community_______________________________________
Location____
Cooperator____________________

Initial Trend Determination: Date:________ Conservationist____________

Plant Factors (circle as appropriate)

Vigor of desired key plants:	Good	Fair	Poor
Seedlings & young desired plants:	Abundant	Some	None
Decadent plants:	Many	Some	None
Plant residues & litter:	Abundant	Adequate	Inadequate
Invading undesirable plants:	None	Some	Many

Soil Factors (circle as appropriate)

Surface erosion:	Slight	Moderate	Severe
Crusting:	Slight	Moderate	Severe
Compaction: :	Slight	Moderate	Severe
Percent bare ground:	Less than expected	Normal	More than expected
Gullies & rills:	None	Few	Numerous
Overall soil degradation:	Slight	Moderate	Severe

Other Factors

Major invading species:____
Canopy and/or cover percent____

Overall Trend Rating (s): (Circle the appropriate kind of trend and rating)

Range Trend (Toward or away from historic climax plant community)

Toward **Not apparent** **Away from**

Planned Trend (Toward or away from desired plant community)

Positive **Not apparent** **Negative**

Followup Trend Determination: Date:________ Conservationist__________

(to be made in subsequent years following initial trend determination)

Plant Factors (circle as appropriate)

Vigor of desired key plants:	Good	Fair	Poor
Seedlings & young desired plants:	Abundant	Some	None
Decadent plants:	Many	Some	None
Plant residues & litter:	Abundant	Adequate	Inadequate
Invading undesirable plants:	None	Some	Many

Soil Factors (circle as appropriate)

Surface erosion:	Slight	Moderate	Severe
Crusting:	Slight	Moderate	Severe
Compaction: :	Slight	Moderate	Severe
Percent bare ground:	Less than expected	Normal	More than expected
Gullies & rills:	None	Few	Numerous
Overall soil degradation:	Slight	Moderate	Severe

Other Factors

Major invading species:____
Canopy and/or cover percent____

Overall Trend Rating (s): (Circle the appropriate kind of trend and rating)

Range Trend (Toward or away from historic climax plant community)

Toward **Not apparent** **Away from**

Planned Trend (Toward or away from desired plant community)

Positive **Not apparent** **Negative**

Worksheet For Determining Similarity Index

Client ______________________ **Ecological site** ______________________

Location ______________________ **Reference vegetation state** ______________________

Date ______________________ **Completed by** ______________________

A	B	C	D	E	F	G	H	I	J
Species name	Green wt. pounds	% dry weight 1/	% current growth ungrazed 1/	% growth curve comple-ted 1/	% of normal produc-tion 1/	Recon-struction factor C / (D)(E)(F)	Recon-structed present weight	Pounds in reference state	Pounds allow-able
K. Total normal annual production in reference vegetation state (from ecological site description).									
L. Total pounds of allowable present (total of pounds in column J).									
M. Similarity index (L divided by K x 100 = M).									

1/ Express all percents as decimal values (Example: 60%=.6)

Instructions for Worksheet for Determining Similarity Index

A. Species name	Enter the common or scientific name of the plant species.
B. Green wt. pounds	Enter the fresh clipped weight of each species.
C. Percent dry weight	Enter the percent air dry weight or oven dry weight as a decimal value.
D. Percent current growth ungrazed	Enter the estimated percent (as a decimal value) of the current growth that has not been removed by grazing or harvest.
E. Percent growth curve completed	Enter the percent (as a decimal value) of the current years growth for each species that should normally have occurred by the date of this determination.
F. Percent of normal production	Enter an estimation of the current years forage growth in comparison to normal expressed as a percent (as a decimal value) of normal. Example: .9 means the year's production is 90% of normal or 10% below normal. 1.1 is 110% of normal or 10% above normal.
G. Reconstruction factor	This factor is calculated by dividing (C) Percent dry weight by the product obtained by multiplying (D) Percent current growth ungrazed times (E) Percent growth curve completed times (F) Percent of normal production. (C / D x E x F = G)
H. Reconstructed present weight	This value is calculated by multiplying (B) Green weight in pounds by (G) the Reconstruction factor. (B x G = H)
I. Pounds in reference vegetation state	Enter the pounds for each plant species as shown in the appropriate reference vegetation state in the ecological site description.
J. Pounds allowable	Enter the lesser of (H) Reconstructed present weight or (I) pounds. No more than the pounds in the reference vegetation state plant community may be counted in determining similarity index.
K. Total normal annual production in reference vegetation state	This is the total normal product of all plants shown in the appropriate reference vegetation state plant community description of the ecological site description.
L. Total pounds of allowable present	This is the total of all weight shown in column (J). It is all the weight that is allowed to count toward determining similarity index.
M. Similarity index	This is calculated by dividing (L) Total pounds of allowable present by (K) total Normal annual production and multiplying by 100 to express it as a percent. (L / K x 100 = M)

Reference Sheet

Author(s)/participants ____

Contract for lead author ____

Date ___________ **MLRA** ______________________**Ecological site**_________________________ This **must** be verified based on soils and climate (see ecological site description): Current plant community cannot be used to identify the ecological site.

Composition (Indicators 10 and 12) based on ☐ Annual production ☐ Foliar cover ☐ Biomass

Indicators
For each indicator, describe the potential for the site. Where possible, (1) use numbers, (2) include expected range of values for above- and below-average years and natural disturbance regimes for **each** community within the reference state, when appropriate and (3) cite data. Continue descriptions on separate sheet.

1. Number and extent of rills:

2. Presence of water flow patterns:

3. Number and height of erosional pedestals or terracettes:

4. Bare ground from ecological site description or other studies (rock, litter, lichen, moss, plant canopy are **not** bare ground):

5. Number of gullies and erosion associated with gullies:

6. Extent of wind scoured, blowouts, and/or depositional areas:

7. Amount of litter movement (describe size and distance expected to travel):

8. Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):

9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):

10. Effect of plant community composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:

11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):

12. Functional/structural groups (list in order of descending dominance by above-ground production or live foliar cover (specify) using symbols: >>, >, = to indicate much greater than, greater than, and equal to; place dominants, subdominants and "others" on separate lines):
    Dominants:
    Subdominants:
    Other:

13. Amount of plant mortality and decadence (include which functional groups are expected to show morality or decadence):

14. Average percent litter cover (_______%) and depth (_______ inches)

15. Expected annual production (this is TOTAL above-ground production, not just forage production):
    _________ - _________ lbs/acre or kg/ha (choose one)

16. Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or codominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years what is NOT expected in the reference state for the ecological site:

17. Perennial plant reproductive capability:

Reference Sheet (standard example)

Author(s)/participants *Winnemucca class participants (May 12-15, 2005)*

Contract for lead author ______________________

Date *5-1-05* **MLRA** *024* **Ecological site** *Loamy 8-10" PZ 024XY005NV* This **must** be verified based on soils and climate (see ecological site description): Current plant community cannot be used to identify the ecological site.

Composition (indicators 10 and 12) based on ☑ Annual production ☐ Foliar cover ☐ Biomass

Indicators

For each indicator, describe the potential for the site. Where possible, (1) use numbers, (2) include expected range of values for above- and below-average years and natural disturbance regimes for **each** community within the reference state, when appropriate and (3) cite data. Continue descriptions on separate sheet.

1. Number and extent of rills:
Minimal on slopes less than 10% and increasing slightly as slopes increase up to 50%. Rills spaced 15-20 feet apart when present on slopes of 10-50%. After wildfires, high levels of natural herbivory or extended drought, or combinations of these disturbances, rills may double in numbers on slopes from 10-50% after high intensity summer thunderstorms.

2. Presence of water flow patterns:
Generally up to 20 feet apart and short (less than 10 feet long) with numerous obstructions that alter the water flow path. On slopes of 10-50%, flow patterns increase in number and length. Flow pattern length and numbers may double after wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances if high intensity summer thunderstorms occur.

3. Number and height of erosional pedestals or terracettes:
Plant or rock pedestals and terracettes are almost always in flow patterns. Wind caused pedestals are rare and only would be on the site after wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances. Pedestals of Sandberg bluegrass on pedestals outside water flow patterns are generally caused by frost heaving, not erosion. Pedestals and terracettes would be particularly apparent on 10-50% slpoes, especially immediately after high intensity summer thunderstorms.

4. Bare ground from ecological site description or other studies (rock, litter, lichen, moss, plant canopy are **not** bare ground):
10-20% or less bare ground with bare patches less than 10% of the evaluation area occurring as intercanopy patches larger than 2 feet in diameter (intercanopy patches can include areas that are not bare ground). Most large patches can include areas that are not bare ground. Within this range, lower slopes are expected to have less bare ground than steeper slopes. Upper end of precip range (10") will also have less bare ground. Canopy gaps generallyless than 12 inches in diameter in the intervals between natural disturbance events. Bare ground would be expected to increase to 80% or more the first year following wildfire but to decrease to prefire levels with 2-5 years depending on climate and other disturbances. Multi-year droughts can also cause bare ground to increase to 30%.

5. Number of gullies and erosion associated with gullies:
Gullies are rare and would only be present when a high intensity summer thunderstorm occurs after wildfires, with high levels of natural herbivory, extended drought, or combinations of these disturbances.

6. Extent of wind scoured, blowouts, and/or depositional areas:
Wind erosion is minimal. Moderate wind erosion can occur when disturbances such as severe wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances. After rain events, exposed soil surfaces form a physical crust that tends to reduce wind erosion.

7. Amount of litter movement (describe size and distance expected to travel):
Litter movement consists primarily of redistribution of fine litter (herbaceous plant material) in flow patterns for distances of 1-3 feet on 2-15% slopes, 4-6 feet on 15-30% slopes and 7-10 feet on 30-50% slopes. After wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances, size of litter and distance litter moves can increase with coarse woody litter and fine litter moving up to 10' (2-15% slope); 25' (15-30% slope) 100' (30-50% slope).

8. Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values):
Values of 4.5-5.5 under canopies and in intercanopy spaces.

9. Soil surface structure and SOM content (include type of structure and A-horizon color and thickness):
Surface layer is light brown and 6-7 inches thick with moderate granular structure. Loss of several millimeters of soil may occur immediately after a high intensity wildfire, high levels of natural herbivory, extended drought, or cominations of these disturbances.

Reference Sheet (standard example cont.)

10. Effect of plant community composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff:
Perennial plants and especially sagebrush capture snow, increasing soil water availability in the spring. High bunchgrass density increases infiltration by improving soil structure and slowing runoff. Loss of sagebrush after a high intensity wildfire reduces snow accumulation in the winter, reducing the depth of soil water recharge negatively affecting growth and production of deep rooted forbs and perennial grasses. This reduced soil water recharge is part of the site dynamics if exotics or other management actions don't delay the succession back to a sagebrush-grass plant community.

11. Presence and thickness of compaction layer (usually none; describe soil profile features which may be mistaken for compaction on this site):
Compaction layers should not be present. There are soil profile features in the top 8 inches of the soil profile that would be mistaken for a management induced soil compaction layer. Silica accumulations can cause denser horizons, however these horizons can be distinguished from compaction by their brittleness and "shiny" material in the horizon. These silica accumulations will increase the hardness of the soil, but compaction can still occur and be detected as degradation of soil structure and loss of macropores.

12. Functional/structural groups (list in order of descending dominance by above-ground production or live foliar cover (specify) using symbols: >>, >, = to indicate much greater than, greater than, and equal to; place dominants, subdominants and "others" on separate lines):
Dominants: *Mid+tall grasses > non-sprouting shrubs (except following fire, when non-resprouting shrubs become rare on the site)*
Subdominants: *Shortgrasses > sprouting shrubs*
Other: *Annual forbs, perennial forbs*
Biological crust will be present with lichen + moss cover of 10-15%
After wildfires the funtional/structural dominance changes to the herbaceous components with a slow 10-20 year recovery of the non-resprouting shrubs (e.g. big sagebrush). Resprouting shrubs tend to increase until the sagebrush re-establishment and increase reduces the resprouting component. High levels of natural herbivory, extended drought, or combinations of these factors can increase shrub/functional/structural groups at the expense of the herbaceous groups and biological crust.

13. Amount of plant mortality and decadence (include which functional groups are expected to show morality or decadence):
Most of the perennial plants in this community are long lived, especially the perennial forbs and shrubs. After moderate to high intensity wildfires, all of the non-resprouting shrubs would die as would a small percentage of the herbaceous understory species. Extended droughts would tend to cause relatively high mortality in short lived species such as bottlebrush squirreltail and Sandberg bluegrass. Shrub mortality would be limited to severe, multiple year droughts. Combinations of wildfires and extended droughts would cause even more mortality for several years following the fire than either disturbance functioning by itself. Up to 20% dead branches on sagebrush following drought alone.

14. Average percent litter cover (___*20*___%) and depth (_*1 1/4*_ inches)
After wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances, litter cover and depth decreases to none immediately after the disturbance (e.g. fire) and dependent on climate and plant production increases to post-disturbance levels in one to five growing seasons.

15. Expected annual production (this is TOTAL above-ground production, not just forage production):
_________ - _________ lb/acre or kg/ha (choose one)
400 lbs/ac in low precip years. 600 lb/ac in average precip years and 800 lb/ac in above average precip years #/acre. After wildfires, high levels of natural herbivory, extended drought, or combinations of these disturbances, can cause production to be significantly reduced (100 -200 lb per ac. the first growing season following a wildfire) and recover slowly under below average precipitation regimes.

16. Potential invasive (including noxious) species (native and non-native). List species which BOTH characterize degraded states and have the potential to become a dominant or codominant species on the ecological site if their future establishment and growth is not actively controlled by management interventions. Species that become dominant for only one to several years what is NOT expected in the reference state for the ecological site:
Cheatgrass is the greatest threat to dominate this site after disturbance (primarily wildfires but disturbances also include high levels of natural herbivory and/or extended drought). Exotic mustards and Russian thistle may dominate soon after disturbance but are eventually replaced as dominants by cheatgrass. Hoary cress, Russian knapweed, bur buttercup and tall whitetop may meet the definition of an invasive species for this site in the future, but do not currently meet the criteria of being a threat to dominate the site after the disturbance.

17. Perennial plant reproductive capability:
Only limitations to reproductive capability are weather-related and natural disease or herbivory that reduces reproductive capability.

Exhibit 4–9 Rangeland health evaluation sheet

Evaluation Sheet (front)

Aerial photo ____

Management unit __________ (Allotment or pasture) State _____ Office _______________ Range/ecol. site code _______________

Ecological site name ____________________ Soil map unit/component name ______________________

Observers ______________________________________ Date ______________

Location (description) ______________________________________

T. _____ R. _____ or ____________N. lat. or UTM E ____________m Position by GPS? Y / N

UTM zone _____ Datum _____

Sec. _____, ______ ____________W. long. or N ____________m Photos taken? Y / N

Size of evaluation area ______________________________________

Composition (indicators 10 and 12) based on: ☐ Annual production ☐ Cover produced during current year or ☐ Biomass

Soil/ site verification:

Range/ecol. site descr., soil surv., and /or ecol.ref. area:

Surface texture______________________

Depth: ☐ very shallow ☐ shallow ☐ moderate ☐ deep

Type and depth of diagnostic horizons:

1. ______________ 3. ______________

2. ______________ 4. ______________

Surf. efferv.:

☐ none ☐ v. slight ☐ slight ☐ strong ☐ violent

Parent material ______Slope _____ % Elevation _____ ft.

Average annual precipation _____ inches

Evaluation area:

Surface texture______________________

Depth: ☐ very shallow ☐ shallow ☐ moderate ☐ deep

Type and depth of diagnostic horizons:

1. ______________ 3. ______________

2. ______________ 4. ______________

Surf. efferv.:

☐ none ☐ v. slight ☐ slight ☐ strong ☐ violent

Topographic position _______________ Aspect ______

Seasonal distribution ______________________

Recent weather (last 2 years) ☐ (1) drought ☐ (2) normal ☐ (3) wet

Wildlife use, livestock use (intensity and season of allotted use), and recent disturbances:

____

____

____

____

____

Off-site influences on evaluation area:

____

____

____

____

____

Criteria used to select this particular evaluation area as REPRESENTATIVE (specific info. and factors considered; degree of "representiveness")

____

____

____

____

____

Other remarks (contiune on back if necessary):

____

____

____

____

____

Reference: (1) Reference sheet: ____________ Author ______________________ Creation date _________

or (2) other (e.g., name and date of ecological site description; locations of ecological reference area(s) ______________

____

Evaluation Sheet (back)

Departure from expected	Code	Instructions for evaluation sheet, page 2
None to Slight	N-S	(1) Assign 17 indicator ratings. If indicator not present, rate None to Slight.
Slight to Moderate	S-M	(2) In the three grids below, write the indicator number in the appropriate column for each indicator that is applicable to the attribute.
Moderate	M	(3) Assign over rating for each attribute based on preponderance of evidence.
Moderate to Extreme	M-E	(4) Justify each attribute rating in writing.
Extreme to Total	E-T	

Indicator	Rating	Comments
1. Rills	S H	
2. Water-flow patterns	S H	
3. Pedestals and/or terracettes	S H	
4. Bar ground _______%	S H	
5. Gullies	S H	
6. Wind-scoured, blowouts, and/or deposition areas	S	
7. Litter movement	S	
8. Soil surface resistance to erosion	S H B	
9. Soil surface loss or degradation	S H B	
10. Plant community composition and distribution relative to infiltration	H	
11. Compaction layer	S H B	
12. Functional/structional groups	B	
13. Plant mortality/decadence	B	
14. Litter amount	H B	
15. Annual production	B	
16. Invasive plants	B	
17. Reproductive capability of perennial plants	B	

E-T	**M-E**	**M**	**S-M**	**N-S**

Attribute rating justification
Soil & Site Stability:______

S (10 indicators):
Soil & Site Stability
rating:______________

E-T	**M-E**	**M**	**S-M**	**N-S**

Attribute rating justification
Hydrologic Function:

H (10 indicators):
Hydrologic Function
Rating:______________

E-T	**M-E**	**M**	**S-M**	**N-S**

Attribute rating justification
Biotic Integrity:

B (9 indicators):
Biotic Integrity
rating:______________

Evaluation Sheet (front)

Aerial photo ______

Management unit *Allotment 1, pasture 1* (Allotment or pasture) State *NM* Office *Las Cruces* Range/ecol. site code *042XB999NM*

Ecological site name *Limy* Soil map unit/component name *Nickel gravelly fine sandy loam*

Observers *Joe Smith, Jose Garcia, and Thaddeus Jones* Date *June 10, 2002*

Location (description) *Limy site two miles north of windmill in S.E. pasture*

T. *11S* R. *23W* or ______ N. lat. or UTM E ______ m Position by GPS? Y / (N)

UTM zone ______ Datum ______

Sec. *12*, *NE 1/4* ______ W. long. or N ______ m Photos taken? (Y) / N

Size of evaluation area *Evaluation area is approximately 3 acres and represents entire ecological site in this pasture*

Composition (indicators 10 and 12) based on: ☐ Annual production ☑ Cover produced during current year or ☐ Biomass

Soil/ site verification:

Range/ecol. site descr., soil surv., and /or ecol.ref. area:

Surface texture *grfsl, grlfs, gl*

Depth: ☐ very shallow ☐ shallow ☐ moderate ☑ deep

Type and depth of diagnostic horizons:

1. *Calcic horizon w/in 20"* 3. ______
2. ______ 4. ______

Surf. efferv.:

☐ none ☐ v. slight ☐ slight ☑ strong ☐ violent

Parent material *Alluv* Slope *0-5* % Elevation *4,100* ft.

Average annual precipation *8-12* inches

Evaluation area:

Surface texture *gfsl*

Depth: ☐ very shallow ☐ shallow ☐ moderate ☑ deep

Type and depth of diagnostic horizons:

1. *Calcic horizon at 15"* 3. ______
2. ______ 4. ______

Surf. efferv.:

☐ none ☐ v. slight ☐ slight ☑ strong ☐ violent

Topographic position *Toeslope* Aspect *South*

Seasonal distribution *Summer thunderstorms dominate*

Recent weather (last 2 years) ☐ (1) drought ☑ (2) normal ☐ (3) wet

Wildlife use, livestock use (intensity and season of allotted use), and recent disturbances:

Wildlife use is dominated by pronghorn antelope in the winter. Livestock use was extremely heavy year long during 1900-1930. Last 50 years livestock use has been cow/calf moderate year long use.

Off-site influences on evaluation area:

None

Criteria used to select this particular evaluation area as REPRESENTATIVE (specific info. and factors considered; degree of "representiveness")

Area is located near a pasture key area. It is located in the center of the ecological site and represents the typical amount of livestock, wildlife, and recreational uses on this area. This ecological site dominates this pasture. The area is 3/4 of mile from the closest water source.

Other remarks (contiune on back if necessary):

Reference: (1) Reference sheet: *Limy SD-42B* Author *J. Christensen* Creation date *3-23-2002*

or (2) other (e.g., name and date of ecological site description; locations of ecological reference area(s) *Limy ecological site 042XB999NM, June 2001*

Evaluation Sheet (back)

Departure from expected	Code	Instructions for evaluation sheet, page 2
None to Slight	N-S	(1) Assign 17 indicator ratings. If indicator not present, rate None to Slight.
Slight to Moderate	S-M	(2) In the three grids below, write the indicator number in the appropriate column for each indicator that is applicable to the attribute.
Moderate	M	(3) Assign over rating for each attribute based on preponderance of evidence.
Moderate to Extreme	M-E	(4) Justify each attribute rating in writing.
Extreme to Total	E-T	

Indicator	Rating	Comments
1. Rills	S H *M*	*Active rill formation evident at infrequent intervals*
2. Water-flow patterns	S H *M-E*	*Flow patterns show cutting and deposition and some connectivity*
3. Pedestals and/or terracettes	S H *S-M*	*Pedestalling in flow patterns only not common*
4. Bar ground _______%	S H *M*	*Bare ground rarely connected*
5. Gullies	S H *N-S*	
6. Wind-scoured, blowouts, and/or deposition areas	S *N-S*	
7. Litter movement	S *M*	*Small litter shows sign of moderate movement, larger litter - slight movement*
8. Soil surface resistance to erosion	S H B *M-E*	*Stability values average from 3-4 on surfaces under vegetation canopy and 1-2 in interspaces*
9. Soil surface loss or degradation	S H B *M*	*Severe past erosion has left much of the site without much surface horizon*
10. Plant community composition and distribution relative to infiltration	H *M-E*	*Change from grass dominated to shrub dominated has decreased infiltration and bare ground has increased run-off*
11. Compaction layer	S H B *N-S*	
12. Functional/structional groups	B *M*	*Subdominate group basically gone (warm-season stoloniferous grass and subdominate group (warm-season narrow leaf bunchgrass) and minor group (evergreen subshrub) have*
13. Plant mortality/decadence	B *S-M*	
14. Litter amount	H B *M-E*	*Very little litter is on the site from the time of year and rainfall for the year*
15. Annual production	B *S-M*	*Production is about 70 % of expected*
16. Invasive plants	B *N-S*	
17. Reproductive capability of perennial plants	B *S-M*	*Plants show some signs of stress that will reduce seed production and stolon production this year*

E-T	M-E	M	S-M	N-S
		9		
		7		*11*
	8	*4*		*6*
	2	*1*	*3*	*5*

Attribute rating justification
Soil & Site Stability:
Although there is some active erosion in flow patterns, most is old and healing. Lots of water leaving the site, but not much erosion. All erosion occurring as concentrated flow.

S (10 indicators):
Soil & Site Stability
rating: *M*

E-T	M-E	M	S-M	N-S
	14			
	10	*9*		
	8	*4*		*11*
	2	*1*	*3*	*5*

Attribute rating justification
Hydrologic function:
Lots of water leaving the site. Runoff is increasing and all litter is being washed away.

H (10 indicators):
Hydrologic Function
Rating: *M-E*

E-T	M-E	M	S-M	N-S
			17	
	14	*12*	*15*	*16*
	8	*9*	*13*	*11*

Attribute rating justification
Biotic Integrity:
Shift in functional structural groups is significant, justifying moderate rating.

B (9 indicators):
Biotic Integrity
rating: *M*

Evaluation Matrix

State __________ **Office**____________________ **Ecological site**___________________________________**Site ID**_________________

Authors ____ **Revision date**____________________

Departure from Reference State of the Ecological Site

Indicator*	Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
1. Rills					Reference Sheet:_____
Generic descriptor	Rill formation is severe and well defined throughout most of the site	Rill formation is moderately active and well defined throughout most of the site	Active rill formation is slight at infrequent intervals; mostly in exposed areas	No recent formation of rills; old rills have blunted or muted features	Current or past formation of rills as expected for the site
2. Water flow patterns					Reference Sheet:_____
Generic descriptor	Water flow patterns extensive and numerous; unstable with active erosion; usually connected	Water flow patterns more numerous and extensive than expected; deposition and cut areas common; occasionally connected	Number and length of water flow patterns nearly match what is expected for the site; erosion is minor with some instability and deposition	Number and length of water flow patterns match what is expected for the site; some evidence of minor erosion. flow patterns are stable and short	Matches what is expected for the site; minimal evidence of past or current soil deposition or erosion
3. Pedestals and/or terracettes					Reference Sheet:_____
Generic descriptor	Abundant active pedestalling and numerous terracettes. Many rocks and plants are pedestaled; exposed plant roots are common	Moderate active pedestalling; terracettes common. Some rocks and plants are pedestaled with occasional exposed roots	Slight active pedestalling; most pedestals are in flow paths and interspaces and/or on exposed slopes. Occasional terracettes present	Active pedestalling or terracette formation is rare; some evidence of past pedestal formation, especially in water flow patterns on exposed slopes	Current or past evidence of pedestaled plants or rocks as expected for the site. Terracettes absent or uncommon

* Descriptions for each indicator should be more specific than those listed in the generic descriptors, if possible, and refer to the criteria included in the none to slight description, which is based on the reference sheet (app. 1).

Evaluation Matrix cont.

	Departure from Reference State of the Ecological Site				
Indicator*	Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
4. Bare ground					Reference Sheet:_____
Generic descriptor	Much higher than expected for the site. Bare areas are large and generally connected	Moderate to much higher than expected for the site. Bare areas are large and occasionally connected	Moderately higher than expected for the site. Bare areas are of moderate size and sporadically connected	Slightly to moderately higher than expected for the site. Bare areas are small and rarely connected	Amount and size of bare areas match that expected for the site
8. Gullies					Reference Sheet:_____
Generic descriptor	Common with indications active erosion and downcutting; vegetation is infrequent on slopes and/or bed. Nickpoints and headcuts are numerous and active	Moderate in number to common with indications of active erosion; vegetation is inermittent on slopes an/or bed. Headcuts are active; downcutting is not apparent	Moderate in number with indications of active erosion; vegetation is intermittent on slopes and/or be. Occasional headcuts may be present	Uncommon, vegetation is stabilizing the bed and slopes; no signs of active headcuts, nickpoints, or bed erosion	Match what is expected for the site; drainages are represented as natural stable channels; vegetation common and no signs of erosion
6. Wind scoured, blowout, and/or depositional areas					Reference Sheet:_____
Generic descriptor	Extensive	Common	Occasionally present	Infrequent and few	Match what is expected for the site

* Descriptions for each indicator should be more specific than those listed in the generic descriptors, if possible, and refer to the criteria included in the none to slight description, which is based on the reference sheet (app. 1).

Evaluation Matrix cont.

Departure from Reference State of the Ecological Site

Indicator*	Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
7. Litter movement (wind or water) ______	______	______	______	______	Reference Sheet:______
Generic descriptor	Extreme; concentrated around obstructions. Most size classes of litter have been displaced	Moderate to extreme; loosely concentrated near obstructions. Moderate to small size classes of litter have been displaced	Moderate movement of smaller size classes in scattered concentrations around obstructions and in depressions	Slightly to moderately more than expected for the site with only small size classes of litter being displaced	Matches that expected for the site with a fairly uniform distribution of litter
8. Soil surface resistance to erosion	______	______	______	______	Reference Sheet:______
Generic descriptor	Extremely reduced throughout the site. Biological stabilization agents including organic matter and biological crusts virtually absent	Significantly reduced in most plant canopy interspaces and moderately reduced beneath plant canopies. Stabilizing agents present only in isolated patches	Significantly reduced in at least half of the plant canopy interspaces, or moderately reduced throughout the site	Some reduction in soil surface stability in plant interspaces or slight reduction throughout the site. Stabilizing agents reduced below expected	Matches that expected for the site. Surface soil is stabilized by organic matter decomposition products and/or a biological crust
9. Soil surface loss of degradation	______	______	______	______	Reference Sheet:______
Generic descriptor	Soil surface horizon absent. Soil structure near surface is similar to, or more degraded, than that in subsurface horizons. No distinguishable difference in subsurface organic matter content	Soil loss or degradation severe throughout site. Minimal differences in soil organic matter content and structure of surface and subsurface layers	Moderate soil loss or degradation in plant interspaces with some degradation beneath plant canopies. Soil structure is degraded and soil organic matter content is significantly reduced	Some soil loss has occurred and/or soil structure shows signs of degradation, especially in plant interspaces	Soil surface horizon intact. Soil structure and organic matter content match that expected for site

* Descriptions for each indicator should be more specific than those listed in the generic descriptors, if possible, and refer to the criteria included in the none to slight description, which is based on the reference sheet (app. 1).

Evaluation Matrix cont.

	Departure from Reference State of the Ecological Site				
Indicator*	Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
10. Plant community composition and distribution relative to infiltration and runoff ___	___	___	___	___	Reference Sheet:___
Generic descriptor	Infiltration is severely decreased due to adverse changes in plant community composition and/or distribution. Adverse plant cover changes have occurred	Infiltration is greatly decreased due to adverse changes in plant community composition and/or distribution. Detrimental plant cover changes have occurred	Infiltration is moderately reduced due to adverse changes in plant community composition and/or distribution. Plant cover changes negatively affect infiltration	Infiltration is slightly to moderately affected by minor changes in plant community composition and/or distribution. Plant cover changes have only a minor effect on infiltration	Infiltration and runoff are not affected by any changes in plant community composition and distribution. Any changes in infiltration and runoff can be attributed to other factors (e.g. compaction)
11. Compaction layer (below soil surface)___	___	___	___	___	Reference Sheet:___
Generic descriptor	Extensive; severely restricts water movement and roof penetration	Widespread; greatly restricts water movement and root penetration	Moderately wide-spread, moderately restricts water movement and root penetration	Rarely present or is thin and weakly restrictive to water movement and root penetration	Matches that expected for the site; none to minimal, not restrictive to water movement and root penetration

* Descriptions for each indicator should be more specific than those listed in the generic descriptors, if possible, and refer to the criteria included in the none to slight description, which is based on the reference sheet (app. 1).

Evaluation Matrix cont.

	Departure from Reference State of the Ecological Site				
Indicator*	Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
12. Functional/ structural groups (F/S groups) see functional/structural groups worksheet					Reference Sheet:_____
Generic descriptor	Number of F/S groups greatly reduced and/or relative dominance of F/S groups has been dramatically altered and/or Number of species within F/S groups dramatically reduced	Number of F/S groups reduced and/or one dominant group and/or one or more sub-dominate group replaced by F/S groups not expected for the site and/or number of species within F/S groups significantly reduced	Number of F/S groups moderately reduced and/or one or more sub-dominant F/S groups replaced by F/S groups not expected for the site and/or number of species within F/S groups moderately reduced	Number of F/S groups slightly reduced and/or relative dominance of F/S groups has been modified from that expected for the site and/or number of species within F/S slightly reduced	F/S groups and number of species in each group closely match that expected for the site
13. Plant mortality Decadence					Reference Sheet:_____
Generic descriptor	Dead and/or decadent plants are common	Dead plants and/or decadent plants are somewhat common	Some dead and/or decadent plants are present	Slight plant mortality and/or decadence	Plant mortality and decadence match that expected for the site
14. Litter amount					Reference Sheet:_____
Generic descriptor	Largely absent or dominant relative to site potential and weather	Greatly reduced or increased relative to site potential and weather	Moderately more or less relative to site potential and weather	Slightly more or less relative to site potential and weather	Amount is what is expected for the potential and weather

* Descriptions for each indicator should be more specific than those listed in the generic descriptors, if possible, and refer to the criteria included in the none to slight description, which is based on the reference sheet (app. 1).

Evaluation Matrix cont.

	Departure from Reference State of the Ecological Site				
Indicator*	Extreme to Total	Moderate to Extreme	Moderate	Slight to Moderate	None to Slight
15. Annual production					Reference Sheet:______
Generic descriptor	Less than 20% of potential production for the site based on recent weather	20-40% of potential production for the site based on recent weather	40-60% of potential production for the site based on recent weather	60-80% of potential production for the site based on recent weather	Exceeds 80% of potential production for the site based on recent weather
16. Invasive plants					Reference Sheet:______
Generic descriptor	Dominate the site	Common throughout the site	Scattered throughout the site	Present primarily in disturbed areas within the site	If present, composition of invasive species, matches that expected for the site
17. Reproductive Capability of Perennial plants (native or seeded					Reference Sheet:______
Generic descriptor	Capability to produce seed or vegetative tillers is severely reduced relative to recent climatic conditions	Capability to produce seed or vegetative tillers is greatly reduced relative to recent climatic conditions	Capability to produce seed or vegetative tillers is moderately reduced relative to recent climatic conditions	Capability to produce seed or vegetative tillers is slightly reduced relative to recent climatic conditions	Capability to produce seed or vegetative tillers is not reduced relative to recent climatic conditions

* Descriptions for each indicator should be more specific than those listed in the generic descriptors, if possible, and refer to the criteria included in the none to slight description, which is based on the reference sheet (app. 1).