CONTENTS FOR AMENDMENT OR-3

600.0401a Oregon Protocols for Rangeland and Pasture / Hayland Inventory and Evaluation

Purpose

The kinds, extents, and magnitudes of resource concerns cannot be determined without an adequate, scientifically defensible resource inventory and evaluation of site-specific data. The analysis is required for the thoughtful development of alternatives that treat the resource concerns, developing critical management specifications, and understanding which aspects of the resource need to be monitored to determine improvement in ecological condition and meeting objectives. This protocol outlines the processes and procedures for collecting resource data for rangelands, pastures, and haylands.

Procedure

The following are usually performed in the order presented. Some of the steps are required for either rangelands or pasture/hayland; these steps are identified with the appropriate land use; otherwise, most of the steps are needed for a complete inventory. Exceptions are noted in each step.

Generally, native plant communities with less than 25% canopy cover by trees are considered rangeland. Dryland (non-irrigated) pastures that do not receive periodic cultural practices are considered seeded range and should be evaluated using the Rangeland Inventory Worksheet (**Exhibits 4-12 & 4-13**). Forage crops (hayland or pasture) should be evaluated using the Pasture/Hayland Inventory Worksheet (**Exhibits 4-17 & 4-18**). Record your findings on the worksheets. Use only the paper or electronic forms approved for use.

Complete the inventory forms as completely as possible. Clearly identify the appropriate ecological site description or forage suitability group (if available).

Detailed instructions for inventorying and evaluating grazing lands can be found in Chapter 4 (***Inventorying and Monitoring Grazing Lands Resources***) of the NRPH.

Assistance for developing alternatives from inventory data and management information can be found in the NRPH Chapter 5 (***Management of Grazing Lands***) section 1 (***Managing Native Grazing Lands***) and section 2 (***Managing Forage Crops and Pasture Lands***). The Entire NRPH is available online.

(a) Required Documentation

The following inventory procedures are required to determine benchmark conditions and to adequately address resource concerns through the conservation planning process.

Inventory – Rangeland: Exhibit 4-12

- ☑ Plant Community Composition
- ☑ Rangeland Similarity Index
- ☑ Annual Productivity and Initial Stocking Rates
- ☑ Apparent Trend
- ☑ Rangeland Health Assessment
- ☑ Planning Notes.

Inventory – Pasture/Hayland: Exhibit 4-17

- ☑ Plant Community Composition
- ☑ Annual Productivity and Initial Stocking Rates
- ☑ Pasture and/or Hayland Condition Score
- ☑ Planning Notes.

Analysis - All Land Uses:

- ☑ Forage & Roughage Inventory by field (Benchmark and Planned)
- ☑ Herd Definition (Benchmark)
- ☑ Livestock-Forage Balance (Benchmark and Planned)
- ☑ Planning Notes.

Required benchmark and planned analysis documents can be developed using the **Grazing Lands Spatial Analysis Tool (GSAT)** computer program. Many of the items listed above can be found in the ***Client Reports*** portion of the program.

(b) Interviewing the Client

It is critical to get as much information as possible from the client in determining benchmark conditions. Usually a great deal of background information that the client knows will help explain current conditions and will indicate opportunities to improve the resources. Experienced planners know that getting the required information is a matter of asking the right questions and communicating respectfully with the client. For grazinglands planning you must know actual grazing use to determine benchmark grazing harvest, how the unit is operated, where the physical structures are (fences, water developments, etc.) in addition to objectives, problems, and opportunities to improve resources.

The following questions have been compiled over the years by planners involved in grazinglands conservation and provide a general indication of the types of information that usually only the client can provide. Obviously, many more questions may need to be answered than those presented here. Use the list as a guide; it can help you avoid missing important facts and save valuable time as well. The answers to these questions should be documented in the planner's notes or on worksheet forms.

Pasture & Range:

- Where is the water in each pasture?

- Where are the salt, mineral, and/or protein supplements located?
- Where are the fence locations? Are they correct on the map? What problems have you had with fencing? Where?
- What types of pasture do you have (native, introduced, irrigated, dryland)?
- Where are your key areas (not overgrazed, not undergrazed)?
- Where are your problem areas?
- When are each of the pastures grazed (dates)?
- How many head are grazed?
- How productive are the pastures? AUMs/acre?
- Pasture rotation? Tillage? Other crops?
- What kinds of wildlife use your rangeland? When? Where? How many?
- Are supplements fed? What type? When is it fed? How much per head per day? Cost per unit?

Hayland:

- Types of hay?
- Hay rotation? Tillage? Other crops?
- Type of roughages harvested? Method?
- When is roughage harvested? How many cuttings? Type of equipment?
- How many tons per acre per year?
- How is the roughage put up? Moisture content?
- How much is sold? Used on the ranch?
- What is the cost of production?
- Is the aftermath grazed? When? How many animals? Productivity? Remaining residue after grazing?

Herd Information:

- How many herds are used?
- What kind(s), breed, class, age, and weight are they?
- What is the bull to cow and/or ram to ewe ratio?
- What are the body condition scores?
- What is the rebreeding percentage?
- Calf or lamb crop (%)?
- Birth dates? Weights?
- Weaning dates? Weights?
- Fixed costs per head?

(c) Inventory Timing

Try to conduct the inventory at a time when the greatest numbers of plant species have grown enough to be easily identified. With experience, your knowledge of your work area and of the plant communities, the effective time for inventory can stretch later into the season. In some cases (pasture/hayland) the plant community will be fairly simple and the major (and minor) components are well known. In rangeland situations, knowledge of the grass and forb communities is required to inventory later in the season.

If you are developing a conservation plan during a period that makes field inventory unreasonable, use the Trend, Health, and Utilization method of forage inventory in the NRPH (Chapter 5 (***Management of Grazing Lands***) section 3 ***Procedures and Worksheets for Planning Grazing Management*** part **600.0510** ***Forage Inventory***). Book values for establishing stocking rates can be selected from **Exhibit 4-13** for rangelands, **Exhibit 4-18** for pastures, or **Exhibit 4-19** for haylands (with or without aftermath grazing). Use either the Oregon Rangeland or Pasture/Hayland Inventory Worksheets or the worksheet in **Exhibit 5.1** of the NRPH.

(d) Key Grazing Area

Use the Key Grazing Area concept for determining the location of the site write-up. The NRPH glossary defines a **Key Grazing Area** as:

> ***A relatively small portion of a pasture or management unit selected because of its location, use, or grazing value as a monitoring point for grazing use. It is assumed that key areas, if properly selected, will reflect the current grazing management over the pasture or management unit as a whole.***

Select an area that is nearest to the geographic center of the pasture/hayland field or ecological site polygon as possible. Avoid fences, water developments, loafing/ruminating areas, salting or supplementing areas, or minor inclusions of differing soils or plant communities. Try to characterize an area that receives neither too little nor too much grazing pressure; try to find an area that reflects the majority of the polygon or field.

Mark the location on your plan map with a number and/or symbol that connects the site with the write-up. If the location is difficult to find, write notes that describe how to get there. Take a GPS waypoint at the site and record on the worksheet (this point can be the beginning of a line intercept transect if one is needed).

Check soil maps and correlations to determine if the observed site is actually what is correlated. It is helpful to dig a small hole with a tile spade to check soil depth, texture, horizons, rock fragments, etc. to confirm the soil type.

(e) Photographs

Photographs should be taken first, before plants are disturbed from conducting the inventory. Take at least three photographs (digital photos are preferred but if using a 35mm camera use ASA 200 color film and have the developer put the photos on a CD). Take a long-range photo that shows the plant community in relation to the landscape (aim at or below the horizon), a short-range photo that shows a local view (aim well below the horizon but not straight down), and a photo of the plant community just in front of your feet (straight down or steep angle).

A good set of photographs at key grazing areas will provide critical benchmark information about pasture and rangeland condition and productivity. They also show the characteristic plant community inventoried at each write-up and provide a starting point for monitoring and follow-up.

If you are clipping for production, take a shot of the clipping ring in place before clipping to show the plant community contained in the plot (***Figure 1***). More photographs may be taken if desired. Record unusual and/or unique qualities of the inventory site: take pictures of water developments, livestock, wildlife, unusual plants, etc.

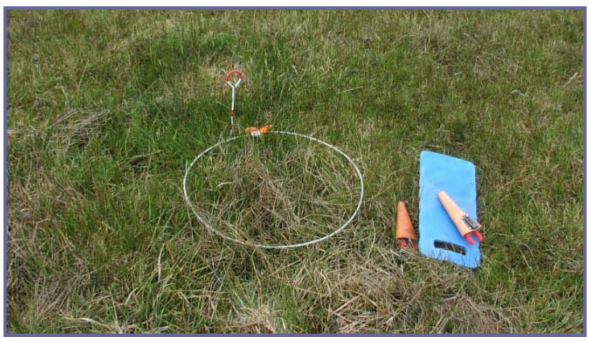


Figure 1, Photo of clipping plot

(f) Growth Curves

Growth curves are a useful tool to help the planner and client determine the availability and accumulation of forage resources. Careful allocation of forages for livestock and wildlife grazing is necessary to ensure sustainability and the maintenance or improvement of ecological condition for all uses. The curves are used to clarify range and pasture forage conditions, evaluate production, allocate forage, and development of time-period stocking rates.

Growth curves show both monthly growth and cumulative growth. Monthly growth is simply the percentage of annual growth that occurs in that month. Cumulative growth shows the rate of growth; usually a sigmoid curve, that occurs on a site. The cumulative growth curve shows for any point in the season, how much of the total annual growth has occurred.

Figure 2 shows a typical growth curve. The bars (histogram) display the estimated monthly growth (read on the left y-axis). Growth can easily be compared between months; the shape of the histogram shows the annual distribution of growth on the site. The line shows the accumulation of annual growth (read on the right y-axis). The steeper the slope of the line, the greater the rate of growth. Where the line flattens, growth rate decreases and dormancy begins when growth stops for a month or longer.

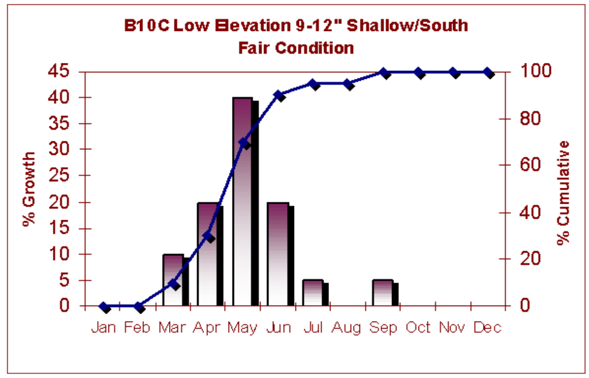


Figure 2, Sample Growth Curve

Growth curves for planning are available from Ecological Site Descriptions in the FOTG, site growth curves folder in Section II of eFOTG, or on the web:

Several curves, estimated by experts in the field, are contained in **Range Technical Notes # 18 (Growth Curves for Western Oregon) & #19 (Growth Curves for Eastern Oregon)**. Some of the same growth curves are used in the **Grazing Lands Spatial Analysis Tool (GSAT)** computer program.

Growth curves may also be developed on site with the client, or from input from other local sources. When developing a curve, start with the overall growth of the plant community in question. Determine the month growth begins and the month it ends. Estimate the month with the most growth and the months with low or no growth. Build the curve for monthly growth first (these should add up to 100%) then mathematically determine the cumulative curve. This information can be entered in the inventory worksheets for rangeland (**Exhibit 4-12**) and pastureland (**Exhibit 4-17**).

(1) Using Growth Curves to Determine Initial Stocking Rates

This section deals with using growth curves for developing seasonal or time-specific stocking guides that reflect the amounts of forage typically present when grazing is taking place. The information in the growth curve will allow you to determine the typical initial stocking rate for a specific time period. Many times an initial stocking rate will express an annual stocking rate, or the stocking rate determined from an allocation of 100% of the growth curve (***Figure 3***).

Time-period stocking rate calculations use the projected or actual use period for grazing to more accurately depict the stocking rate for the period. Using an annual stocking rate for early spring grazing may seriously over estimate the safe amount of forage to allocate to grazing animals.

Figures 3, 4, 5, and 6 depict a bottomland site growth curve with different grazing management considerations. Assuming an annual production of this site at 1600 lbs./acre/year and a Harvest Efficiency (HE) of 25%, the stocking rate for any period of grazing can be calculated and a prescribed grazing plan can be developed that is based on a safe allocation of forage for grazing animals. A "safe" allocation is planned to leave enough plant material for other functions and uses and encourages maintenance or increase in ecological condition (usually determined by the Harvest Efficiency).

The general formula for determining ***time-period stocking rates*** is:

$$\frac{(A \times G \times HE)}{913 \text{ lbs./AUM}}$$

A **= Annual air-dry production in lbs./acre/year**
G **= % of growth curve used**
HE **= Harvest Efficiency**

The following examples show how the stocking rates can be calculated for different management alternatives for prescribed grazing on a single site. Notice how the annual stocking rate differs from the time period stocking rates. In some instances, using the annual stocking rate (100% of the growth curve) for planning grazing may have a deleterious effect on the grazing resource when used for grazing a portion, usually an early portion, of the growth curve.

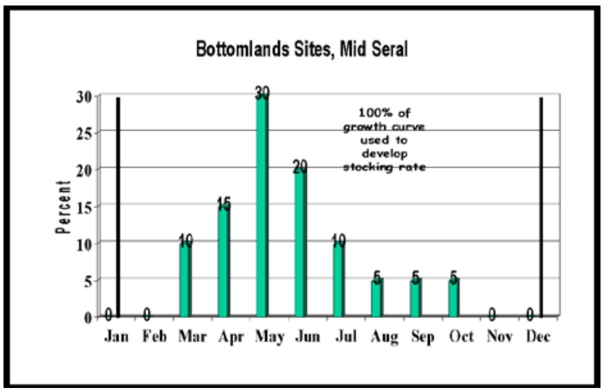


Figure 3, Annual Growth Example

The ***annual stocking rate*** in ***Figure 3*** would be:

$$\frac{1600 \text{ lbs.} \times 100\% \times 25\%}{913 \text{ lbs./AUM}} = 0.44 \text{ AUMs/acre}$$

Figure 4 depicts an early spring grazing scheme where livestock are grazed March through May only (55% of growth curve used @ 25% HE).

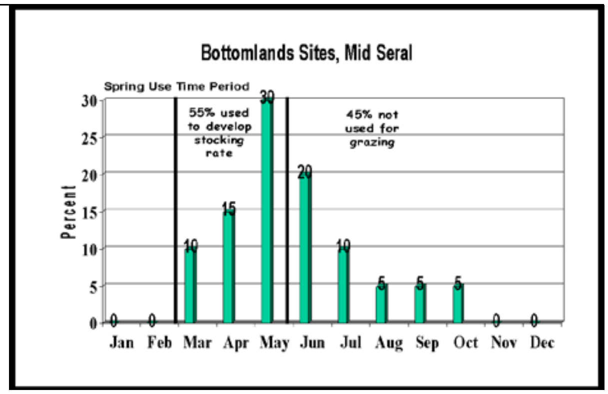


Figure 4, Spring Use Example

The ***time-period stocking rate*** in ***Figure 4*** would be:

$$\frac{1600 \text{ lbs.} \times 55\% \times 25\%}{913 \text{ lbs./AUM}} = 0.24 \text{ AUMs/acre}$$

Figure 5 depicts a summer grazing scenario where livestock are grazed May through August. Even though the livestock do not enter the site until May the growth accumulated March and April are used to determine the stocking rate (90% of growth curve used @ 25% HE).

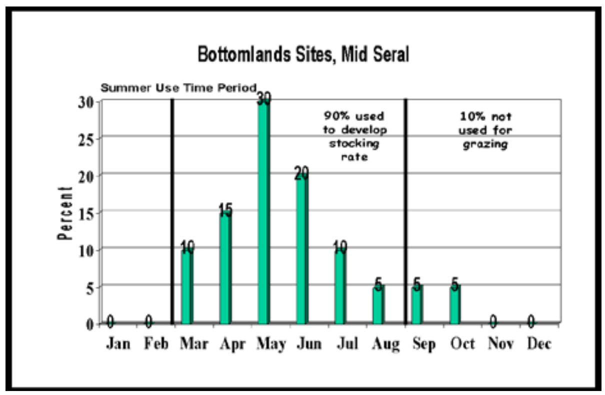


Figure 5, Summer Use Example

The ***time-period stocking rate*** in ***Figure 5*** would be:

$$\frac{1600 \text{ lbs.} \times 90\% \times 25\%}{913 \text{ lbs./AUM}} = 0.39 \text{ AUMs/acre}$$

Figure 6 depicts a dual use time-period; livestock will be grazed in the spring (25% of growth curve @ 25% HE) and later in the season (75% of growth curve @ 25% HE). As in ***Figure 5***, livestock may not enter the site until later in the season but the forage accumulated since the last grazing period is used in the stocking rate calculations.

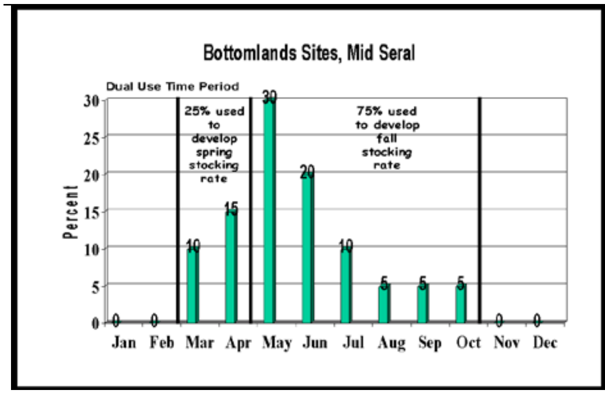


Figure 6, Dual Use Example

The ***time-period stocking rate*** in ***Figure 6*** would be:

Early (25%):

1600 lbs. x 25% x 25%
913 lbs./AUM
= 0.11 AUMs/acre

Late (75%):

1600 lbs. x 75% x 25%
913 lbs./AUM
= 0.33 AUMs/acre

(g) Harvest Efficiency

Harvest efficiency is defined in the NRPH glossary as:

The total percent of vegetation harvested by a machine or ingested by a grazing animal compared to the total amount of vegetation grown in the area in a given year.

Harvest efficiencies are used to assign safe levels of forage allocation for determining stocking rates. They are based on the physical ability of a grazing animal to consume vegetation on a particular site or of machinery to harvest roughages. The number represents a percentage of current forage that will be ingested by the animal or will be converted to stored feed.

Allocation of forages using harvest efficiencies implies that the allocation to livestock leaves enough plant cover and weight for all of the other uses of the site. Soil stability, mineral cycling, water cycling, and wildlife habitat are considered and provided for in the assignment of harvest efficiencies. For example, an irrigated pasture may have a harvest efficiency of 35-40%, because this level of harvest is feasible and the main use of the pasture is for livestock forage production. A rangeland upland or riparian site may have an assigned harvest efficiency of 15-20% in order to leave the plant community relatively intact for other needs and uses (usually a maximum of 25% on rangeland is recommended).

Proper use factors are similar but they represent the percentage of forage that was consumed, damaged, trampled, dunged on, etc. on the site. In general, a proper use factor of 50% on rangeland would equate to a harvest efficiency of 25%; that is 25% of the current forage supply gets into the rumen of the animal and approximately 25% is trampled, damaged, etc.

Harvest efficiencies are influenced by slope, aspect, roughness of soil surface, density of forage plants, and other physical factors influencing grazing. Harvest efficiency increases as the number of animals (in an area) increases, however, season long grazing or increased stocking rates can eventually decrease forage intake.

Use harvest efficiencies for determining initial stocking rates. Use care and judgment in assigning harvest efficiencies to different sites, land uses, and forage types. ***Table 1*** shows some guidelines and ranges for harvest efficiencies.

Table 1, Harvest Efficiencies

Land Use	Class	HE
Seeded Range	Smooth	**30-35**
	Rough	**25-30**
Range / Riparian Areas	Moderate Use	**20-25**
	Light Use	**15-20**
Pastures & Hay Aftermath (Irr/Non Irr)	Smooth	**35-40**
	Smooth & Dense	**30-35**
	Rough	**25-30**
Crop Aftermath (Irr/Non Irr)	General	**10-25**
	Wheat Stubble	**10-15**
	Barley Stubble	**15-20**
	Specialty	**40-45**
Roughage Harvest (Irr/Non Irr)	Smooth	**75-80**
	Rough	**65-70**

Do not exceed 25% HE for native rangelands or 40% for pastures and haylands. Dryland crop stubble (aftermath) harvest efficiencies are typically low, but site-specific conditions may have higher harvest efficiencies (i.e. when there is significant volunteer grain or preferred forbs growing in the stubble). Specialty crops refer to crops planted and upturned for livestock grazing. Harvest efficiencies can be relatively high depending on the crop, method of feeding, and terrain. Additional information can be found in Chapter 5 (***Management of Grazing Lands***) section 3 (***Procedures and Worksheets for Planning Grazing Management***) of the NRPH.

(h) Determining Annual Production

Annual production estimates are critical for the safe allocation of forage for livestock and wildlife use, determining magnitude of resource problems, determining if quality criteria are met, and for designing prescribed grazing, facilitating, and/or accelerating practices. Chapter 4

(*Inventorying and Monitoring Grazing Lands Resources*) part **600.0401** (*Inventory*) **(a)** (*Total Annual Production*), **(b)** (*Definition of Production for Various Kinds of Plants*), **(c)** (*Methods for Determining Production and Composition*), and **(d)** (*Methods for Determining Production and Composition for Specific Situations*) contains information and methods for determining annual production. The annual Productivity is needed to determine an Initial Stocking Rate. The NRPH glossary defines **Initial Stocking Rate** as:

> ***A safe starting stocking rate assumed to ensure against excessive grazing utilization. It is intended as a guide until experienced yields can be determined and realistic stocking rates established for a given area.***

This section clarifies procedures for Oregon-NRCS in determining and documenting annual production. Also, see the sections **(i) Rangeland Inventory Worksheet** and **(k) Pasture & Hayland Inventory Worksheets** for additional information on selecting and/or determining initial stocking rates.

(1) Using Existing Data (All Land Uses)

Sources of existing production data may be used when collecting site-specific field data is not practical or feasible (i.e. a plan needs to be completed in wintertime or in a small amount of time). Annual total production potentials are available from soil surveys, ecological site descriptions, forage suitability groups, or other local sources of information.

(i) Initial Stocking Rates for Rangelands, Pasture, & Hay Aftermath:

Oregon **Exhibits 4-13, 4-18, 4-19**, and **4-22** contain information about annual production and initial stocking rates. **Exhibit 4-13** contains initial stocking rates based on rangeland similarity index and normal productivity from the *Rangeland Productivity and Characteristic Plant Communities* table in most soil surveys. **Exhibit 4-18** contains initial stocking rates and annual productivity based on pasture condition score, management level, and potential AUMs/Acre/Year contained in the *Yields per Acre for Crops and Pasture* table in most soil surveys. **Exhibit 4-19** contains hayland yields (tons/acre/year), initial stocking rates for aftermath grazing, and annual productivity based on hayland condition score, management level, and potential Tons/Acre/Year contained in the *Yields per Acre for Crops and Pasture* table in most soil surveys. See sections **(i) Rangeland Inventory Worksheet** and **(k) Pasture & Hayland Inventory Worksheets** for detailed information on development and use of the initial stocking rate exhibits.

(ii) Initial Stocking Rates for Small Grain Crop Aftermaths:

Exhibit 4-22 contains initial stocking rates and forage productivity for dryland small grain crop aftermaths. These figures can be used to determine stocking on small grain aftermaths after harvest of the crop. The first page of the exhibit shows aftermath stocking rates at 10%, the second page shows stocking rates at 15% harvest efficiency. ***Table 1 (above)*** shows various recommended harvest efficiencies for different types of forages. Small grain crop aftermath harvest efficiencies are generally low due to the low palatability of the residue, standing clipped stubble that interferes with grazing, and generally low stocking density on most crop fields.

The crop aftermath stocking rates are based on amount of residue associated with the level of crop yield. Initial stocking rates are developed by determining useable forage. Aftermath stocking rates are calculated for spring barley, spring wheat, and winter wheat. Yields are multiplied by the straw/grain ratio to determine remaining residue. Subtracting 1500 lbs/acre of residue (for soil protection) leaves the amount of available forage.

$$\frac{(1500 \text{ lbs/ac} - (Y \times SGR)) \times HE}{913 \text{ lbs/AUM}}$$

Y **= Crop Yield (lbs/ac for Barley, or bushels/ac for Wheat)**
SGR **= Straw to Grain ratio**
HE **= Harvest Efficiency**

Determine the small grain crop harvest amount and use the tables or graphs to determine stocking rates. For the graphs (***Figure 7***), select the appropriate crop and harvest efficiency graphs. Find the crop yield on the x-axis and read up to the red line then right to the second y-axis to find the stocking rate in AUMs/acre/year. Use the blue line and read to the left y-axis to find total pounds per acre of aftermath forage.

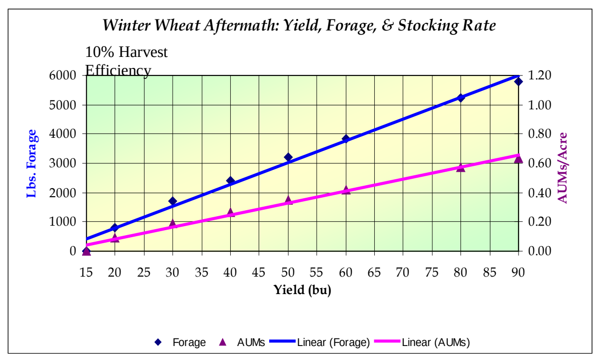


Figure 7, Portion of Exhibit 4-22; Winter Wheat aftermath stocking rates at 10% harvest efficiency

Be aware that these figures are the least accurate compared to measured production. Use your best professional judgment in adjusting these figures for planning. Use actual use records for a period of three years or more to determine if initial stocking rates are adequately depicting long-term productivity and are leading to improvements in the grazinglands resource.

(2) Using Actual Use Records (All Land Uses)

For almost every plan, the actual use records will provide valuable information about the long-term stocking rate. If the pastures are in good (or better) condition, or rangelands with more than 60% similarity index, then the existing harvest rate (AUMs/acre/year) is probably adequate and balanced with available forage resources. If the converse is true, then the stocking rate is probably too high. Calculate the AUMs/acre/year harvested on the entire planning unit first, then by management unit (if records are adequate).

Procedures for using this method can be found in **600.0510 (a)** Forage Inventory based on trend, health, and utilization in Chapter 5 (***Management of Grazing Lands***) section 3 (***Procedures and Worksheets for Planning Grazing Management***) of the NRPH. **Exhibits 5-1 or 5-2** can be used for documenting the forage inventory.

Reviewing your client's grazing records can be helpful in determining stocking rates (see **(p) (2) Grazing Records**). Grazing records need to contain information on numbers and kinds of livestock grazed and dates in and out of each management unit. For each management unit determine the ***Animal Unit Equivalent (AUE)*** for the livestock grazed (use the following formula):

$$\frac{(W \wedge 0.75)}{(1000 \wedge 0.75)}$$

W **= weight (in Lbs. of the grazing animal)**

This equation is shown in graphic format in ***Figure 8***.

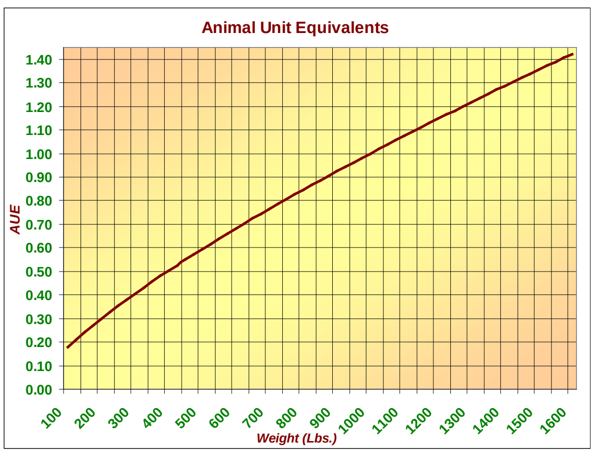


Figure 8, Animal Unit Equivalents by animal weights (use only for grazing animals)

Calculate the days grazed in the management unit from the date in and date out. The ***Animal Unit Months (AUMs)*** used can be calculated by:

$$\frac{(N \times D \times AUE)}{30.4}$$

N **= Number of Animals**
D **= Days Grazed. (30.4 is the average number of days in a month)**
AUE **= Animal Unit Equivalent**

Divide this figure by the number of acres in the management unit to determine the past stocking rate in AUMs/Acre. Compare this stocking rate with current trend, health, and condition to determine if it is too high, too low, or adequate.

Animal Unit Months (AUMs) are an amount of forage needed to support the grazing animal and meet nutritional needs. Based on air-dry intake of forage (standing crop) or roughage (harvested forage crops) the AUM represents 30 lbs. of forage per day for a month. The general figure used for 1 AUM is 913 lbs. The planner is able to adjust the demand of the animals grazed based on their body weight. A 1000 lb. cow and calf have an AUE of 1.0 and require 913 air-dry lbs. of forage/roughage per month. Larger animals require more and smaller animals require less.

(3) Forage Value Rating (All Land Uses)

A determination of the annual weight of plants suited to the target grazing animal is needed to (more accurately) calculate stocking rates. Including weights of plants in the community that will not be consumed by the target grazing animal, will over estimate the amount of forage available for grazing and can result in degradation of the resource. Forage value ratings can be made for livestock and/or wildlife use on a particular site. See **(m) Wildlife** for more information on determining forage value ratings and multi-species stocking.

A quick and efficient method can be used with either the rangeland or the pasture/hayland inventory worksheets (**Exhibits 4-12 & 4-17**). Determine the preference of the target grazing animal for each of the plant species in the plant community composition portion of the worksheet. Use **Range Technical Note #16, Relative Forage Preference of Plants for Grazing Use by Season** to determine preferences (use #1-Preferred and/or #2-Desirable only).

Make a mark by the name of each plant species that is preferred or desirable to the appropriate animal. Sum the percent composition of each species marked and multiply the result by total annual forage. The result can be used to create a preference based stocking rate. Additional information can be found in Chapter 5, (***Management of Grazing Lands***) section 3 (***Procedures and Worksheets for Planning Grazing Management***) of the NRPH.

(i) Rangeland Inventory Worksheet

The rangeland inventory worksheet (**Exhibit 4-12 and *Figures 10, 11, & 12***) will be used for determining benchmark conditions on rangelands and seeded range. The Oregon form has incorporated **Exhibit 4-7**, Determining Similarity Index Worksheet, **Exhibit 4-6**, Trend Determinations Worksheet, and **Exhibit 4-8** Rangeland Health Ecological Attributes Worksheet.

The worksheet also leads you through the process of evaluating plant community composition and the Total Useable Production that will be used for determining initial stocking rates. Enter the general information at the top of the form; fill out as much information as possible. Use a GPS unit to determine the location of the write-up; use either UTM or latitude/longitude.

(1) Plant Community Composition & Rangeland Similarity Index:

The NRPH glossary defines **Similarity Index** as:

> ***A similarity index is the percentage of a specific vegetation state plant community that is presently on the site.***

A comparison of the benchmark vegetation to the Reference Plant Community (RPC) is required. The RPC is the main plant community described in each ecological site description. Some ESDs have additional plant communities described that have crossed some sort of threshold. It is generally not necessary to determine similarity index to any of these disturbance states. The similarity index can be used to discern where the inventoried site is within the state and transition model.

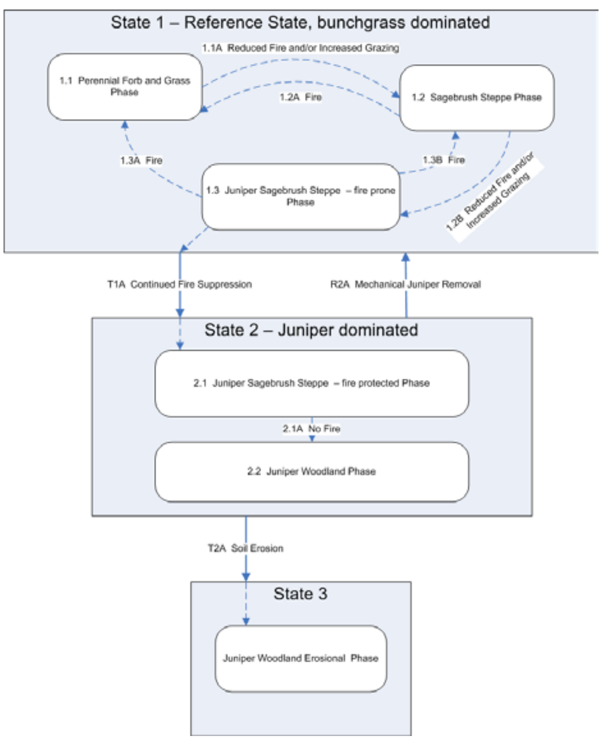


Figure 9, Example State & Transition Model for Cool-Season Bunchgrass Rangelands

Figure 9 shows an example of a state and transition model for cool season bunchgrasses in Oregon. The inventory should determine if the benchmark vegetative state is part of the natural variability of the RPC, or if it has crossed a threshold (biotic and/or abiotic) that would have a significant impact on options and opportunities for managing or restoring the site.

PLANT LIST / SIMILARITY INDEX

Species Name	Green Weight	%Dry Weight	% Un-grazed	%Growth Done	% of Normal	Recon Factor	Recon Weight	Ref Lbs	Lbs Allowed
Basin Wildrye	**5000**	50%	100%	75%	100%	**67%**	**3333.3**	4150	**3333.3**
Bluebunch Wheatgrass	**250**	50%	80%	75%	100%	**83%**	**208.3**	100	**100.0**
Bluegrass	**300**	50%	75%	75%	100%	**89%**	**266.7**	100	**100.0**
Other Perennial Grasses						**0%**	**0.0**	100	**0.0**
						0%	**0.0**		**0.0**
Cheatgrass	**400**	75%	100%	100%	100%	**75%**	**300.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
Perennial Forbs						**0%**	**0.0**	50	**0.0**
						0%	**0.0**		**0.0**
Prickly Lettuce	**100**	65%	100%	80%	100%	**81%**	**81.3**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
Willow						**0%**	**0.0**	250	**0.0**
Basin Big Sagebrush	**100**	50%	100%	60%	100%	**83%**	**83.3**	50	**50.0**
Rabbitbrush	**50**	50%	100%	60%	100%	**83%**	**41.7**	50	**41.7**
Other Shrubs						**0%**	**0.0**	100	**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
Cottonwood						**0%**	**0.0**	50	**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
						0%	**0.0**		**0.0**
TOTALS	**6200**						**4314.6**	**5000**	**3625.0**
							Similarity Index		**73%**

Figure 10, Portion of Exhibit 4-12; Plant Community Composition / Similarity Index and Cover Estimates

Begin the inventory at the Key Grazing Area by walking in slowly expanding circles and documenting the species found on the site; cover enough ground so that you are satisfied all of the species are listed on your worksheet (***Figure 10)***; enter common or scientific name. Estimate (see NRPH Chapter 4 section 600.0401 (c) 1) or clip the current green weight for each species and enter as pounds per acre in the second column. The total green weight for the site (use data from clipping or estimated total green weight in the current condition – this figure is current pounds per acre and not annual green weight) is entered at the bottom of the second column. Enter the remaining information in the rest of the columns considering the following:

Percent Dry Weight: Estimate current percent air-dry weights of each species (in the format 0.00) – use **Exhibit 4-2** in the NRPH (Chapter 4 (***Inventorying and Monitoring Grazing Lands Resources***) Exhibits). An alternative method is to clip and weight units of different plants, place in a paper bag and air-dry for at least 48 hours. Re-weigh the weight units and determine the percentage air-dry weight (this would be a good thing to do for the major range plants in your area to give you a feel for percent air-dry weights in relation to phenological stage). ***Table 2*** contains some general values for major plant types in Oregon.

Table 2, Percentage of Air-Dry Matter at Various Stages of Growth

Plant Type	**Before Heading**	**Headed Out**	**Seed Ripe**	**Leaves Dry, Stems Drying**	**Dormant**
Cool Season Bunch-grasses	**35**	**45**	**60**	**85**	**95**

Warm Season Grasses	**30**	**45**	**60**	**85**	**95**
Plant Type	**Initial growth to Flowering**	**Flowering to Seeding**	**Seed Ripe**	**Leaves Dry, Stems Drying**	**Dry**
Forbs, Succulent	**15**	**35**	**60**	**90**	**100**
Forbs, Leafy	**20**	**40**	**60**	**90**	**100**
Forbs, Fibrous/mat	**30**	**50**	**75**	**90**	**100**

Plant Type	**New Leaf & Twig Growth**	**Older & Full Size Green Leaves**	**Green Fruit**	**Dry Fruit**
Shrubs, Evergreen	**55**	**65**	**35**	**85**
Shrubs, Deciduous	**35**	**50**	**30**	**85**
Trees, Evergreen	**45**	**55**	**35**	**85**
Trees, Deciduous	**40**	**50**	**35**	**85**

Percent (Current Growth) **Ungrazed**: You can avoid estimating this by selecting a site for inventory that has not been grazed. If it has, estimate the percent of forage ungrazed for each species and enter in this column (in the format 0.00).

Percent Growth Done: For each species, enter the amount of annual growth currently completed (in the format 0.00).

Percent of Normal (Production): Enter a 1.0 if current conditions approximate long-term normal or average growing conditions at the time of inventory. If conditions have created changes in the amount of production in the current plant community, enter the percent change (in the format 0.00). If production is lower, enter a number from 0.70 to 0.99. For higher production enter numbers from 1.01 to 1.30 (generally, err on the conservative side unless you have local data that would back up lower numbers). Use local information, interview with landowners, and climate data to evaluate this. Note that the percent reduction or increase may be different for each species but generally applies to the entire plant list.

Calculate **Recon**struction **Factor** (see NRPH section 600.0402 (b) (4)) and multiply the result by **Green Weight** for each species. Enter this figure in the **Recon**structed **Weight** column for each species.

NOTE: Reconstructed weights may be used on any land use to determine annual productivity via reconstruction. This may be very helpful, when needed, to determine productivity on pasture, wetlands, forest understory, and other uses. **Recon**structed **Weight** is summed to determine annual production in pounds/acre/year.

Reference Pounds: Enter the pounds of each species from the reference state in the ecological site description (usually the Reference Plant Community). If a species in your plant list is not in the reference plant community enter a zero. When using an older Range Site Description, multiply the Normal Pounds per acre production for the site by the percent composition for the species (if this is a range, use the midpoint).

Pounds Allowed: Enter the smaller of the **Recon**structed **Weight** or **Reference Pounds** for each species.

Calculate Similarity Index by entering the total normal annual production from the ecological site description at the bottom of the **Reference Pounds** column. Enter the sum of **Pounds Allowed** at the bottom of that column. Divide the total **Pounds Allowed** by the total **Reference Pounds** times 100. The result is the Similarity Index and indicates how similar the plant community is to the reference plant community. When compared to the RPC this number can be considered a percentage of ecological condition or an indicator of seral condition.

Calculate the percent of the plant community that is useable for the target grazing animal by reviewing the species list and summing the reconstructed weight of each species that is preferred or desired by the target grazing animal, dividing by the total reconstructed weight, and entering in **% Used** column on the first page (see **(h)(3), Forage Value Rating**). Calculate useable production for each month by multiplying the monthly **Lbs/Acre** by **% Used** and enter the result in **Useable** column. Add current and previous months useable amounts and enter this in the **Use Cum**ulative column.

(2) Estimating Annual Production by Clipping

Whenever possible this method is preferred for the most accurate determination of initial stocking rates; it also provides a valuable record of benchmark conditions for current and future planning. General guidance, methods, and procedures can be found in Chapter 4 (***Inventorying and Monitoring Grazing Lands Resources***) part **600.0401** (***Inventory***) **(c)** (***Methods for Determining Production and Composition***), and **(d)** (***Methods for Determining Production and Composition for Specific Situations***) of the NRPH.

For general inventory use, clipping at least one plot and comparing current total green weights (estimated and clipped) using the rangeland inventory form (**Exhibit 4-12**) and the procedure described above will suffice. The following steps outline the recommended procedure for collecting clipping data.

(i) Select the location of the plot

Pick a location within the write-up area that most closely represents the common density, composition, and structure characterizing the site. Look for a spot that will allow you to clip the highest number of species present on the site and that represents the average total current production.

(ii) Select the plot size

Clipping plots are designed to allow weighing the plant material with a gram scale; then multiply the weight by a conversion factor to determine pounds per acre. The size and conversion factors of some common clipping hoops are in ***Table 3***. The circumference is provided if you want to make a particular clipping hoop size. Use vinyl coated ¼-inch cable and connect with a crimped aluminum or copper dual ferrule.

Table 3, Conversion Factors		
Plot Size (Sq. Ft.)	**Hoop Circumference (add 1" for ferrule)**	**Conversion Factor**
9.6	11 feet	**10**
4.8	7 feet, 9 inches	**20**
2.4	5 feet, 6 inches	**40**
1.96	5 feet	**50**
0.96	3 feet, 6 inches	**100**

Generally, for rangeland, use a 9.6 square foot clipping plot and a grams/plot to pounds/acre conversion factor of 10. For pasture and hayland, or rangelands that have high production and/or high plant density, use a 2.4 square foot clipping plot and a grams/plot to pounds/acre conversion factor of 40.

(iii) Clip the plot

Place the clipping hoop on the ground, making sure that plant stems along the edge are not folded under the hoop. Do not clip shoots and stems that originate outside of the plot. Remove as much litter as possible making sure that current annual growth that has cured is not removed.

Clip the plants as close to the ground as possible, being careful not to collect plant crowns. Place the clippings in a lightweight paper or plastic bag of a known weight (or use a scale with a tare weight adjustment feature). Do not place last year's cured growth into the bag. For shrubs, clip only the current year's leaders and leaves.

(iv) Weigh and record

When the plot is clipped, weigh the bag with a gram scale (a 0 to 300-gram scale with 2-gram increments works well for most conditions). Record the grams weighed in the Notes section of the plant inventory page of the inventory worksheet.

(v) Adjust clipping results

In the Notes portion of the plant inventory page of the inventory worksheet, enter the appropriate conversion factor and multiply the clipped green weight by that factor to determine pounds per acre.

(3) Cover Estimates

If needed, a benchmark of the amount of basal and canopy cover can be entered in the Cover Estimates portion of page 1 of the worksheet (***Figure 11***). Cover information will be important if the amount of bare ground or canopy cover of particular species or category is in question or the opportunity for treatment will affect cover.

Use **Exhibit 4-11** or another method to determine percent basal and canopy cover of the following categories present on the site (Grass & Grasslikes, Forbs, Shrubs, Trees), and basal cover of Litter, Biotic Crusts, & Bare Ground. See **(J) Cover Measurements** for more information and an alternative method for measuring cover of a particular category or species.

(4) Growth Curve

Enter the estimated growth curve of the site in the Growth Curve portion at the top of page 1 of the worksheet (***Figure 11***). Percent growth by month will add up to 100%; percent cumulative growth is calculated by adding the current month's monthly growth to the previous month's percent cumulative use. These can be used to determine percent of growth completed for time period stocking rates. See **(f) (1) Using Growth Curves to Determine Initial Stocking Rates**.

The growth curves may be entered from field determinations, client information, ecological site descriptions, or forage suitability groups, etc. When determining growth curves in the field, determine which month has the largest amount of growth, which ones have no growth, and which are in-between. Generally use no less than five percent increments for monthly growth unless better information is available.

GROWTH CURVE			STOCKING RATES						
Month	%Growth	%Cum	Lbs/Acre	% Used	Useable	Use Cum	H.E	AUMs/Ac	AUM Cum
Jan		0%	0.0	100%	0.0	0.0	25%	0.00	0.00
Feb		0%	0.0	100%	0.0	0.0	25%	0.00	0.00
Mar	5%	5%	215.7	100%	215.7	215.7	25%	0.06	0.06
Apr	15%	20%	647.2	100%	647.2	862.9	25%	0.18	0.24
May	35%	55%	1510.1	100%	1510.1	2373.0	25%	0.41	0.65
Jun	25%	80%	1078.6	100%	1078.6	3451.7	25%	0.30	0.95
Jul	15%	95%	647.2	100%	647.2	4098.9	25%	0.18	1.12
Aug		95%	0.0	100%	0.0	4098.9	25%	0.00	1.12
Sep	5%	100%	215.7	100%	215.7	4314.6	25%	0.06	1.18
Oct		100%	0.0	100%	0.0	4314.6	25%	0.00	1.18
Nov		100%	0.0	100%	0.0	4314.6	25%	0.00	1.18
Dec		100%	0.0	100%	0.0	4314.6	25%	0.00	1.18

COVER ESTIMATES									
Type	Grass/Gl	Forbs	Shrubs	Trees	Litter	Crusts	Rocks	Bare G	Total
Basal	90%	1%	2%		5%			2%	100%
Canopy	90%	5%	10%		N/A	N/A	N/A	N/A	105%

Figure 11, Portion of Exhibit 4-12; Growth Curve and Stocking Rates

(5) Calculating Initial Stocking Rates

The Stocking Rates portion of page 1 of the rangeland inventory worksheet (***Figure 11***) provides room for calculating available forage based on inventoried plant production and typical growing conditions. Growing conditions vary considerably from year to year. Additionally, the grazing animals used (type, age, size, experience, etc) and the manager's experience will influence the animal forage preferences and harvest efficiency. Therefore, these available forage calculations are to be used as an initial guide to stocking rates.

An alternative method is to use current similarity index estimations. **Exhibit 4-13** contains stocking rates for rangeland based on Rangeland Similarity Index groupings (0-25%, 26-50%, 51-75%, 76-100%). ***Figure 12*** shows a portion of the exhibit. Find the appropriate "Normal" annual productivity for the correlated rangeland ecological site (from soil survey or ecological site description). Read the annual initial stocking rate (AUMs/acre/year) under the column that matches the estimated similarity index group for the site.

The stocking rates are calculated by assuming a linear relationship between similarity index and available forage (generally true in cool-season bunchgrass rangelands in

Oregon). The 0-25% class assumes 12.5% useable forage, the 26-50% class assumes 37.5%, the 51-75% class assumes 62.5%, and the 76-100% class assumes 87.5% useable forage.

Normal #/Ac/Yr	Stocking Rate (AUMs/Acre/Year) by Rangeland Similarity Index			
	0-25%	26-50%	51-75%	76-100%
750	0.03	0.08	0.13	0.18
775	0.03	0.08	0.13	0.19
800	0.03	0.08	0.14	0.19
825	0.03	0.08	0.14	0.20
850	0.03	0.09	0.15	0.20
875	0.03	0.09	0.15	0.21
900	0.03	0.09	0.15	0.22

Figure 12, Portion of Exhibit 4-13; Rangeland Stocking Rates

This method will not replace any of the more accurate methods of determining initial stocking rate. They are designed to be conservative and always should be checked with actual use records and/or monitoring information.

(6) Apparent Trend Determinations

Use the Trend Determination section of the worksheet to determine Apparent Trend. The NRPH glossary defines **Apparent Trend** as:

> ***An interpretation of trend based on a single observation. Apparent trend is described in the same terms as measured trend except that when no trend is apparent it shall be described as not apparent.***

The Trend Determination section of the rangeland inventory worksheet is essentially the same as **Exhibit 4-6** in the NRPH. Instructions for completing this form are in Chapter 4 (***Inventorying and Monitoring Grazing Lands Resources***) part 600.0402 (a) (***Trend***) of the NRPH. Exhibit 4-6 may be used for follow-up visits to record trend after a system of practices has been installed or to determine planned trend over a longer period as part of a monitoring system. The NRPH glossary defines **Planned Trend** 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 moving towards or away from the desired plant community or objective.***

On the worksheet, make a judgement for each of the plant and soil factors and mark one of the three choices. Document the major invading species and the estimated percent canopy cover in the blocks provided (if applicable). Determine trend by adding the marks in each column and circling the trend determination (for apparent trend and planned trend if applicable) with the greatest number of circled factors. If there is a tie between two columns circle both determinations and take notes to capture impressions, thoughts, etc.

(7) Rangeland Health Assessment

The NRPH glossary defines **Rangeland Health** as:

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

The Rangeland Health Assessment section of the range inventory worksheet (***Figure 13***) is based on the Rangeland Health Evaluation Summary Worksheet in **Interpreting Indicators of Rangeland Health, Version 4:** available online. This publication is an appendix to the NRPH and contains information and instructions for completing a rangeland health assessment. Additional instructions and procedures can be found in Chapter 4 (***Inventorying and Monitoring Grazing Lands Resources***) part **600.0402 (c)** (***Rangeland Health***) in the NRPH.

(i) Rangeland Health Indicators

The following indicator descriptions are from the interagency manual, **Interpreting Indicators of Rangeland Health.**

1. Rills

Rills (small erosional rivulets) are generally linear and do not necessarily follow the microtopography that flow patterns do. They are formed through complex interactions between raindrops, overland flow, and the characteristics of the soil surface (Bryan 1987). 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 (Bryan 1987, Quansah 1985). Therefore, it is important to establish the degree of natural versus accelerated rill formation by interpretations made from the soil survey, rangeland ecological site description, and the ecological reference area. Generally, concentrated flow erosional processes are accelerated when the distance between rills decreases and the depth and width of rills increase (Morgan 1986, Bryan 1987).

2. Water Flow Patterns

Flow patterns are the path that water takes (i.e., accumulates) as it moves across the soil surface during overland flow. Overland flow will occur 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 (Morgan 1986). Interrill erosion caused by overland flow has been identified as the dominant sediment transport mechanism on rangelands (Tiscareno-Lopez et al. 1993). 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 depositional areas, thereby increasing the time for water to soak into the soil.

Generally, as slope increases and ground cover decreases, flow patterns increase (Morgan 1986). Soils with inherently low

infiltration capacity may have a large number of natural flow patterns.

3. Pedestals and/or Terracettes

Pedestals and terracettes are important indicators of the movement of soil by water and/or by wind (Anderson 1974, Morgan 1986, Satterlund and Adams 1992, Hudson 1993). Pedestals are rocks or plants that appear elevated as a result of soil loss by wind or water erosion. Pedestals can also be caused by non-erosional processes, such as frost heaving or through soil or litter deposition on and around plants (Hudson 1993). Thus, 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 affect erosion by concentrating water flow and/or changing infiltration. These effects are recorded with the appropriate indicators (e.g., water flow patterns, compaction layer, and soil surface loss and degradation).

4. Bare Ground

Bare ground is exposed mineral or organic soil that is susceptible to raindrop splash erosion, the initial form of most water-related erosion (Morgan 1986). It is the remaining ground cover after accounting for ground surface covered by vegetation (basal and canopy (foliar) cover), litter, standing dead vegetation, gravel/rock, and visible biological crust (e.g., lichen, mosses, algae) (Weltz, et al. 1998).

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 (Smith and Wischmeier 1962, Morgan 1986, Benkobi, et al. 1993, Blackburn and Pierson 1994, Pierson et al. 1994, Gutierrez and Hernandez 1996, Cerda 1999). In general, a site with bare soil present in a few large patches will be 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 (Gould 1982, Spaeth et al. 1994, Puigdefabregas and Sanchez 1996).

The amount of bare ground can vary seasonally, depending on impacts on vegetation canopy (foliar) cover (e.g., herbivore utilization), and litter amount (e.g., trampling loss), and can vary annually relative to weather (e.g., drought, above average precipitation) (Gutierrez and Hernandez 1996, Anderson 1974). Current and past climate must be considered in determining the adequacy of current cover in protecting the site against the potential for accelerated erosion.

5. Gullies

A gully is a channel that has been cut into the soil by moving water. Gullies generally follow natural drainages and are caused by accelerated water flow and the resulting downcutting of soil. Gullies are a natural feature of some landscapes and ecological sites, while on others management actions (e.g., excessive grazing, recreation vehicles, or road drainages) may cause gullies to form or expand (Morgan 1986). In gullies, water flow is concentrated but intermittent. Gullies can be caused by resource problems offsite (document this on the Evaluation Sheet, Appendix 2), 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. General signs of active erosion, (e.g., 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 (Anderson 1974), and a reduction in gully depth (Martin and Morton 1993). Active headcuts may be a sign of accelerated erosion in a gully even if the rest of the gully is showing signs of healing (Morgan 1986).

6. Wind-Scoured, Blowouts, and/or Deposition Areas

Accelerated wind erosion, on an otherwise stable soil, increases as the surface crust (i.e., 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 these surface crusts is often weakly consolidated and vulnerable to movement via wind (Chepil and Woodruff 1963). 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 wind stream where they may be transported off the site (Chepil 1945, Gillette, et al. 1972, Gillette, et al. 1974, Gillette and Walker 1977, Hagen 1984).

Wind erosion is reflected by wind-scoured or blowout areas where the finer particles of the topsoil have blown away, sometimes leaving residual gravel, rock, or exposed roots on the soil surface (Anderson 1974). They are generally found in interspace areas with a close correlation between soil cover/bare patch size, soil texture, and degree of accelerated erosion (Morgan 1986).

Deposition of suspended soil particles is often associated with vegetation that provides roughness to slow the wind velocity and allow soil particles to settle from the wind stream. The taller the vegetation, the greater the deposition rate (Pye 1987); thus shrubs and trees in rangeland ecosystems are likely sinks for deposition (e.g., mesquite dunes, Gibbens et al. 1983, Hennessey et al. 1983). The soil removed from wind-scoured depressions is redistributed to accumulation areas (e.g., eolian deposits), which increase in size and area of coverage as the degree of wind erosion increases (Anderson 1974).

Like water erosion, wind deposited soil particles can originate from offsite but affect the function of the site by modifying soil surface texture (Hennessey et al. 1986, Morin and Van Winkel 1996). The changes in texture will influence the site's hydrologic function. Even when soil particles originate from offsite, they can have detrimental effects on plants at the depositional site.

7. Litter Movement

The degree and amount of litter (i.e., dead plant material that is in contact with the soil surface) movement 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 offsite is an indication 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 (Thurow, et al. 1988a).

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 sediments 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 the 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.

8. Soil Surface Resistance to Erosion

This indicator assesses the resistance of the surface of the soil to erosion. Resistance depends on soil stability, microtopography, and on the spatial variability in soil stability relative to vegetation and microtopographic features. The stability of the soil surface is key to this indicator. Soil surfaces may be stabilized by soil organic matter, which 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/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.

In areas with low vegetative cover, the stability of soil in the plant interspaces is more important than stability under plants. Similarly, where pedestals have formed along flow paths, the soil at the edge of the pedestal will be subjected to more intense forces during overland flow than soil, which is topographically above the flow path.

This indicator is not applicable to areas in which there is no soil present at the surface due to the presence of an extensive erosion pavement (nearly 100 percent surface cover by stones) or there is continuous open water.

9. Soil Surface Loss or Degradation

The loss or degradation of part or all of the soil surface layer or horizon is an indication of a loss in site potential (Dormaar and Willms 1998, Davenport et al. 1998). 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 (Wood et al. 1997). 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 (Satterlund and Adams 1992, O'Hara et al. 1993). 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 (e.g., 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 discussions of Indicator 3, Pedestals and/or Terracettes, and subsurface degradation in Indicator 11, Compaction Layer.

The two primary indicators used to make this evaluation are the organic matter content (Dormaar and Willms 1998) and the structure (Karlen and Stott 1994) 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 contents are 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 by the loss of clearly defined structural units or aggregates at one or more scales from <1/8 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 (Warren et al. 1986). In heavier soils, degradation may also be reflected by more angular structural units. 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 (e.g., Hennessey et al. 1986) may make identification of appropriate reference areas difficult.

10. Plant Community Composition and Distribution Relative to Infiltration and Runoff

Vegetation growth form is an important determinant of infiltration rate and interrill erosion (Thurow et al 1988a, b). The distribution of the amount and type of vegetation has been found to be an important factor controlling spatial and temporal variations in infiltration and interrill erosion rates on rangelands in Nevada (Blackburn 1975; Blackburn and Wood 1990), Idaho (Johnson and Gordon 1988, Blackburn and Wood 1990) and Texas (Wood and Blackburn 1984, Thurow et al. 1988a, b).

Changes in plant community composition (see Appendix 3, Functional/Structural Groups Sheet) and the distribution of species can influence (positively or negatively) 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 and/or runoff. 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 (Thurow et al. 1986, 1988a, b). An example of a composition change that reduces infiltration and increases water runoff is the conversion of desert grasslands to shrub-dominated communities (Schlesinger et al. 1990). 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 snow entrapment and soil water storage may be reduced by this vegetation type conversion. Care must be exercised in interpreting this indicator in different ecosystems as the same species may have different effects.

11. Compaction Layer

A compaction layer is a near-surface layer of dense soil caused by repeated impacts on or disturbances of the soil surface. Compaction can also occur below the surface at the bottom of a tillage layer. These plow pans are often found in abandoned agricultural fields. Compaction becomes a problem when it begins to limit plant growth (Wallace 1987), water infiltration (Willat and Pullar 1983, Thurow et al 1988a), or nutrient cycling processes (Hassink et al. 1993). Farm machinery, herbivore trampling (Willat and Pullar 1983, Warren et al. 1986, Chanysk and Naeth 1995), recreational and military vehicles (Webb and Wilshire 1983, Thurow et al. 1988a), foot traffic (Cole 1985), brush removal, and seeding equipment, or any other activity that repeatedly causes an impact to the soil surface can cause a compaction layer. Moist soil is more easily compacted than dry or saturated soil (Hillel 1998). Recovery processes (e.g., earthworm activity and frost heaving) are generally sufficient to limit compaction by livestock in many upland systems (e.g., Thurow et al 1988a).

A compaction layer is a structural change, not a textural change, as described in a soil survey or observed at an ecological reference area. Compacted layers in rangelands are usually less than 6 inches below the soil surface. They are detected by digging a small hole (generally less than 1-foot deep) and describing the soil structure and root morphology; this is done by a person with soils experience. These layers may be detected in some soils with the use of a penetrometer (Larson and Pierce 1993) or by simply probing the soil with a sharp rod or shovel and "feeling" for the compaction layer (Barnes et al. 1971). 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, horizontal root growth, and increased density (measured by weighing a known volume of oven-dry soil) (Blake and Hartge 1986). Increased resistance to a probe can be simply due to lower soil moisture or higher clay content.

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 (fibrous vs. tap) structure, photosynthetic pathways, nitrogen fixing ability, or life cycle (Chapin 1993, Dawson and Chapin 1993, Solbrig et al. 1996). Functional composition and functional diversity are the principal factors explaining plant productivity, plant percent nitrogen, plant total nitrogen, and light penetration (Tilman et al. 1997). 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 effect on ecosystem processes.

The evaluator(s) should use the Functional/Structural Groups Worksheet (Appendix 3) in the development of the Reference Sheet (Appendix 2) and in the assessment of the evaluation area.

Relative dominance is based upon the relative annual production, biomass, or relative cover that each functional/structural 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 that has been developed from the Functional/Structural Groups Worksheet. 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 climatic variability. It should not be limited to a comparison with the historic climax community, which is the reference included in the old NRCS Range Site Descriptions. Instead, the comparison should be to communities in the reference state (in the state and transition model for the ecological site). For more information, please see the Concepts section.

The Functional/Structural Groups Worksheet can accommodate changing or adding functional group categories for different ecological sites (see Tables 6 and 7). Functional groups that are now present, but were not original components of the site (e.g., weeds, introduced plants), need to be identified on this sheet.

The number of species in each functional group is also considered when selecting the appropriate rating category on the Evaluation Sheet. If the numbers of species in many of the functional/structural plant groups have been greatly reduced, this may be an indication of loss of biotic integrity. Both the presence of functional groups and the number of species within the groups have a significant effect on ecosystem processes (Tilman et al. 1997).

Non-vascular plants (e.g., biological crusts) are included in this example since 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.

In Oregon, Ecological Site Descriptions use the plant functional groupings shown in ***Table 4***.

Table 4, Functional Groupings for Rangeland Ecological Sites in Oregon

Grass and Grass-like	C3 (cool season)	Perennial	Bunch	Shallow Rooted
				Moderate Rooted
				Deep Rooted
			Sod-Forming	Shallow Rooted
				Moderate Rooted
				Deep Rooted
		Annual		
	C4 (warm season)	Perennial	Bunch	Shallow Rooted
				Moderate Rooted
				Deep Rooted
			Sod-Forming	Shallow Rooted
				Moderate Rooted
				Deep Rooted
		Annual		
Forb	C3 (cool season)	Perennial	Tap Rooted	Nitrogen Fixing
				Non-Nitrogen Fixing
			Rhizomatous Rooted	Nitrogen Fixing
				Non-Nitrogen Fixing
			Fibrous Rooted	Nitrogen Fixing
				Non-Nitrogen Fixing
		Annual		
	C4 (warm season)	Perennial	Tap Rooted	Nitrogen Fixing
				Non-Nitrogen Fixing
			Rhizomatous Rooted	Nitrogen Fixing
				Non-Nitrogen Fixing
			Fibrous Rooted	Nitrogen Fixing
				Non-Nitrogen Fixing
		Annual		
Succulent (CAM)				
Shrub – Tree	Evergreen	Sprouting	Nitrogen Fixing	
			Non-Nitrogen Fixing	
		Non-Sprouting	Nitrogen Fixing	
			Non-Nitrogen Fixing	
	Deciduous	Sprouting	Nitrogen Fixing	
			Non-Nitrogen Fixing	
		Non-Sprouting	Nitrogen Fixing	
			Non-Nitrogen Fixing	
Moss – Lichen				

13. Plant Mortality/Decadence

The proportion of dead or decadent (e.g., 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 undesirable plants (e.g., weeds or invasives) may increase (Pyke 1995). A healthy range has a mixture of many age classes of plants relative to site potential and climatic conditions (Stoddard et al. 1975).

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

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 litter that is in contact with the soil surface (as opposed to standing dead vegetation) provides a source of soil organic material and raw materials for on-site nutrient cycling (Whitford 1988, 1996). All litter helps to moderate the soil microclimate and provides food for microorganisms (Hester et al. 1997). Also, 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 (Hester et al. 1997). Litter biomass represents a significant obstruction to runoff (Thurow et al. 1988a or b).

The amount of litter (herbaceous and woody) present 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 the degree of biomass utilization each year. Therefore, climatic influences (e.g., drought, wet years) must be carefully considered in determining the rating for the amount of litter. Be careful not to confuse standing-dead plants (plant material that is not detached from the plant and is still standing) 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 (e.g., cheatgrass) compared to native shrub steppe plant communities. In this case, the litter in excess of the expected amount 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 be important because larger litter tends to decompose more slowly and is more resistant to runoff. If litter size is considered as part of this indicator, it should be addressed in the Reference Sheet (Appendix 2).

15. Annual Production

Primary production is the conversion of solar energy to chemical energy through the process of photosynthesis. Annual production, as used in this document, is the net quantity of above-ground 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 (Whittaker 1975), biological diversity (Tilman and Downing 1994), and latitude (Cooper 1975). 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 above ground 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 production estimate. Do not include standing dead vegetation (produced in previous years) or live tissue (woody stems) not produced in the current year as annual production.

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

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

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 (e.g. 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 (i.e., plants that are listed by a State because of their unfavorable economic or ecological impacts), nonnative, and native plants. Native invasive plants (e.g., pinyon pine or juniper into sagebrush steppe) must be assessed by comparing current status with potential status described in the Reference Sheet. Historical accounts, ecological reference areas, 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 interrelationships, and the processes by which energy and nutrients move through the ecosystem. These impacts can influence both biological organisms and physical properties of the site (Olson 1999). These 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 (e.g., salt cedar (tamarisk) in riparian areas) or rapid nutrient depletion (e.g., high nitrogen use by cheatgrass).

Some invasive plants (e.g., knapweeds) are capable of invading undisturbed, climax bunchgrass communities (Lacey et al. 1990), further emphasizing their use as an indicator of new ecosystem stress. Even highly diverse, species rich plant communities are susceptible to exotic species invasion (Stohlgren et al. 1999).

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 (Harper 1977). Since reproductive growth occurs in a modular fashion similar to the remainder of the plant (White 1979), inflorescence production (e.g., seedstalks) becomes a basic measure of reproductive potential for sexually reproducing plants, and clonal production (e.g., 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. Ecological reference areas provide a good benchmark to separate weather versus management influences 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 or 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 (Hanson and Stoddart 1940).

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 since 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 on the Evaluation Sheet, but is not considered in rating the reproductive capabilities of perennial plants.

This indicator considers only perennial plants. With the exception of hyperarid ecosystems (e.g., Arabian peninsula and northern Atacama desert), nearly all rangelands have the potential to support perennial plants (Whitford 2002). A plant community that lacks perennial plants is rarely, if ever, included in the reference state. Evaluation areas that have no perennial plants would be rated "Extreme to Total" for this indicator because they no longer have the capacity to (re)produce perennial plants.

(ii) Evaluating Indicators

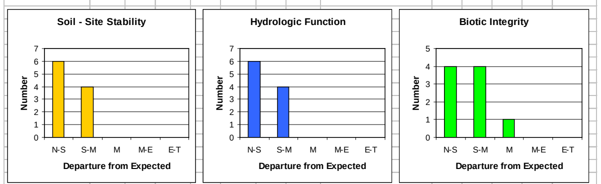
At the write-up site, use the Oregon Rangeland Health Indicator Evaluation Matrix (**Exhibit 4-12 and *Figure 13***) and the appropriate rangeland health reference sheet (part of ecological site descriptions – which briefly describes expected conditions in the reference plant community for each indicator - ***Figure 14***) to determine a rating for each of the seventeen health indicators. Read all five descriptions for each indicator and consult the rangeland health reference sheet to see what conditions are expected for the site. Make a determination based on the degree of departure from the ecological site description (extreme to total, moderate to extreme, moderate, slight to moderate, or none to slight). Each of these indicators has significant importance to one or more of the rangeland health attributes. The unshaded areas on the worksheet show which indicators are important to each of the three attributes (soil site stability, hydrologic function, & biotic integrity). The worksheet is designed to use ratings of the indicators to make a determination for each of the three attributes. ***Figure 13*** shows the rangeland health assessment portion of **Exhibit 4-12**, Rangeland Inventory Worksheet).

RANGELAND HEALTH EVALUATION

Indicator	Rating	SSS	HF	BI
1 Rills	N-S	N-S	N-S	
2 Water Flow	S-M	S-M	S-M	
3 Peds/Terrs	N-S	N-S	N-S	
4 Bare Ground	N-S	N-S	N-S	
5 Gullies	N-S	N-S	N-S	
6 Wind Scour	N-S	N-S		
7 Litter Movement	S-M	S-M		
8 Soil Resistance	N-S	N-S	N-S	N-S
9 Soil Loss	S-M	S-M	S-M	S-M
10 Infilt & Runoff	S-M		S-M	
11 Compaction	S-M	S-M	S-M	S-M
12 F/S Groups	S-M			S-M
13 Mortality	N-S			N-S
14 Litter Amount	N-S		N-S	N-S
15 Annual Prod	N-S			N-S
16 Invasive Plants	M			M
17 Reproduction	S-M			S-M
Sum (10,10,9)		10	10	9

Attribute	Abbv.
Soil - Site Stability	SSS
Hydrologic Function	HF
Biotic Integrity	BI

Departure from Expected	Rating
None to Slight	N-S
Slight to Moderate	S-M
Moderate	M
Moderate to Extreme	M-E
Extreme to Total	E-T



Rating	SSS	HF	BI
Rating	S-M	S-M	S-M

Figure 13, Portion of Exhibit 4-12; Rangeland Health Evaluation

The following describes how to properly determine the ratings for each of the three attributes using the worksheet:

Assign all seventeen indicator ratings. If an indicator is not present, rate N-S; and justify in comments. Identify departure from Ecological Site Description / Reference Area (see **Exhibit 4-14**, Evaluation Matrix, and rangeland health reference sheet in ecological site description).

Compare conditions to what may be expected for the ecological site. Cover the area by walking through the site while considering the attributes. If possible, complete the assessment with other technical experts and the client.

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. However, if one or more of the indicators is particularly important for the site (e.g., bare ground), a different rating can be supported.

Reference Sheet

Author(s)/participant(s): Jeff Repp, Bruce Franssen

Contact for lead author: Oregon State Rangeland Management Specialist

Date: 4/23/2003 MLRA: 010X Ecological Site: JD SHRUBBY MOUNTAIN LOAMY 12-16 PZ R010XB028OR 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:
X 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 for <u>each</u> community and natural disturbance regimes within the reference state, when appropriate and (3) cite data. Continue descriptions on separate sheet.

1. Number and extent of rills: None to some

2. Presence of water flow patterns: None to some

3. Number and height of erosional pedestals or terracettes: None to some

4. Bare ground from Ecological Site Description or other studies (rock, litter, standing dead, lichen, moss, plant canopy are not bare ground): 5-15%

5. Number of gullies and erosion associated with gullies: None

6. Extent of wind scoured, blowouts and/or depositional areas: None

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

8. Soil surface (top few mm) resistance to erosion (stability values are averages - most sites will show a range of values): Moderately resistant to erosion: aggregate stability = 4-6

9. Soil surface structure and SOM content (include type and strength of structure, and A-horizon color and thickness): weak medium platy to subangular blocky structure, dry color value 4-5, 2-9 inches thick; moderate (1-4 percent) soil organic matter

10. Effect on plant community composition (relative proportion of different functional groups) and spatial distribution on infiltration and runoff: Moderate ground cover (60-70%) and gentle slopes (0-12%) effectively limit rainfall impact and overland flow

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

12. Functional/Structural Groups (list in order of descending dominance by above-ground weight using symbols: >>, >, = to indicate much greater than, greater than, and equal to) with dominants and sub-dominants and "others" on separate lines:
    Dominant: Perennial, cool-season, deep-rooted bunchgrasses
    Sub-dominant: Deciduous shrub
    Other: Forbs, other grasses
    Additional:

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

14. Average percent litter cover (15%) and depth (1 inches):

15. Expected annual production (this is TOTAL above-ground production, not just forage production: 1500 lbs/ac

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 co-dominant 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 (e.g., short-term response to drought or wildfire) are not invasive plants. Note that unlike other indicator, we are describing what in NOT expected in the reference state for the ecological site: Perennial brush species will increase with deterioration of plant community. Western Juniper readily invades the site. Cheatgrass and Medusahead invade sites that have lost deep rooted perennial grass functional groups.

17. Perennial plant reproductive capability: All species should be capable of reproducing annually

Figure 14, Rangeland Health Reference Sheet

(iii) Attribute Summary

After the attributes have been rated, determine which of the seventeen indicators are adversely affecting the attribute rating. In general, an indicator rating of less than Moderate is a resource problem and any alternatives developed should address these problems. The client should know which indicators are not ranking above Moderate and take appropriate actions to stave off continued ecological decline. For example, if indicators 5 (Gullies) and 9 (soil surface loss or degradation) are rated Moderate to Extreme (note that indicator 5 affects both soil site stability and hydrologic function and indicator 9 affects all three attributes), then the excessive soil loss resource concern should be addressed in an alternative.

When the rangeland inventory worksheet is completed, the planner should be able to make conclusions about the productivity, condition, functioning, and overall health of the site. The sections are designed to work together to identify what is working well, what is at risk, and what should be addressed immediately. At this point, the planner and client should have reached consensus about past use, benchmark conditions, and the practicality and feasibility of potential treatments to the site. There should be enough information to continue to the next steps of developing and evaluating alternatives to meet objectives and treat resource concerns.

(j) Cover Measurements

Both foliar and basal cover should be estimated on rangelands (including seeded range). Basal cover is usually measured at ground level. For plants, determine the percent cover of stem area. Estimates of basal cover add up to 100%, while foliar cover estimates can exceed 100% (due to layering and overlap of different plants on the site).

The NRPH defines **Foliar Cover** as:

> ***The percentage of ground covered by the vertical projection of the aerial portion of plants. Small openings in the canopy and intraspecific overlap are excluded. Foliar cover is always less than canopy cover; either may exceed 100 percent***

The NRPH defines **Basal Cover** as:

> ***The cross sectional area of the stem or stems of a plant or of all plants in a stand. Herbaceous and small woody plants are measured at or near the ground level; larger woody plants are measured at breast or other designated height.***

An ocular estimate can be made using a scattergram such as **Exhibit 4-11**. Choose a percentage of cover that matches the average for the site. Estimate foliar cover and basal cover for grasses and grasslike plants, forbs, shrubs, trees. Estimate basal cover only for biotic crusts, litter, and bare ground. Continued experience in estimating cover, coupled with occasional measurement will increase the accuracy of the planner.

(1) Line-Intercept Cover Measurement Worksheet

This method is recommended for measuring cover for planning purposes. Use this to check ocular estimates, to measure before and after cover (i.e. Brush Management), or to collect information needed for developing alternatives and/or practice specifications. This method is relatively easy and can be performed quickly in the field. A description and instructions for performing line intercept can be found in the NRPH Appendix **Sampling Vegetation Attributes**, Interagency Technical Reference 1734-4, 1996: available online.

Exhibit 4-15 (***Figure 15***) is a worksheet, adapted from **Sampling Vegetation Attributes** that can be used for collecting and analyzing cover data. At the inventory write-up site select an azimuth for the transect (usually 360 degrees unless an obstacle is in the way). Take a GPS waypoint (if a unit is available) at the beginning and end of the transect in order to locate it later and to plot it on plan maps. Use a tape or hip chain (that measures to 0.10 inch for measuring Western Juniper and other large species). Transect length should be long enough to get a reasonable number of individuals (15-30 or more).

Exhibit 4-15 also allows measurement of average height of species. This may be especially helpful for shrub species important for wildlife habitat. For each individual encountered along the transect, record the height from base to highest part and record in the space provided. Tally the heights for each species and divide by the number of individuals in the transect to determine average height. Enlist the assistance of local biologists for information and recommendations when working in habitats with plant species important for wildlife.

LINE INTERCEPT COVER MEASUREMENT WORKSHEET

Client:	Testcase Ranch			Date:	5/14/2004	Write-Up No.:	
Tract/Field:	5433			Ecological Site:	Shallow South 12-16 PZ		
Location:				N / W E / S			
Section:	12	Township: 3S	Range: 7E		Veg. State:	HCPC	
Azimuth:	360	Units:	degrees		Completed by:	JPR	
Waypoint 1	@ write-up site			Waypoint 2	300 feet due north		
GPS Coord.:	UTM 536753N 147564E			GPS Coord.:	UTM 536755N 147569E		

	Species 1		Species 2		Species 3		Species 4		Species 5		Species 6	
	Basin Big Sage		Juniper									
	Canopy	Height	Canopy	Height	Canopy	Height	Canopy	Height	Canopy	Height	Canopy	Height
	3.4	2.5	12	25								
	1.9	1	11.3	20								
	0.9	1	8.5	15								
	1.2	1	2.1	10								
	3.2	2.3	1.9	5								
	2.5	1.6	13	30								
	2.4	1.7	6.5	11								
	1.8	1.2	9.5	17								
	1	0.9	13	25								
	0.6	0.5	8	12								
	2.1	1	6	10								
	4.1	2.9	2	4.5								
	3.7	2.1	16	21								
	2.9	2.5	11	15								
	1.7	1.5	5	9.5								
	2	1										
	0.8	0.5										
	1.8	1.5										
	2.8	2.5										
A. Totals:	40.8	29.2	125.8	230								
B. Line Length:	300		300									
% Cover (A / B x 100)	13.6		41.9									
C. No.of Plants:		19		15								
Avg. Height (A / C)		2.1		8.4								

CANOPY COVER: Enter the width of the canopy cover at the widest part of the crown and enter each for each individual encountered along transect (2nd reading minus 1st reading). Calculate % cover by summing the canopy measurements and dividing by the tot

AVERAGE HEIGHT: Measure height from ground level to highest point of plant. Enter the height of the plant and enter for each individual encountered among the transect. Calculate average height by summing the heights of all individuals measured and divi

Figure 15, Line Intercept Cover Estimation Worksheet

(k) Pasture & Hayland Inventory Worksheet

This worksheet (**Exhibit 4-17**) lets you inventory up to three fields on one form. Enter the general information at the top of the form; fill out as much information as possible (***Figure 16***). Use a GPS unit to determine the location of the write-up; use either UTM or latitude/longitude. There are places to document information about:

- Irrigation (system, scheduling with grazing, efficiency, etc.)
- Fertilization (type, amounts, dates, incorporation, etc.)
- Stock water (system, water source, locations, season of use, etc.)
- Grazing System (herd type, kind, numbers, rotations, etc.)
- Noxious weeds (species, locations, treatments, etc.)
- Crop rotations (cultural practices, tillage, dates, crops, etc.)
- Harvest Operations (roughages, dates, stubble heights, etc.)

Enter **N/A** if any of these items is not applicable or not present. These items can alternately be documented in planner's notes or in ***Agronomy Tech Note #20 Cropland Inventory Worksheets for Resource Management System Planning***. If either of these is used, make a note on the inventory form.

Soil erosion can be easily and reliably estimated using the **RUSLE2** program on both pastures and haylands. For more information, see the RUSLE2 website.

(1) Plant Community Composition & Productivity

The lower portion of page 1 of the Oregon Pasture & Hayland Inventory Worksheet (**Exhibit 4-17 and *Figure 16***) contains the Plant List and Productivity section.

Enter the field or write-up name/number in the blank space provided. Walk in slowly expanding circles from the key area and document the species found on the site; cover enough ground so that you are satisfied all of the major species are listed on your worksheet; enter in the **Species Name** column in the plant list/productivity section. Estimate the percent composition by current weight for each species (this column should add up to 100%) and enter in **% Comp** column.

Above the plant community description are spaces to enter productivity information. The information entered here can come from actual use records, existing initial stocking rate information (such as **Exhibits 4-18** & **4-19**), comparison with similar sites, or from clipping and reconstruction. When you need a better estimation of productivity, clipping is the preferred method. The instructions for this portion of this worksheet are in the exhibit and are supplemented in **(i) Rangeland Inventory Worksheet:** sections **(1) Plant Community Composition & Rangeland Similarity Index**, **(2) Estimating Annual Production by Clipping**, **(4) Growth Curve** & **(5) Calculating Initial Stocking Rates**.

For pasture, enter the Annual Stocking Rate **(AUMs/Acre/Year)** in the space provided. It will be helpful to also enter Annual Growth **(Total Pounds/Acre/Year)**.

For hayland, enter the Hay (Roughage) Yield **(AUMs/Acre/Year)** in the space provided. It will be helpful to also enter Annual Growth **(Total Pounds/Acre/Year)**.

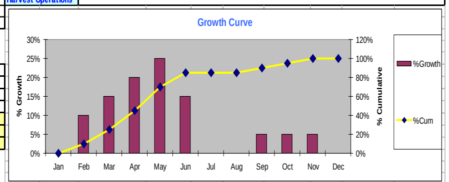
GROWTH CURVE: MLRA 2, Non-Irr., FSG 2

GENERAL INFORMATION		Month	%Growth	%Cum	Lbs/Acre	% Used	Useable	Use Cum	H.E	AUMs/Mo	AUM Cum
Cooperator	Horse Heaven										
Write Up	HH-09-01	Jan	0%	0%	0	85%	0	0	35%	0.0	0.0
Date	4/15/2009	Feb	10%	10%	1,564	85%	1,330	1,330	35%	25.5	25.5
Tract	T-4321	Mar	15%	25%	2,346	85%	1,994	3,324	35%	38.3	63.8
Field	1 - central	Apr	20%	45%	3,129	85%	2,659	5,983	35%	51.0	114.8
Acres	50	May	25%	70%	3,911	85%	3,324	9,308	35%	63.8	178.5
Section	NW 1/4 of NW 1/4 sect. 12	Jun	15%	85%	2,346	85%	1,994	11,302	35%	38.3	216.8
Township	T. 5 S.	Jul	0%	85%	0	85%	0	11,302	35%	0.0	216.8
Range	R. 3 W.	Aug	0%	85%	0	85%	0	11,302	35%	0.0	216.8
Waypoint	HH-09-01	Sep	5%	90%	782	85%	665	11,967	35%	12.8	229.5
Latitude		Oct	5%	95%	782	85%	665	12,632	35%	12.8	242.3
Longitude		Nov	5%	100%	782	85%	665	13,296	35%	12.8	255.0
Elevation	850	Dec	0%	100%	0	85%	0	13,296	35%	0.0	255.0
MLRA	2 (Willamette Valley)		100%	TOTAL LB./YEAR	15,643					255.0	AUM/YEAR

STOCKING RATES per ACRE — TOTAL AUMs per WRITE-UP

Soils	64B - Salkum silcl	Irrigation	non-irrigated
FS Group(s)	Well Drained - G002XY002OR	Fertilization	no fertilization
Drain Class	VP (Very Poorly)	Stockwater	Creek access at west end of pasture
Isomesic ?	No (Mesic (not foggy))	Grazing System	rotational with month-long use
Slope	8%	Weeds	Canada Thistle, Scotch Broom
Aspect	Not Applicable	Crop Rotation	
Stand Age	10 years	Harvest Operations	
Service Cntr.	Dallas		
Planner	Bob Gillaspy		

PRODUCTION DATA	
Adjustment factor	100%
Write-up Acres	50.0
AUM/ACRE/YEAR (soil survey)	6.0
AUM/YEAR	300
TOTAL POUNDS/ACRE/YEAR	15,643
TOTAL POUNDS/YEAR	782,143



CLIPPING DATA — OR — % COMP. ESTIMATES

PLANT LIST / PRODUCTIVITY Species Name	A Green Weight (lbs per acre)	B % Dry Weight	C % Un-grazed	D % Growth Done	E % of Normal	F Recon. Factor (B/C*D*E)	Recon. Wt. (A*F)	% Comp	Weight per Acre	AUM per Acre
Kentucky Bluegrass						0%	0.0	50%	7,821	3.0
Perennial Ryegrass						0%	0.0	20%	3,129	1.2
Orchardgrass						0%	0.0	15%	2,346	0.9
						0%	0.0	0%	0	0.0
						0%	0.0	0%	0	0.0
Canada Thistle						0%	0.0	5%	782	0.3
Scotch Broom						0%	0.0	10%	1,564	0.6
						0%	0.0	0%	0	0.0
						0%	0.0	0%	0	0.0
						0%	0.0	0%	0	0.0
						0%	0.0	0%	0	0.0
						0%	0.0	0%	0	0.0
						0%	0.0	0%	0	0.0
TOTALS	0						0.0	100%	15,643	6.0

Figure 16, Portion of Exhibit 4-17; General Information, Plant Community Composition, & Productivity

(2) Initial Stocking Rates

Stocking rates can be determined from actual use records, clipping and reconstruction, or from existing data. **Exhibits 4-18**, Pasture Productivity Estimates and **Exhibit 4-19**, Hay & Aftermath Productivity Estimates provide productivity information needed for planning roughage harvests and initial annual stocking rates for pastures and hayland aftermath. Both of these exhibits are meant to be used with local soil surveys, client interviews, and pasture & hayland condition scoring.

For pastures, **Exhibit 4-18** contains suggested initial stocking rates for pastures based on management level and pasture condition score. To use the exhibit, find the matrix that represents the potential productivity of the major soil on the pasture (refer to soil survey report *Yields per Acre for Crops and Pasture*). The exhibit displays potential productivity from 1.0 to 12.5 AUMs/acre/year in 0.5 AUMs/acre/year increments.

The stocking rate in the upper left block should correspond to the potential productivity of the soil (if no soil survey is available choose the potential productivity matrix based on similar pastures, client information, or other local knowledge). Estimate the management level of the client and determine the pasture condition score (see **(4) Pasture & Hayland Condition Score Sheet**, below).

Figure 17 shows a portion of the exhibit for a soil with a potential of 5.0 AUMs/acre/year. At the intersection of pasture condition score and management level are the initial stocking rate (AUMs/acre/year) and annual production (Lbs/acre/year) estimates. Both of these numbers should be entered in the productivity section of the worksheet for each field inventoried. The percentages in parentheses in the management level and pasture condition score boxes are the expected percent of potential. For example, a fair pasture condition score is generally expected to have only 70% of potential (5.0 vs. 3.5 AUMs/acre/year). A medium management level is expected to have 85% of potential (5.0 vs. 4.3 AUMs/acre/year). With fair pasture condition score and medium management level the percent of potential is 70% x 85% = 60% (5.0 vs. 3.0 AUMs/acre/year).

Pasture Prod. (AUMs/Ac/Yr)	Pasture Condition Score				
Management Level	Excellent (100%)	Good (85%)	Fair (70%)	Poor (45%)	V. Poor (20%)
High (100%)	5.0	4.3	3.5	2.3	1.0
Lbs./Ac/Yr	13,043	11,086	9,130	5,869	2,609
Med. (85%)	4.3	3.6	3.0	1.9	0.9
Lbs./Ac/Yr	11,086	9,423	7,761	4,989	2,217
Low (60%)	3.0	2.6	2.1	1.4	0.6
Lbs./Ac/Yr	7,826	6,652	5,478	3,522	1,565

Figure 17, Portion of Exhibit 4-18; Pasture Stocking Rates

For hayland, **Exhibit 4-19** contains suggested hay yields and aftermath initial stocking rates for hayland based on management level and pasture condition score. To use this exhibit, find the matrix that represents the potential productivity (tons/acre/year) of the major soil on the hayland (refer to soil survey report *Yields per Acre for Crops and Pasture*). The exhibit displays potential productivity from 2.0 to 10.5 tons/acre/year in 0.5 tons/acre/year increments.

The hay yield in the upper left block should correspond to the potential productivity of the soil (if no soil survey is available choose the potential productivity matrix based on similar haylands, client information, or other local knowledge). Estimate the management level of the client and determine the hayland condition score (see **(4) Pasture & Hayland Condition Score Sheet**, below).

Figure 18 shows a portion of the exhibit for a soil with a potential of 7.5 tons/acre/year. At the intersection of hayland condition score and management level are the annual hay yield (tons/acre/year), aftermath initial stocking rate (AUMs/acre/year), and annual production (lbs/acre/year) estimates. These numbers should be entered in the productivity section of the worksheet for each field inventoried. The percentages in parenthesis below management level and pasture condition score are the expected percent of potential. For example, a fair pasture condition score is generally expected to have only 70% of potential (7.5 vs. 5.3 tons/acre/year). A medium management level is expected to have 85% of potential (7.5 vs. 6.4 tons/acre/year). With fair pasture condition score and medium management level the percent of potential is 70% x 85% = 60% (7.5 vs. 4.5 tons/acre/year).

Hay/Aftermath (Tons/Ac/Yr & AUMs/Ac/Yr)	Hayland Condition Score				
Management Level	Excellent (100%)	Good (85%)	Fair (70%)	Poor (45%)	V. Poor (20%)
High (100%)	7.5	6.4	5.3	3.4	1.5
A.M. AUMs	2.46	2.09	1.73	1.11	0.49
Lbs./Ac/Yr	21,429	18,214	15,000	9,643	4,286
Med. (85%)	6.4	5.4	4.5	2.9	1.3
A.M. AUMs	2.09	1.78	1.47	0.94	0.42
Lbs./Ac/Yr	18,214	15,482	12,750	8,196	3,643
Low (60%)	4.5	3.8	3.2	2.0	0.9
A.M. AUMs	1.48	1.26	1.04	0.67	0.30
Lbs./Ac/Yr	12,857	10,929	9,000	5,786	2,571

Figure 18, Portion of Exhibit 4-19; Hayland/Aftermath Stocking Rates

(3) Forage / Roughage Partitioning (Hayland)

In general, "forage" refers to standing crop used for grazing and "roughage" refers to a harvested crop that is fed in another form (bales, etc.). On most pasture and rangeland where the only consumptive use of the forage crop is grazing, the growth curve is not partitioned. That means that the entire growth curve will be considered for one type of use (i.e. grazing). Growth curve partitioning is automated in the **Grazing Lands Spatial Analysis Tool (GSAT)** computer program.

In the case of hayland that is also used for grazing (usually after the roughage crop has been harvested) the growth curve may be partitioned to determine the yield of each type of crop (hay for roughage and aftermath for grazing).

Figure 19 demonstrates a common situation where the hayland is grazed in February and March, ungrazed and grown for hay from April through July, and grazed again after the last hay harvest from August through November. This results in 15% of annual growth for spring grazing, 15% for aftermath grazing, and 70% for hay. Many times, there will be no grazing in the first part of the growing season. When that is the case use the period from beginning of growth through harvest (in this case that would be 85% of the growth curve) for hay production. If the annual air-dry weight and harvest efficiencies (HE) are known for this site the stocking rates for each period and the hay yield may be calculated.

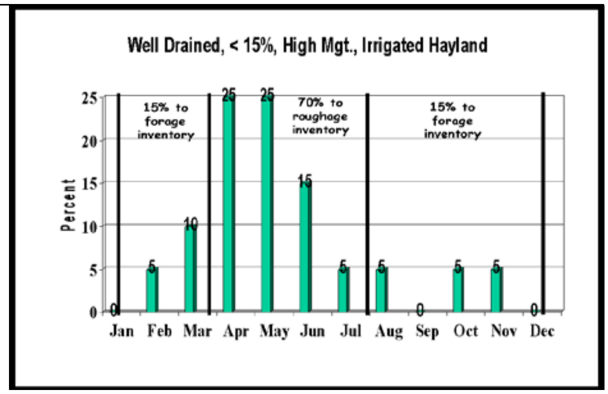


Figure 19, Forage/Roughage Partitioning Example

Formulas Used:

Grazing (time-period stocking rates) in ***AUMs/acre***

$$\frac{(A * G * GHE)}{913 \text{ lbs. /AUM}}$$

A **= Annual air-dry production in lbs./acre/year**
G **= % of growth curve used**
GHE **= Grazing harvest efficiency**

Harvested Roughage in tons/acre

$$\frac{(A \times G \times RHE)}{2000 \text{ lbs. /ton}}$$

A **= Annual air-dry production in lbs./acre/year**
G **= % of growth curve used**
RHE **= Roughage harvest efficiency**

Roughage Aftermath in AUMs/acre

$$\frac{[A \times GA \times GHE] + [A \times GR \times (100 - \% RHE) \times GHE]}{913 \text{ lbs. /AUM}}$$

A **= Annual air-dry production in lbs./acre/year**
GA **= % of growth curve used after roughage harvest**
GHE **= Grazing harvest efficiency**
GR **= % of growth curve used for roughage**
RHE **= Roughage harvest efficiency**

Forage / Roughage Partitioning Example:

Parameters:
Annual air-dry production (lbs./acre) for the site = 7000
Grazing Harvest Efficiency = 35%
Roughage Harvest Efficiency = 75%
Roughage Residue = 25% (100% - 75% HE)
70% of growth curve is Harvest Roughage
15% of growth curve is early grazing
15% of growth curve is aftermath grazing

Early Grazing - 15% of annual growth at 35% Harvest Efficiency.

$$\frac{(7000 \text{ lbs} \times 15\% \times 35\%)}{913 \text{ lbs./AUM}} = 0.40 \text{ AUM/acre}$$

Hay Production – 70% of annual growth at 75% Harvest Efficiency.

$$\frac{(7000 \text{ lbs} \times 70\% \times 75\%)}{2000 \text{ lbs./ton}} = 1.84 \text{ tons/acre}$$

Aftermath Grazing – 15% of annual growth *and* hay aftermath at 35% Harvest Efficiency.

$$\frac{[7000 \text{ lbs} \times 15\% \times 35\% \text{ HE}] + [7000 \text{ lbs} \times 70\% \times 25\% \text{ remaining} \times 35\% \text{ HE}]}{913 \text{ lbs./acre}} = 0.87 \text{ AUM/acre}$$

At this point, the initial stocking rates are determined for early season grazing and for grazing hay aftermath (which also includes roughage residue @ 35% HE). Hay production in tons is also estimated. Calculations may be made for benchmark and projected future conditions (if annual production can be estimated). These calculations can now be used to balance forage/roughage supply (benchmark and/or future) with animal demand and to develop prescribed grazing specifications.

(4) Pasture & Hayland Condition Score Sheet

Page 2 of the Oregon Pasture & Hayland Inventory Worksheet (**Exhibit 4-17 and *Figure 20***) contains the pasture and hayland condition scoresheet. The objective of the scoresheet is to evaluate current pasture or hayland productivity and the stability of its plant community, soil, and water resources and identify what treatment needs, if any, are required to improve productivity and protect soil, water, and air quality.

It can be used to rate different pastures/hayland in a single growing season, or the same pasture/hayland over a period of years, or at different times during the season. If the pasture or hayland is relatively diverse, more than one estimate may be done on the unit or several pasture and hayland fields may be evaluated at one time using the columns on the pasture summary sheet.

Paddocks in rotational pastures may be rated separately or as a combined unit. It depends on how alike they are. If any indicator looks markedly different from paddock to paddock, it may pay to rate each one separately. Score all ten indicators for a complete description of pasture condition.

(i) Pasture/Hayland Condition Indicators

The following ten indicator descriptions are used in determining the pasture condition score (see ***Figure 20***). These descriptions come from **Guide to Pasture Condition Scoring** in the appendix of the NRPH: available online.

1. Percent desirable plants

This indicator determines if the pasture has the kind of plants that the livestock on it will graze readily. A desirable species is readily consumed, persistent, and provides high tonnage and quality for a significant part of the growing season. Undesirable species, such as woody invaders, noxious weeds, and toxic plants, are those that typically are not eaten (rejected) by most livestock or cause undesirable side effects when eaten, and that crowd out more desirable species. A few forages for a time are undesirables during a specific growth stage when they produce toxins. Intermediate species are those, which, while eaten, provide low tonnage or lose quality fast, and often have a short-lived grazing use period. Some examples are dandelions, wild plantains, and annual grasses, such as crabgrass. Estimate visually the proportion of desirable species present in the entire sward by weight, and score accordingly.

2. Plant cover

The percentage of the soil surface covered by plants is important for pasture production and soil and water protection. A dense stand (high stem count) ensures, when properly grazed, high animal intake and high sunlight interception for best forage growth. Bare, open spots allow for weed encroachment, increased water runoff during intense rains, and soil erosion. Visually estimate the total cover of all desirable and intermediate species. Assign a value based on either green leaf canopy or live vegetative basal area cover percentage. Use the most familiar method that provides a consistent, reliable estimate of plant cover for the pasture being rated.

Canopy cover works best on sod-forming pastures. It can be determined at any time on continuously grazed pastures provided stubble heights greater than 1 inch are present. On rotational pastures, estimate canopy cover of a paddock the day prior to livestock entry. This will represent the best possible condition. If it rates fair or lower at this growth stage, management changes are definitely in order.

Basal area works best on bunch grass pastures. It is hard to use on pastures where sod-forming grasses and broadleaf plants dominate. Estimate by eye or use either the step-point or the point-intercept methods. Basal area is measured by both methods by counting pin hits on live stems and plant crowns at ground level (within 1 inch above). Where it is most useful, basal area is more constant than canopy cover and thus is more reliable

3. Plant residue

Plant residue, in various states of decay, provides additional surface cover and organic matter to the soil. However, too much standing dead material in the grass stand reduces the feed value of the forage consumed and animal intake, and inhibits new plant shoot growth. Excessive amounts of standing dead material may cause the forage to be rejected by the grazing animal. Less than 25 percent of the standing forage mass should be dead or dying leaves and stems. Buildup of thatch (mat of undecomposed residue) at the soil surface indicates retarded residue decay. Thatch promotes fungal diseases and retards or prevents shoot and seedling emergence. This results in forage stand decline.

4. Plant diversity

Plant diversity is the number of different forage plants that are well represented (20% or more of plant cover) in a pasture. Low species diversity causes season-long pastures, or a set of pastures grazed as a unit, to be less reliable suppliers of forage to livestock during the grazing season. Forage production varies more widely through the grazing season because of changing weather and light conditions and insect and disease pressure. Pastures that have high species diversity tend to be older, moderately grazed permanent pastures. Here planted and volunteer forages have adjusted to the management and the prevailing environmental stresses. No single forage species is so dominant as to crowd out others.

Having more than one functional plant group growing either in a pasture or in different, complementary pastures is highly important. This maintains the most consistent forage supply during the grazing season. Functional groups of forages are plant groupings that have similar growth habits and management needs. The four basic functional groups for improved pastures are cool-season grasses, warm-season grasses, legumes, and other grazable broadleaf plants (e.g., Brassicas and forage chicory). These basic functional groups can be split into more specific groups, such as upright versus prostrate and sod-formers versus bunch grasses. However, this extra detail is unwarranted in improved pasture condition evaluations.

Plants from different functional groups are most compatible when they can compete successfully together as managed. Mixed species pastures with at least two functional groups and three to four well-represented forage species are generally the most productive. Higher diversity (over six species) does not assure higher productivity. It may actually spur animals to avoid some species and graze others hard, as species differences in palatability and maturity are more likely. Potential forage is wasted. Less desirable species gain in area by outcompeting overgrazed desirable species. However, trying to prevent this selectivity by reducing forage on-offer and forcing animals to eat everything reduces intake and gains. This also decreases productivity.

When plant diversity scores low, several courses of action are possible. The appropriate response depends on the region in which the pasture is located, its intended use period, and the species growing in it. Applying other treatment measures may be easier or more appropriate than trying to grow several plant species together within a single pasture. These measures include:

- ***Applying nitrogen fertilizer to a pasture with few or no legumes present***
- ***Establishing a different forage functional group in a separate pasture***
- ***Oversowing an annual forage crop into a perennial forage pasture going into dormancy***

Always rate plant diversity even if you may ultimately not wish to change it in that pasture. Monocultures can be quite productive on seasonal and irrigated pastures. They can provide abundant production at times precisely when other pastures on the operating unit are unproductive. However, when plant diversity is rated low on an individual field, some alternative course of action must be in place or developed. Some, such as feeding hay or applying N fertilizer, are expensive alternatives.

5. Plant vigor

Desirable species should be healthy and growing at their potential for the season when rated. If not, they will be replaced by weeds and low quality forage plants. If plant growth conditions really suffer, bare soil will begin to appear. Some things to consider when rating plant vigor are color, size of plants, rate of regrowth following harvest, and productivity. Determine overall vigor of desirable and intermediate species, and record. If score is less than four, utilize the causative factors below to help determine what may be causing the lack of vigor.

Plant Vigor Causative Factors

❖ Soil fertility

Adequate, but not excessive, fertility is critical for good plant vigor. Test soil or plant tissue to determine nutrient status. Excessive amounts of nutrients, particularly N, P, and K, can also cause animal health and/or water quality problems. Rank, often lodged, dark green to blue-green forages are a warning sign of excessive soil fertility. Maintain adequate nutrient balance to not exceed maximum economic yield of desirable forage species. In some areas of the United States, excess salts and sodium are often present in the soil at levels that reduce plant vigor. Test those soils for electrical conductivity and exchangeable sodium. Reduce their levels, or plant forage species tolerant of the levels found.

❖ Severity of use

Grazing management is critical in maintaining productive pastures. Close, frequent grazing (mown lawn appearance) often causes loss of vigor reducing yields and ground cover. Low stocking rates promote selective grazing that causes excessive residue build-up (presence of mature seed stalks and dead leaves). This standing residue blocks sunlight, reduces overall forage quality, and favors the spread of less palatable and/or taller, grazing intolerant forages. Assign a value based on the proportion of the pasture grazed closest and the height at which it is grazed. Compare that height to minimum stubble heights recommended for maintaining desired forages.

❖ Site adaptation of desired species

Climate and soil type play a major role in the vigor of a given species. Consider these items when evaluating adaptability:

- ◊ *cold hardiness*
- ◊ *tolerance to aridness*
- ◊ *summer heat and humidity levels*
- ◊ *frost heave or soil cracking*
- ◊ *soil wetness*
- ◊ *flooding or ponding*
- ◊ *soil acidity or alkalinity*
- ◊ *toxic elements*
- ◊ *salinity*
- ◊ *sodicity*
- ◊ *low or high nutrient levels*

Two other factors to consider are the desired species tolerance to existing grazing pressure and soil and water management. Plants that hold their growing point close to the ground can be grazed close provided they are allowed some time between grazing events to push out new leaf area. Others that elevate the growing point into the grazing zone need grazing events timed to release new shoot growth. The presence and balance of desired species are compared with those species present now and their balance. This verifies how well adapted the desired species were to the site, grazing pressure, and management.

❖ Climatic stress

Extremely wet, dry, hot, or cold weather may threaten plant vigor even when climatically adapted forage species are present. When rating the pasture, consider recent weather events and their role in the present health of a forage stand. Extremely cold and wet weather can cause temporary nitrogen deficiency symptoms (yellowish leaves). A hard winter may weaken the stand. A drought can cause the stand to go dormant. Check for frost or freeze damage to foliage.

❖ Soil pH

Soil pH influences plant vigor primarily through its effect on nutrient availability. It also influences the amount of nitrogen-fixing nodules formed on legume roots. Determine the pH in the surface 3 to 4 inches through a soil test or reliable field methods. Adjust pH to provide optimum yield of desirable forage species.

Note: Reduced yields may continue if the pH in the subsoil is too low or high. Contact a soil fertility or forage management specialist for further management options.

❖ Insect and disease pressure

Look for signs of leaf, stem, and root damage caused by insects and disease. Assess their impact on forage quality, quantity, and stand life. Some are chronic, occurring yearly, but with little consequence to the forage stand life. Others take the forage species under attack out of the stand. Corrective actions to take are numerous and specific to the insect or disease involved. Consult with a local, respected forage expert when unsure of proper course of action.

6. Livestock concentration areas (pasture only)

Concentration areas are places in pastures where livestock return frequently and linger to be near water, feed, mineral, or salt, or shelter, or to be in shade. Typically, well-worn pathways lead to these preferred areas. Depending on the degree of usage, these areas are usually bare and receive extra animal waste. Depending on where they are on the landscape and flow paths, they can direct sediment, nutrients, and bacteria to nearby water bodies.

7. Uniformity of use (pasture only)

Check uniformity of use by observing animal grazing patterns. Uniform grazing results in all desirable and intermediate species being grazed to a similar height. Spotty or patterned grazing appears uneven throughout a pasture with some plants or parts of paddocks grazed heavily and others lightly. Individual forage species are being selected for or against by the livestock based on their palatability and nutritional value. Selectivity is also affected by forage species stage of maturity differences, amount of forage offered to livestock, and their length of stay in the paddock. Zone grazing occurs when one end of the pasture is heavily grazed and the other end is ungrazed or lightly grazed. It occurs on long and narrow pastures and ones that run lengthwise up and down steep slopes. Other pastures that have shady areas, windbreaks, or hay feeding, creep feeding, and watering sites whose location and duration of use at that location skew foraging to one end of a pasture are often zone grazed as well. Physical barriers, such as streams, cliffs, and obstructing fencelines, can confine livestock to one area of a pasture causing zone grazing.

When rating this factor keep in mind that while overgrazing may result in a uniform height (mown lawn appearance), it is to a height lower than that needed to maintain all desirable forage species.

8. Erosion

❖ Sheet & rill

This erosion is soil loss caused by raindrop impact, drip splash from rainwater dropping off plant leaves and stems onto bare soil, and a thin sheet of runoff water flowing across the soil surface. Sheet and rill erosion increases as ground cover decreases. Evidence of sheet erosion in a pasture appears as small debris dams of plant residue that build up at obstructions or span between obstructions. Some soil aggregates or worm castings may also be washed into these debris dams. Rills are small, incised channels in the soil that run parallel to each other downslope. They join whenever the ground surface warps and deflects the direction of their flow. When rills appear, serious soil loss is occurring. This erosion type also includes most irrigation-induced erosion.

❖ *Streambank, shoreline, & gully*

This erosion occurs in large, open drainage channels or around shorelines. When in pastures, these channels or shorelines can have heightened erosion problems and losses of vegetative cover that typically grows on them. These heightened damages result from grazing animal traffic in or on them. Open channels may be intermittent or perennial flowing streams or dry washes. The factors that affect the extent of disturbance livestock cause to gullies, streambanks, shorelines, and their associated vegetation are:

- ◊ ***Livestock traffic patterns***
- ◊ ***Frequency of use***
- ◊ ***Attractiveness of these channels or banks as sunning, dusting, travel lanes, watering, grazing, or rubbing areas***
- ◊ ***Channel shape (depth, width, presence and frequency of meanders, and bank stability)***
- ◊ ***Flow characteristics (frequency, depth, sediment carried, swiftness, and turbulence)***

❖ *Wind*

Erosion occurs when heavier, windblown soil particles abrade exposed soil and cause dust to become airborne. Deposition of the heavier soil particles occurs downwind of obstructions, such as fencelines, buildings, and vegetation. Often vegetative debris is windrowed against obstructions.

9. Percent legume

Legumes are important sources of nitrogen for pastures and improve the forage quality of a pasture mix when they comprise at least 20 percent of total air-dry weight of forage. Deep-rooted legumes also provide grazing during hot, dry periods in mid-summer. Visually estimate the percentage of legume present in the total forage mass. Rate this indicator even if site or grass species preclude successful legume establishment and reliable survival to have an effective legume component to fix nitrogen. Most pastures are nitrogen-limited since much of the nitrogen excreted by animals eludes plant uptake. Pastures with few or no legumes present need alternative means of supplying nitrogen for optimum forage production. When bloating legume content is greater than 60 percent of total forage dry weight, bloat incidence in livestock is likely without preventative steps.

10. Soil compaction

Soil compaction impacts water infiltration rates and runoff. Lack of infiltration decreases water available for plant growth in the soil. Instead, water runs off, increasing channel erosion downstream, and conveys contaminants, such as nutrients, from the site, reducing water quality. Soil compaction is best determined by measuring the bulk density (weight per volume of soil) at 1-inch increments to plow depth. However, compaction can be detected in the field using a soil probe, metal rod, or knife. As these tools are pushed into the soil, compacted soil layers interrupt their ease of penetration. Compare in-field resistance to penetration with resistance found at a grazed fence line where the livestock cannot stand or walk on the soil surface. The more noticeable the difference in resistance between the two areas is, the worse the compaction is in the pasture.

(ii) Other considerations

When scoring hayland, enter a "0" for the Uniformity of Use and Livestock Concentration indicators if the hayfield is not grazed at any time during the year.

Using the pasture & hayland condition score sheet and indicator criteria (**Exhibit 4-17 and *Figure 20*, below**), read the scoring criteria for each of the ten pasture condition indicators one at a time and rate before moving onto the next. Use the 1 to 5 scale provided (use a "x.5" to score between two indicator classes). Estimate by eye or measure as precisely as needed to rate the indicator reliably.

If the plant vigor score is less than four, refer to the Plant Vigor Causative Factors criteria on page 3 of **Exhibit 4-17** to identify the plant stresses causing reduced vigor. Rate each causative factor independently on the score sheet. Do not average to adjust the original vigor score. Use only the original plant vigor score for overall condition score; do not add causative factor scores to pasture or hayland condition scores.

When scoring erosion, rate sheet and rill erosion every time. Rate other types of erosion only if present. When present, indicate which one(s) by identifying the erosion type with a unique symbol next to its score. Divide the box as needed to score them separately. Erosion is rated by averaging the individual scores. You will still need to consider correcting the most serious erosion problem.

Evaluate the site and rate each indicator based upon your observations. Scores for each indicator may range from 1 to 5. Splitting between two scores is acceptable. Multiply the points x the weight to get weighted points. Sum the weighted points to determine overall pasture condition score.

Indicator/Weight	1 Point	2 Points	3 Points	4 Points	5 Points	Points	Weight	Weighted Points
Percent Desirable Plants **15%**	Desirable forage species represent <30% of stand (air-dry weight). Annual weeds, other undesirable herbaceous plants, and/or woody species, dominate pasture.	Desirable forage species represent 30 to 50% of stand (air-dry weight). Broadleaf weeds and other undesirable herbaceous species are prevalent and expanding. Woody species often present. Productivity 30 - 60% of listed potential for soil component.	Desirable forage species represent 50 to 75% of stand (air-dry weight). Broadleaf weeds and annual grasses > 15% by weight & expanding. Some woody species may be present. Pasture productivity 60 - 70% of potential listed for soil component.	Desirable forage species represent 75 to 90% of stand (air-dry weight). Remainder of the stand is composed primarily of perennial forage species with intermediate grazing value. Broadleaf weeds or annual grasses < 15% by weight. No woody species. Yields 70-85% of potential listed for soil component.	Desirable forage species exceed 90% of pasture stand (air-dry weight). Remainder of the stand is comprised of perennial forage species having intermediate grazing value. Broadleaf weeds & annual grasses < 5% by weight. Yields > 85% of listed potential for the soil component.	3.0	1.5	4.50
Live Plant Cover (Live stems and green leaf cover of all species at adjusted 6" height.) **10%**	FOLIAR COVER: <50% BASAL AREA: <15% Photosynthetic area very low. Very little plant cover to slow or stop runoff.	FOLIAR COVER: 50 to 60% BASAL AREA: 15 TO 25% Photosynthetic area low. Low retardation of runoff by pasture vegetation.	FOLIAR COVER: 60 to 75% BASAL AREA: 25 TO 35% Most forage plants grazed close; little leaf area to intercept sunlight. Moderate retardation of runoff by pasture vegetation.	FOLIAR COVER: 75 to 85% BASAL AREA: 35 TO 50% Pasture not uniformly grazed and there is some loss of potential for photosynthetic activity. Pasture vegetation offers high retardation to runoff.	FOLIAR COVER: 85 to >100% BASAL AREA: >50% Forages maintained in leafy condition for best photosynthetic activity. Very dense stand with either no runoff, or very slow runoff flows.	4.0	1.0	4.00
Plant Diversity (Evaluate as a complete system. Functional groups of forages are plant groupings that have similar growth habits and management needs). **5%**	One dominant perennial forage species (>75% of stand by air-dry weight). (stand > 2 years old)	Two forage species from one functional group (>75% of stand by air-dry weight). (stand > 2 years old)	Three to five forage species all of one functional group (>75% of stand by air-dry weight).	Two to four forage species representing two functional groups (each group at least 20% of stand by air-dry weight & both groups totaling at least 75% of the stand by air dry weight) – at least one perennial grass and one desirable legume species are present.	At least five desirable forage species representing at least three functional groups (each group at least 20% of stand by air-dry weight) – at least one grass and one legume species are present.	3.0	0.5	1.50
Plant residue (organic material covering soil between tillers or stems) **5%**	Ground Cover: No identifiable residue present on soil surface. Thatch, if present, is heavy (>1-inch thick). STANDING-DEAD FORAGE: More than 25% of total pasture production (air-dry weight).	Ground Cover: <10% of soil surface with dead forage plant residue present. Thatch, if present, 0.5" to 1" thick. STANDING-DEAD FORAGE: 15 to 25% of total pasture production (air-dry weight).	Ground Cover: 10 to 20% of soil surface with dead forage plant residue present. Thatch buildup, if present, less than 0.50" thick. STANDING-DEAD FORAGE: 10 to 15% of total pasture production (air-dry weight).	Ground Cover: 20 to 30% of soil surface with dead forage plant residue present. No thatch buildup. STANDING-DEAD FORAGE: Less than 10% of total pasture production (air-dry weight).	Ground Cover: 30 to 70% of soil surface covered with dead forage plant residue. No thatch buildup. STANDING-DEAD FORAGE: Less than 5% standing dead forage plant material available to grazing animals.	3.0	0.5	1.50
Plant Vigor **20%**	No recovery after grazing; or leaves pale yellow to brown; or plants at permanent wilting point; or most all plants evidence stress due to insects and/or disease. Proper stubble heights not maintained. Exercise paddock only. Or, lodged, dark green, overly lush, forage that is generally avoided.	Recovery after grazing takes 2 or more weeks longer than normal; or yellowish-green leaves; or major insect or disease loss. Proper stubble heights not maintained throughout season.	Recovery after grazing takes 1 week longer than normal; or urine or dung patches dark green in contrast to rest of plants; or minor insect or disease loss.	Recovery after grazing takes 1 or 2 days longer than normal; or light-green leaves of most plants as contrasted to greener plants in urine and dung patches; or minor insect or disease damage.	Expected normal seasonal recovery following grazing. Healthy green color of foliage. Little sign of insect or disease damage.	3.0	2.0	6.00
Percent legume **10%**	No legume in pasture; or, more than 70% (air-dry weight) of bloat-causing legumes.	Forage legumes 1-5% or 50 - 70% (air-dry weight) of spreading legume with grass composition declining.	Forage legumes represent 5 - 10% or 40 - 50% (air-dry weight) of pasture production.	Forage legumes represent 10% to 15% (air-dry weight) of pasture production.	Forage legumes represent 15% - 40% (air-dry weight) of pasture production. No forage grass loss; forage grasses may be increasing.	1.0	1.0	1.00
Uniformity of Use **10%**	Overgrazed patches cover over 50% of pasture. Mosaic pattern of grazing use; or there are identifiable areas within pasture being avoided. Or, grazing continuous & livestock numbers exceed stocking rate.	Overgrazed patches 25 to 50% of pasture either in a mosaic pattern or as identifiable areas within pasture. Inadequate forage regrowth periods.	Overgrazed patches cover 10 to 25% of pasture either in a mosaic pattern or as identifiable areas within pasture. Regrowth periods not adequate to maintain forage vigor.	Overgrazed patches represent minor areas. Urine and dung patches avoided. Frequent herd rotation, regrowth periods adequate to reach proper forage height. Proper stubble heights maintained.	Ungrazed areas only at urine or dung patches. Regrowth periods adequate to reach proper forage height. Proper stubble heights maintained.	3.0	1.0	3.00
Livestock Concentration Areas **10%**	Livestock concentration areas and trails cover >15% of the pasture; or all concentration areas allow for contaminated runoff to be conveyed directly into adjacent water bodies.	Livestock concentration areas and trails cover 10 to 15% of the pasture; most concentration areas are close to water channels allowing contaminated (unbuffered) runoff to drain into adjacent water bodies.	Isolated livestock concentration areas and trailing evident (<10% of pasture); no more than one concentration area that drains (unbuffered) directly into adjacent water body.	Some livestock trailing evident with one or two, small, concentration areas. There is a buffer zone between any concentration area and adjacent water bodies.	Absence of livestock concentration areas and trailing; Or, heavy use areas located or treated to minimize contaminated runoff.	2.0	1.0	2.00
Soil Compaction (Probe moist soil comparing the treatment unit to an ungrazed area; i.e. fence row.) **5%**	Soil very hard, surface uneven over large areas due to rutting and/or hoof action. Very hard to push a probe into soil without damage to probe.	Dense compaction layer at surface. Livestock trails common. Off-trail hoof prints common. Hard to push a probe through soil layers.	Compaction layer present at one or more depths within plow depth, can be identified with probe or shovel. Some soil ruts or hoof marks evident.	Soil probe enters soil easily. Scattered signs of livestock trails and hoof prints with impact confined to lanes or small wet areas.	No evidence of compaction due to vehicle or livestock traffic.	3.0	0.5	1.50
Erosion (Including irrigation induced) **10%**	Large bare areas with active sheet & rill erosional features represent more than 20% of pasture. Enlarged (deepened or widened) corrugates or center pivot wheel tracks; >50% of corrugate lengths are eroded; sediment deposition evident within the pasture.	Bare areas with active sheet & rill erosion less than 20% of pasture. >50% of corrugate lengths are eroded; active erosion at turnouts from water conveyances, near sprinkler heads; or center pivot wheel tracks; irrigation tailwater has visible sediment load; large-sized debris off the pasture accumulates at bottom of field.	Active sheet & rill erosion represents no more than 5% of pasture with most erosion limited to sites adjacent to irrigation system components (i.e., turnouts, sprinkler heads, center pivot tracks); <50% of corrugate lengths are eroded; irrigation tailwater or runoff with little visible sediment load; some plant litter collects at bottom of field.	No visible evidence of active erosion; some evidence of past erosion but features are blunted and now vegetated; debris dams formed by litter, if present, are random and scattered over pasture area.	No evidence of past or current erosion.	5.0	1.0	5.00

Pasture Score	Hayland Score	Individual Indicator Score	Management Change Suggested	Overall Pasture Condition Score =	30.00
45-50	35-40	5	No changes in management needed at this time.	Excellent	
35-45	25-35	4	Minor changes would enhance, do most beneficial first.	Good	
25-35	17-25	3	Improvements would benefit productivity and/or environment.	Fair	
15-25	9-17	2	Needs immediate management changes, high return likely.	Poor	
10-15	1-9	1	Major effort required in time, management and expense.	Very Poor	

Figure 20, Portion of Exhibit 4-17; Pasture Condition Score Sheet

Total the score for each pasture or hay field and determine the score using ***Table 6*** (both overall and individual scores). Also, focus on any low scoring individual indicators or causative factors for potential items to treat in the conservation plan.

When an individual indicator's score falls below a five, determine its worth to the operation. Then, decide whether to correct the cause or causes for the low rating. If you choose to correct, plan the most suitable management options for your area and operation.

When the pasture & hayland inventory worksheet is completed, the planner should be able to make conclusions about the productivity, condition, functioning, and overall health of the site. The sections are designed to work together to identify what is working well, what is at risk, and what should be addressed immediately. At this point, the planner and client should have reached consensus about past use, benchmark conditions, and the practicality and feasibility of potential treatments to the site. There should be enough information to continue to the next steps of developing and evaluating alternatives to meet objectives and treat resource concerns.

Table 6, Pasture & Hayland Condition Scores

Condition Score			Condition Rating & Management Change Needed
Pasture Overall	**Hayland Overall**	**Individual**	
45-50	**35-40**	**5**	**Excellent**: no changes in management needed at this time.
35-45	**25-35**	**4**	**Good**: minor changes would enhance, do most beneficial first.
25-35	**17-25**	**3**	**Fair**: improvements benefit productivity and/or environment.
15-25	**9-17**	**2**	**Poor**: needs immediate management changes, high return likely.
10-15	**1-9**	**1**	**Very poor**: major effort required in time, management, & expense.

(l) Grazed Forest (Understory Grazing)

For inventory and evaluation of forage resources in forest understory, use **Exhibit 4-12** Rangeland Inventory Worksheet. If a forest ecological site is available, use the understory plant community data and interpretations in conducting the inventory and evaluation.

Determine the plant community composition (if a forest ecological site is available, determine similarity index) and production (by any of the methods mentioned in section (i) Rangeland Inventory Worksheet). Estimate cover, growth curve, and forage value rating. Calculate stocking rates (annual and any time-period stocking rates as needed). Take notes about any aspects of the site that will influence planning. Perform any other inventory and evaluation needed if site is used for timber production (see the **National Forestry Handbook** for more information)

In most cases Western Juniper woodlands in Oregon can be considered rangelands with either a Juniper component to the RPC or a mid to low seral ecological condition where Juniper has invaded the site. Use the rangeland inventory worksheet to evaluate these sites. Additional guidance and procedures can be found in **Inventorying, Classifying, and Correlating Juniper and Pinyon Communities to Soils in the Western United States** in the appendix of the NRPH; available online.

(m) Fish and Wildlife

A determination of the quality of fish and wildlife habitat needs to be a part of inventory and evaluation. Different ecological sites will have different potentials for providing habitat components for various species. Sites have on-site and off-site effects that can degrade, maintain, or improve aquatic habitat for fish and amphibians. Rangelands (uplands and riparian areas) provide important food, cover, shelter, and travel corridors for a variety of species. Pasture and hayland provides important food for many wildlife species. Information is available in ecological site descriptions and forage suitability group descriptions. Ask for assistance from Oregon Department of Fish & Wildlife and/or other agency biologists in determining habitat requirements and interpretations of benchmark conditions. Conversations with local biologists should be documented in the case file.

Determine the benchmark and potential aquatic habitat using **Stream Visual Assessment Protocol version 2** and if needed **Biology Technical Note #12 Procedures for Using Oregon Stream Habitat Data Sheet**. Determine the benchmark and potential wildlife habitat quality using **Biology Technical Note #27 Wildlife Habitat Evaluation Guides**. Use the **Openland** worksheet for crop aftermaths, pasture, and hayland, the **Rangeland** worksheet for rangeland, and the **Woodland** worksheet for understory grazing in grazed forest.

Additional information is contained in Chapter 8 (Wildlife Management on Grazing Lands) of the NRPH. **Exhibits 5-3 Stocking Rate and Forage Value Rating** and **Exhibit 5-4 Determining Forage Composition and Value Rating** can be used to determine and plan use of plant community components for multi-species stocking.

(n) Field Notes

Notes are often critical for completing planning efforts. A well-documented case file should have enough notes for someone other than the planner to determine the planning steps clearly. There are several places on the rangeland and pasture & hayland inventory worksheets and other worksheets for documenting thoughts, observations, judgements, and other information. These observations are instrumental in properly discerning the condition of the resource and for making sound decisions about possible treatments for resource concerns.

Record such things as wildlife observations, current and recent climate, disturbances and disturbance history, location notes, soil information, plant community structure and appearance, client observations, or any other information that may be germane to characterizing the site. Notes about cause and effect relationships are particularly useful for finding effective treatments to resource concerns.

Complete notes in the field if possible. Too much information may be lost if notes are taken a day or more after the fieldwork was completed. Enter appropriate notes in Toolkit for a more permanent record of critical planning information.

(o) Mapping and Forage Inventory

Depending upon the complexity of the area inventoried there should be a benchmark write up for each ecological site or forage suitability group description on the planning unit. Additional write-ups may be needed for different plant communities within an ecological site or forage type within a forage suitability group.

The land use, condition, and production of each polygon should be either referenced to the benchmark write-up within that polygon or based upon a benchmark write up on the same type of site. Use benchmark write-ups to make decisions about similar polygons. Use judgement to adjust productivity, similarity index, pasture/hayland condition score, growth curves, stocking rates, etc.

Identify polygons by ecological site or forage suitability group (if no ESD or FSG is available, identify by plant type for each land use). Each polygon within each management unit should have a unique label to be able to distinguish it in the forage inventory. Polygons may be further divided by other factors such as distance from water, slope, accessibility, or location of past or planned conservation practices (usually accelerating practices). These polygon subdivisions can be considered response units: discrete units within a management unit (usually a fenced, manageable unit of a single land use) with similar conditions and potentials.

For each polygon identified, document the land use, acres, site (ESD, FSG), Rangeland Similarity Index or Pasture/Hayland Condition Score, harvest efficiency (planned), productivity (lbs. / acre / year), and stocking rate. **Exhibit 5-2** in the NRPH provides a suitable forage inventory worksheet. Forage inventory may also be documented using the **Grazing Lands Spatial Analysis Tool (GSAT)** computer program.

(p) Monitoring

A thorough site inventory and evaluation should suggest components or functions of the ecosystem that need to be monitored to determine if selected treatments to resource concerns are adequate and to suggest further inventory, evaluation, and planning needs. Similarity index, initial trend determinations, production information, growth curve, pasture or hayland condition scores, and rangeland health assessments all contribute information for developing a monitoring plan.

Before developing a plan for monitoring the resource, ask what needs to be monitored, where monitoring should occur, and when (or how often) monitoring needs to be conducted. Specify what components, functions, or portions of the ecosystem need to be observed, when it will be collected, at what intervals, who will do the collection and analysis of data, and what form the report will have. Effective monitoring does not need to be complex or difficult to accomplish. Any information that allows evaluation of the effectiveness of treatments will be helpful in maximizing success of conservation practices and systems.

(1) Photopoints

Photo documentation is easy to collect and provides a visual representation of resource conditions. Once key areas have been identified and write-ups completed for benchmark conditions, a series of photographs can be taken (see **(e) Photographs**) at least once a year to document vegetation conditions. If a GPS unit is used to locate the key area (inventory location) or transect the site can be revisited easily. If no GPS waypoints are available, a post can be placed at the desired location. For more information, see **Range Technical Note #9 Photo Plots**.

(2) Grazing Records

Keeping useful grazing records is a matter of monitoring, documenting, and controlling supply and demand of forages and roughages. Records of amounts of forages and roughages grown and/or purchased, compared to amounts harvested and consumed by grazing animals and wildlife will indicate whether a suitable balance exists on the ranch or unit. A positive (supply exceeds demand) balance is necessary for meeting long-term landscape and economic goals.

Grazing records are designed to help ranchers monitor the condition and productivity of individual pastures and to respond with management that will encourage their long-term sustainability, quality, and profitability.

Grazing records should log basic information about herd size(s), the dates of pasture rotations and the duration of grazing in individual pastures, season of use, and utilization. These records will help monitor the amount of forage harvested from each pasture, help identify changes in range condition toward or away from your landscape and economic goals, monitor the degree of use of key forage plants, and point out improvements needed in pastures. This record will help clients make good economic decisions and improve their management abilities.

GRAZING RECORD - RANGE								
Pasture Number / Name:		North Thompson Place						
Year or Season:		Late summer			Acres:	875	Eco Site:	Loamy 10-12 PZ
Livestock Type	Livestock Number	Date In	Date Out	Days Grazed	Animal Units	AUMs (Days * AUs / 30.4)	Use Class (1-5)	Notes
pairs	230	6/15	9/1	77	230	582	3	
AUMs Available:	500				Total ->	582	AUM Balance:	-82

Figure 22, Portion of Exhibit 4-21; Range Grazing Records

GRAZING RECORD - PASTURE							
Pasture Number / Name:	*Nelson East*						
Year or Season:	*mid summer*				Acres:		*155*
Soil Test (year):	*2001*				Forage Type:		*Orchardgrass/alfalfa*
Fertilizer-date applied:	*5/20*				Fertilizer-type:		*N @ 40#/AC/YR*
Livestock Type	Livestock Number	Last Irrigation	Date In	Forage Height	Date Out	Forage Height	Notes
pairs	*230*	*5/15*	*6/1*	*10*	*9/1*	*3*	

Figure 23, Portion of Exhibit 4-21; Pasture Grazing Records

Clients should keep grazing records when prescribed grazing is planned as part of a resource management system. When contracting prescribed grazing, use client's records to determine if the actual use matched the planned use and if there was a positive supply/demand balance for that year. There are several grazing record booklets available. Use any that meets the client and planner's needs. **Exhibit 4-21** (***Figures 22 & 23*** - Grazing Records for Rangeland and Pasture) may be used to collect the necessary information for evaluating prescribed grazing. Print or photocopy the appropriate pages (the first page of the exhibit has two rangeland grazing records, the second has two for pasture) as needed for the client. Refer to section **(h) (2), Using Actual Use Records**, for more information on evaluation of actual use records.

(3) Range and Pasture Utilization Estimate Worksheets

An effective check of grazing pressure can be obtained with several simple procedures for measuring utilization of forage resources. Utilization checks should be completed with the client. It is difficult to visually estimate utilization; frequent use of a method to measure utilization will increase the planner's accuracy in judging use.

Utilization checks should be used with growth curves for determining annual utilization. Checking utilization at the end of the growing season will capture the impact on the entire year's growth. If utilization is checked within the growing season, use the growth curve for the site to adjust current utilization to annual utilization (if that is the information desired from monitoring).

The formula for determining annual utilization is:

$$\frac{(CU \times GC)}{100}$$

***CU* = Current Utilization (%)**
***GC* = % Growth Curve Completed**

The result will give the utilization compared to the annual growth. Checking utilization when there is more growth to be completed artificially inflates the utilization figure for most uses. Conversely, if the percent utilization at a specified point in the growth curve is desired then no adjustment is necessary.

Using the growth curve in ***Figure 2***, if the utilization check was conducted at the end of June there would have been 75% of annual growth completed (in a normal year). If the utilization measured at this time was 65% (rangeland) then the adjustment would be:

$$\frac{(65\% * 75\%)}{100}$$

= 49% Annual Utilization

What appeared at the time of field checking, was 65% utilization is actually 49% of annual growth. This figure is more useful for comparing utilization to annual AUMs used obtained from actual use records.

Exhibit 4-3 (Proper Grazing Use) in the NRPH may be used to document several years' worth of use evaluations. **Exhibit 4-16** (***Figure 24*** -Oregon Rangeland Utilization Estimate Worksheet) and **Exhibit 4-20** (***Figure 25*** -Oregon Pasture Utilization Estimate Worksheet) can be used in the field to collect frequency data for determining use. Rangeland utilization is collected by use class of key species (***Table 7***) while pasture utilization is determined by measuring stubble height. Use the pasture utilization estimate worksheet if stubble height targets are desired for rangeland. The instructions for each worksheet are on the back of each form.

RANGELAND UTILIZATION ESTIMATE - KEY FORAGE PLANT METHOD				
Client:		*Testcase*	Mgt. Unit:	*#6*
Range Site & Condition:		*Loamy 10-12 PZ, 53% similarity index*	Response Unit:	
Transect Location:		*UTM 435326N 293873E*	Examiner:	*JPR*
Season of Use:		*Summer*	Date:	*9/1/2003*
Soil Moisture or Plant Growth:		*adequate for first 2/3rds of growing season*	Key Species:	*Bluebunch*
Use Class (1-5)	Midpoint (a)	Tally (checks or marks)	Grazed Plants (b)	Current Use (b)x(a)
None 0-15%	8	*xxxxx*	*5*	*40*
Light 16-35%	25	*xxxxx xxxxx xxxxx xxxxx xx*	*22*	*550*
Moderate 36-65%	50	*xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xx*	*72*	*3600*
Heavy 66-80%	73	*xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx*	*55*	*4015*
Severe 81-100%	90	*xxxx xxxxx xxxxx xxxxx xxxxx xxxxx xx*	*32*	*2880*
		TOTALS (C & D)-->	*186*	*11085*
		PERCENT SPECIES UTILIZATION	(d)/(c) -->	*60*

Figure 24, Portion of Exhibit 4-16; Rangeland Utilization Estimate Worksheet

Table 7 describes the different use classes and their descriptions. Degree of use refers to the amount of annual, aboveground forage removed by grazing animals (wildlife and domestic) measured at the end of the grazing period.

Table 7, Guide to Degree of Use	
Degree of Use	**Description**
None 0-15%	Very little or no use of key forage plants. Only choice areas and choice forage grazed.
Light 16-35%	Key forage plants lightly to moderately used. Practically no use of low-value forage plants. Most of accessible range shows grazing. Very little trailing to grazing.
Moderate 36-65%	Key forage plants used correctly for the season of grazing and ecological sites involved. Some use of low-value forage plants. All fully accessible areas are grazed; some trampling damage may be evident.

Heavy 66-80%	Key forage plants closely cropped. Low-value forage plants generally being grazed. Trampling damage is widespread in accessible areas.
Severe 81-100%	Key forage plants are grubbed and weakened from continual grazing of regrowth and mechanical damage. Low-value forage plants carrying the grazing load and are closely cropped.

Additional methods for monitoring grazinglands can be found in the NRPH Appendix **Sampling Vegetation Attributes**, Interagency Technical Reference 1734-4, 1996 and **Utilization Studies and Residual Measurements**, Interagency Technical Reference 1734-3, 1996 in the appendix of the NRPH; both are available online.

PASTURE UTILIZATION ESTIMATE - KEY FORAGE PLANT METHOD				
Client:		Testcase	Mgt. Unit:	#8
Forage Suitability Group & Condition Score:		PCS = 32: FAIR	Response Unit:	
Transect Location:		300' west of pivot center	Examiner:	JPR
Season of Use:		Summer/fall	Date:	9/1
Soil Moisture or Plant Growth:		adequate	Key Species:	Orchardgrass
Stubble Height	Factor (a)	Tally (checks or marks)	Grazed Plants (b)	Current Use (b)x(a)
1"	1	xxxxx xxxxx xx	12	12
2"	2	xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx xxxxx x	46	92
3"	3	xxxxx xxxxx xxxxx xxxxx xxxxx	25	75
4"	4	xxxxx xxxxx xxxxx xxxxx	20	80
5"	5	xxxxx xxxxx xx	12	60
6"	6	xxxxx	5	30
7"	7		0	0
8"	8		0	0
		TOTALS (C & D) -->	120	349
		AVERAGE STUBBLE HEIGHT	(d)/(c) -->	3

Figure 25, Portion of Exhibit 4-20; Pasture Utilization Estimate Worksheet

Table 8 describes the recommended minimum heights for commonly used pasture grasses and legumes for commencing grazing, end of season height, and height after cutting (for hay). These recommended heights can be used to evaluate pasture (and hay aftermath) utilization.

Table 8, Minimum Heights of Grasses and Legumes Used for Grazing or Hay (inches)

Species	Begin Grazing	End of Season	Height After Cutting
Kentucky Bluegrass	4	3	3
Smooth Brome	8	4	3
Reed Canarygrass	12	4	6
Tall Fescue	8	4	3
Creeping Foxtail	6	3	5
Meadow Foxtail	6	3	5
Orchardgrass	8	4	3
Annual Ryegrass	8	3	n/a
Perennial Ryegrass	8	4	5
Timothy	6	6	3
Russian Wildrye	5	4	2
Beardless Wheatgrass	7	7	6
Bluebunch Wheatgrass	7	7	6
Crested Wheatgrass	4	2	2
Intermediate Wheatgrass	8	6	6
Pubescent Wheatgrass	8	6	6
Tall Wheatgrass	16	6	4
Tall Oatgrass	8	4	4
Alfalfa	10	4	4
Birdsfoot Trefoil	8	6	2
Big Trefoil	8	4	2
Clover, Ladino	8	3	2
Clover, New Zealand	8	2	2
Clover, White Dutch	6	2	2
Clover, Red	8	3	2
Clover, Alsike	8	3	2
Clover, Annual (Sub.)	4	2	2