Watershed Management Guide for the Interior Northwest

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Watershed Management Guide for the Interior Northwest

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Use pesticides safely!

✓ Wear protective clothing and safety devices as recommended on the label. Bathe or shower each time after using pesticides.

✓ Read the pesticide label—even if you’ve used the pesticide before. Follow closely the label instructions and any other directions you have.

✓ Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.
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Introduction

Thomas E. Bedell
Michael M. Borman

1 What is a watershed?
2 Watershed functions
3 For more information

This guide was originally published in 1991 to give managers of public and private lands certain information they need to improve their watershed management. This revised edition takes into account several relatively new developments, notably the current emphasis on landscape-scale analysis and the concerns about water quality, especially for cold water fisheries.

The trend in public agencies is to consider the watershed as a whole rather than to focus on its parts. Similarly, the Oregon Cattlemen's Association Watershed Ecosystem (WESt) program indicates that private landowners also are working together to improve the resource for all users within a watershed.

This guide reviews basic concepts and principles of watersheds, describes how watersheds function, and discusses management tools to enhance a watershed's ability to function properly. We emphasize management that restores or maintains fully functioning water cycles on range and forestland. Land management must provide the opportunity for appropriate kinds and amounts of vegetation to not only establish but also to complete their life cycles. Frequently, such management does not need to be complex—but you do need to apply it thoughtfully.

Our purpose is not to give management recipes. We firmly believe you will want to apply the knowledge you acquire here to your own situation. As a landowner or manager, you must develop the commitment to apply knowledge and management skills. The bottom line for successful management is having the initiative, the commitment, and the means to develop and apply specific management prescriptions. This guide should make the process clearer to you.

The experiences and background used to develop this guide come from range and forestland east of the Cascades. The principles we describe apply elsewhere, also, but our research base is centered there.

What is a watershed?

The simplest description of a watershed is the land on which water from the atmosphere falls, runs off, or is stored in the soil and, over time, is released downslope. Any given piece of land is part of a particular watershed.
We can visualize each watershed as a catchment area divided from the next watershed by topographic features such as ridgetops. Much of the water that falls in a watershed but is not used by existing vegetation will seek the lowest points, ultimately appearing in the streams and rivers that drain the system. Smaller watersheds combine in larger watersheds. In the Northwest, the Columbia River Basin is the largest watershed and is composed of numerous levels of smaller watersheds.

Terrestrial life within a watershed depends on the soil, the water falling on that soil, and the air above and within that soil. Thus, watershed management extends beyond water management to include other resources. Of these resources, soil has paramount importance. Without a healthy mantle of soil, we cannot maintain healthy watersheds.

We do not directly manage soil, for the most part. We manage the vegetation that grows in the soil. We directly manage domestic grazing animals; we indirectly manage grazing wildlife. We also alter the soil surface on forest and range lands by building roads and by mining; both activities directly affect the water cycle.

In watersheds, the water cycle is the combination of processes in which water falls primarily as either rain or snow and either:

- Is captured and so has an opportunity to move into the soil
- Is retained in the soil for plants' use
- Moves through the soil by gravity into springs, streams, rivers, lakes, and ultimately the sea

From liquid form, it returns to the atmosphere by evaporation, and the cycle starts again.

**Watershed functions**

A watershed has three primary functions, as described by Hugh Barrett:
1. Capturing water
2. Storing it in the soil
3. Releasing it safely

_Capture, store, and release_ is a useful phrase for describing what we are attempting to accomplish with management practices on a watershed. However, it is imperative we remember that this is a generic term. Each site within a watershed has a different potential to capture, store, and release water, depending on a variety of factors including the interactions of soil, slope, aspect, amounts and temporal distributions of precipitation, and vegetation.

Capture

_Capture_ refers to the process by which water migrates from the atmosphere into the soil. Watershed management means maximizing the opportunity for water to enter the ground _where it falls_. Managers of range and forest land affect water capture by managing vegetation, which in turn influences infiltration and percolation.

Infiltration is the movement of moisture from the atmosphere into and through the soil surface. Percolation is the downward movement of water through the soil profile.

Several fixed factors affect infiltration rate: soil type (primarily texture and depth), topography, and climate. However, you can influence infiltration rates by managing the form and pattern of vegetation for any site, within its potential, to give water the maximum opportunity to penetrate the surface where it falls. This minimizes the overland flow that causes erosion.

You enhance infiltration by managing vegetation structure: the density of plant cover and the accumulation of plant litter at or near the soil surface. Infiltration rates are helped by:

- Plant cover that reduces raindrop impact on the soil surface and minimizes soil crusting
- Plant litter and organic matter on and in the soil surface to absorb moisture and help maintain soil structure
- Plant cover that will trap snow at or very near the soil surface. Trapped snow also keeps the soil warm, enhancing water's chance to enter soil during the winter

Some moisture is captured in tree and shrub foliage. In dry areas dominated by trees and shrubs, these plants often catch snow and even some rain so that it evaporates or sublimates (goes directly from solid to vapor phase) before it has a chance to reach and infiltrate the soil.

A healthy vegetative cover with its root mass will keep soil more permeable and help water percolate into the soil profile for storage. Water often follows abandoned root channels as well as live roots, which may penetrate compacted soil layers or deeper horizons. The activity of burrowing animals, insects, and earthworms also aids percolation.

Storing water in soil

Once water permeates the soil, it is stored between soil particles in the soil profile. Management can significantly affect storage capacity on any particular site. However, keep in mind that the capacity of a soil to hold moisture will largely be determined by the soil's depth, texture, and structure.

Field capacity is the amount of water a soil holds when saturated. Once a soil reaches field capacity, water either percolates deeply or runs off the surface.

Captured soil moisture is transferred from the site through:

- Plants that grow on the site (via transpiration)
- Drainage water that flows through the soil profile and into subsurface flows or seeps and then is released
- Direct evaporation from soil surfaces (via capillary action)

The kinds and amounts of vegetation and the structure of the plant community can greatly affect the storage on any particular site. For example, a site can have a lot of less-desirable vegetation—noxious weeds, brush, or weedy trees. Some of these plants extract water from the deeper soil profile. Others, such as weedy annual grasses, have
shallow root systems that do not provide organic matter deeper in the soil and so do not contribute to the water-holding capacity of the deeper soil.

If you can reduce a significant amount of undesirable vegetation and allow more beneficial plants to succeed, the soil water formerly used by the undesirables either can be used by the more desirable plants or can percolate through the soil profile.

You also can modify the microclimate just above the soil surface—slowing air movement and shading soil, for example—to reduce evaporation and so conserve moisture.

**Safe release** Water is used by desirable vegetation or moves through the soil profile to seeps, springs, and ultimately into streams and rivers that are the conduits from the uplands. We believe it is desirable that water be released slowly, through streams, rather than run rapidly overland—which results in short and severe peaks in streamflow.

The amount and rate of water release depend on:

- Whether water in soils of the uplands, riparian areas, and stream banks exceeds field capacity, and if so by how much
- Whether precipitation (rain or snowmelt) exceeds the infiltration rate and flows over the soil surface (overland flow), and if so by how much

For the interior Northwest, the critical time for safe release is the wet season, winter and spring.

The form and amount of vegetation in the riparian zone affects both water quality and, to some extent, the rate at which water moves through the soil. The most severe example of rapid water release, whether or not safely captured or stored, is a straight or straightened channel with little resistance to water movement.

The ideal is to keep water where it falls, resulting in less runoff and a more even streamflow. Sometimes the ideal may be difficult to achieve. A number of circumstances beyond our control can interrupt the capture, storage, and safe release of water. For example, when warm rain melts snow over frozen ground, water cannot infiltrate and must run off. However, managers can take many steps to affect these processes and benefit the watershed.

Managing a watershed is not complicated. It is managing every small area and understanding the three elements of success:

1. The entire watershed must be completely cared for, regardless of ownership.
2. Each small piece of the landscape plays its part in the health of the entire watershed.
3. All parts of a watershed are equally important.

Paying attention primarily to the riparian zone, which is mostly a watershed's release mechanism, will not make up for lack of attention to any part of the associated uplands, which are so important for water capture and storage.

For more information:

Because of the site-specific nature of each situation, direct conversations with qualified professionals is the most effective way to arrive at appropriate management solutions. Your county Extension agent is a useful source of information; so are the resource professionals in the field offices of the federal Bureau of Land Management and the U.S. Forest Service. Each agency's staff have expertise to offer when they are asked the right questions.

Other good sources are the technical guides published by the Natural Resource Conservation Service (formerly called the Soil Conservation Service, or the SCS), which you can find in local NRCS offices.
Chapter 1. Introduction

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Rangeland is a unique kind of land. Its vegetation is mostly grasses, grass-like plants, forbs, and shrubs. Trees may be present in varying numbers, depending on rain and soil conditions.

Rangelands have many uses, including forage for grazing livestock, habitat for many kinds of wildlife, wood-fiber products, and recreation. For the most part, rangelands are not cultivated, although some rehabilitation measures may be used.

Range management should focus on the vegetation components that are key to watershed health. Management prescriptions should reflect the effectiveness of various practices on the watershed's main functions: to capture, store, and safely release water.

It is not desirable to concentrate management on only one plant species, but it may be necessary to focus short-term management on one or several that have a "choke hold" on the site because of past management.

An example is dense stands of western juniper (*Juniperus occidentalis*), a tree that occurs naturally in central and eastern Oregon. Before settlers arrived, periodic fire apparently kept distribution and stand densities in check. However, western juniper has dramatically expanded its range to more productive sites in the past 70 to 100 years. The tree requires a great deal of water. As stand density increases, especially on better sites, a high percentage of available water goes to support juniper. On other sites, excessive runoff and soil erosion may be associated with juniper that has upset the water cycle, and the overall area becomes drier as a result. By restoring an effective water cycle on rangeland, levels of other products besides water usually are improved.
Developing management strategies for your range

This section covers issues facing rangeland cow and calf producers as they develop management strategies for their overall operations. Underlying assumptions are, first, that spring calving is the common practice; second, that producers make hay and use it for winter feeding. If you do neither, some information in this chapter will not be of interest to you.

A yearly calendar of management activity and a management planning section are in this chapter. The planning section is first because it sets the stage for the yearly calendar.

Management planning

Every producer plans, whether formally or not. Many plan more or less continuously through the year. This is good. Designating one certain time of year for planning also has some merits, which are addressed in this section and offered as a logical way to plan the range and hay parts of an overall production program.

Major planning can be done at any time of year, but we suggest late fall to early winter for two reasons: The experiences of the previous season are fresh and can better be brought to bear; and, if any slack time exists in the year, it should be then.

Review the year just ended. Analyze your notes and records carefully. Then answer these questions.

- How well did you meet your objectives?
- What kind of a forage year was it on the range? How did it rate in terms of both weather and the effect that weather had on the amount, timing, and duration, and quality of forage growth?
- How well did forage supply and demand balance? Were you short or long on forage? If short, what could you have done differently to avoid the shortage? If long, what were the reasons? Could or should you have done anything to use more forage?
- Did you make adjustments to your plan? Were they effective in meeting your objectives?
- To what extent did weather compared to your forecast management, positively or negatively affect plant and animal production? In other words, is your management having positive effects?

Review your current range plan:

- Is it still viable? As you build your database, you will get a better idea of whether your goals are realistic. Discard or revise impractical goals.
- If you operate on property that contains a stream, wetland, or lake listed on your state’s water-quality-limited list—also called the 303(d) list—you should consider water-quality management as part of your ranch plan.

Set objectives for the coming year:

- Consider tax management and borrowing practices. They can greatly affect profitability objectives.
- Break objectives into their component parts and develop an action plan to meet each part. Be sure to consider all feasible, economical alternatives.
- Make objectives both realistic and limited. For example, the objective in pasture A may be a total of 500 animal-unit-months (AUMs) of grazing based on forage potential. (An animal unit is commonly equivalent to one cow with a calf less than 6 months old; an animal unit month is the amount of dry matter needed to fill an animal unit’s needs for 1 month.)

Say you currently produce 300 AUMs. To get to 500 AUMs—a 67 percent increase—may take several changes, such as developing more water for stock and adjusting both grazing time and numbers of animals. So, set your objective for this year at 350 or 400. Try to achieve the increase by changing the grazing patterns, perhaps by developing another water source or changing salting patterns.

Develop grazing plans and schedules:

- Determine where grazing management changes would be beneficial. Base your decision on forage production and forage or observe and on a Proper Functioning Condition (PFC) assessment of your riparian areas.
- Determine what improvements in the coming year are needed to make those changes.
- Build in necessary flexibility to accommodate, for example, a poor forage year.

Review plans for range improvements:

- Are you meeting your range improvement schedule? If not, should you modify your schedule?
- Are improvements meeting your production expectations? Let’s say you seeded a new pasture with crested wheatgrass (Agropyron cristatum). Are your cows breeding back faster, and in larger numbers, since you began using the new seeding as a breeding unit?
- Are the improvements giving your operation the management flexibility you intended?

Review maintenance schedule for fences, water developments, roads, etc.

Consider adjustments in livestock numbers:

- Is your forage and range management permitting increases or requiring decreases in head of livestock? If so, you must decide in advance when and how to buy or sell, what classes to buy or sell, and how many to buy or sell.
- Maintain proper seasonal balance of feed supply and animal demand.
- Let your lender know your money needs well in advance.
- If you plan to take part of your ranch out of grazing to permit range improvements, you may need to reduce livestock temporarily.
Evaluate leased forage:
- Review grazing leases, including public land licenses and permits. Are provisions satisfactory? If not, what changes are necessary?
- Determine the security of forage sources.
- Examine alternative forage sources.
- If you’re planning to change your animal grazing (say, times and numbers) and if you have a public land grazing permit or license, be certain you coordinate with public land administrators.
- Evaluate hay production:
  - Review your overall hay management program. For example, be sure the kind and amount of fertilizer you use is paying its way. Order supplies well in advance of need.

Calendar of management activities

This is a reminder of major considerations, not an exhaustive list of things to do. Keep a record of your own activities and modify this calendar to fit your operation. It is very important to keep a daily diary or notebook. With information on how many cattle were put into and taken from pastures on certain dates, you can make a continuous overall use record.

When you make a utilization check, write down the percentage of forage the cattle used. The information will be quite useful each winter when you review management plans for the coming year.

**Winter** Range plants generally are dormant, and management concerns are for livestock health and well-being. If livestock are wintering out, make certain adequate forage is available to them because nutritive values may be at their yearly low. Cattle with access to palatable shrubs and grasses are better able to meet their needs than on grasses alone.

Fully dormant perennial grasses and forbs should not be damaged by heavy grazing. More damage can occur from physical effects such as trampling than from defoliation. Caution: If plants are not completely dormant, use levels probably should not exceed 60 percent.

Annual plants normally are dead, so removal is not damaging. Fall-germinated annuals are too short to provide more than subsistence-level forage.

Removing more than about 75 percent of current twigs is detrimental to most shrubs because twigs store some energy for maintaining plant health.

**Spring** Record the date each species starts to grow. This will help you predict when ranges will be safe to begin spring grazing that year. Build a start-of-growth record over several years. You will find it helpful in long-range planning.

Monitor relative development rates of forage plants. This should help you assess whether adjustments in grazing plans will be necessary.

Use crested wheatgrass for flexibility in using native pastures. Cows get a flushing effect from crested wheatgrass, and so it may best serve as the first pasture in spring; also, it is generally more dependable than native species as forage at that time.

For example, stock at 3 to 4 acres per animal-unit-month (AUM) in early season and 1 to 2 acres per AUM in late spring on full, healthy stands. Alternatively, evaluate using native pastures early, then crested wheatgrass. In that case, you may be able to provide a rest period for the native plants during their reproduction phase when they are most vulnerable to damage from repeated grazing.

Use rough country for yearlings, if possible, rather than for cows and calves. Yearlings cover country better and use forage more efficiently. Weigh yearlings before turning them out so you can determine their performance and range forage.

Fertilize hay meadows. Leave a check, or control, strip so you can determine the relative value of fertilizing.

Assess the effects, if any, that winter big game have had on spring forage supply. Quantifying the impacts is necessary to justify positions for reducing the wildlife impacts.

Assess weed encroachment, and manage or control as needed.

**Summer** Coordinate with the appropriate range conservationist on plans involving federally leased forage. Make sure communication channels are clear so misunderstandings occur.

**Winter** Coordinate with the appropriate range conservationist on plans involving federally leased forage. Make sure communication channels are clear so misunderstandings occur.

Record, by range unit, what kind of year it was for forage levels and quality. (For guidelines, see the section on Rating Your Range, later in this chapter.)

Record the degree of grazing use by date. Are your grazing objectives being met? Degree of grazing use on a particular date will vary over the years. For example, in a good forage year, amount of use will be much less unless the stocking rate was increased to make up the difference.

Record grazing use so overall grazing capacity can be determined. Combined with trends in range condition, actual-use information can help you assess whether target grazing capacities are realistic.

Record hay production by field. Also record species composition and expected feed quality. Record conditions for hay making.

Determine the value of fertilizing by comparing production in check strips against production in the fertilized area.

**Late summer** assess Proper Functioning Condition of riparian areas.

**Fall** Determine animal production: weigh yearlings, note their gains on range and/or pasture; and weigh weaned calves.

Determine the pregnancy rate among your cattle. Was there a positive relationship between feed conditions during breeding time and pregnancy rate?
At or near the end of the use period of each grazed pasture, make an overall use map for that pasture. Use the map in planning for the next year.

Assess seedling establishment in new range seedings. Are plants well rooted? When can you safely schedule grazing? Take soil samples from meadows and other areas you want to fertilize to determine nutrient needs.

Continuous management activities Monitor grazing to make sure grazing plans work right. Use salt and water to distribute grazing. Move a fence if that will help.

Establish photo points where they will be most useful to document trends and your progress toward management objectives.

Watch for poisonous plants and noxious weeds. Put them on your pasture map to make control easier.

Make use checks. Build up your information base so you can make better overall use in future years.

Do not be reluctant to ask your county Extension agent or Natural Resource Conservation Service representative for help. Their jobs are to serve you.

Range plants: Foundation of the grazing resource

Range owners and managers should learn the identity of the important plant species. Each has a scientific name and at least one common name. It is important to use proper nomenclature. Some plants are known by more than one name, and some names are used for more than one plant.

Why learn a plant’s identity?
- It is necessary when you inventory.
- You cannot rate your range without knowing the main species.
- Some species are grazed more than others.
- Some are more productive.
- Some are undesirable, for one or more reasons.
- Some indicate particular site and ecological conditions.

Each plant has specific parts with particular functions. Plants usually have roots, crowns, stems, leaves, and seed heads. To tell one plant from another, you must know the names of the main parts and their differences.

Grasses, generally, are the most important plant category for beef producers. Figure 2-1 shows the parts of the grass plant. Roots, unlike stems, have no joints, leaves, or flowers. The root’s growing part is at the tip. The main functions of the root are to take water and minerals from the soil to the stems, to store food over winter for spring growth, and to anchor the plant in the soil.

Rhizomes are creeping underground stems with joints and leaflike scales. You may have seen quackgrass (Agropyron repens) or western wheatgrass (Agropyron smithii or Pascopyrum smithii) rhizomes produce a new plant. Rhizomes store food and produce new plants.

Stolons are like rhizomes except they grow above ground. They do the same job as rhizomes: food storage and reproduction.

The aboveground parts of a plant are either vegetative or flowering. Vegetative parts include the stems and leaves. The grass stem is made up of nodes (joints) and internodes (between the joints). The stem usually is hollow, but sometimes, as in corn, it has pith in the center. The main functions of the stem are to transport water, minerals, and food between the roots and the leaves and to support the leaves.

At each node (joint) on the stem, there is a bud, which may reproduce a branch or remain dormant. The leaf also arises from a node on the stem.

The leaf is made up of two parts: the sheath, which fits closely around the stem, and the broad, expanded portion known as the blade.

These two parts are joined together at the collar, which has two parts. On the inside of the collar, next to the stem, is a smaller surface projection known as the line. On the outside of the collar, on some grasses, are two ear-shaped tips that keep the sheath from sliding down the stem. These tips are called auricles.

The growing point of the grass leaf is at the base of the leaf and the sheath rather than at the tip. That explains why grass leaves can be grazed and still grow and produce forage for livestock. By contrast, the growing point of a forb stem is at the tip. When the tip is grazed or clipped off, the stem quits growing.

The flower or head of a grass plant is made up of many smaller units known as spikelets. At the base of each spikelet there are two leaflike bracts known as glumes. When there is more than one floret (single grass flower) in each spikelet, each floret is supported on a short stem known as a rachilla.

Each of these florets at maturity produces a seed. The seed is enclosed by two more leaflike bracts known as the lemma and the palea. In many grasses, such as bluebunch wheatgrass (Agropyron spicatum or Pseudoroegneria spicata), the lemma and palea remain with the seeds after they ripen and fall.

If you do not have an identification key but you need to know the name and importance of a plant, take the plant to your county Extension agent or another range technician. If they cannot identify it, keep one specimen and send another to your Extension range specialist or to the herbarium of your state college or university.

When you collect plants for identification, collect the entire plant. It will aid in identification, shipping, or storing in a collection if you press each specimen.

Plants can be grouped according to how long they live and how they grow.

Annual plants live only one season. They must reproduce each year from seed. They do not grow a second year from roots or crowns. Examples are cheatgrass (Bromus tectorum) and Russian thistle (Salsola kali).

Biennial plants live 2 years and reproduce by seed the second year. Yellow sweet clover (Melilotus officinalis) is a biennial. There are no biennial grasses.
Raceme Panicle Spike

Spikelet
Lemma
Caryopsis (seed)
Palea
One floret per spikelet

Rachilla
Glumes
Several florets
Spikelet

Leaf blade
Collar
Sheath
Ligule
Auricle
Veins
Node

Rhizome
Crown
Soil surface

Figure 2-1.—The grass plant.

Chapter 2. Managing rangelands
Perennial plants live over from year to year, producing leaves and stems for more than 2 years from the same crown. They reproduce by seeds, stems, bulbs, and underground rootstocks. There are both short-lived and long-lived perennials.

Plants grow in different seasons of the year. Cool-season plants make their principal growth during the cool weather in the spring or late fall. Warm-season plants generally make their principal growth during the frost-free period and develop seed in the summer or early fall.

Plants also are grouped according to their growth forms; that is, their shapes, or how they look as they grow. For convenience, we group range plants into five main categories: grasses, grasslike plants, forbs, shrubs, and half-shrubs (Figure 2.2).

**Grasses**

Grasses are plants with jointed stems. Stems are generally hollow, leaves are in two rows on the stem, and veins on the leaves are parallel. These are “true” grasses and are among the most important kinds of range plants. Examples are:
- Bluebunch wheatgrass, a perennial bunchgrass
- Quackgrass and western wheatgrass, perennials with creeping underground stems or rhizomes
- Cheatgrass brome, an annual grass

**Grasslike plants**

These plants look like grass, but they have solid (not hollow) stems that are either triangular or round, and they have no joints. Leaf veins are parallel. These are forbs and rushes. Examples are:
- Elkseedge (Carex geyeri), which is triangular in cross-section
- Baltic rush (Juncus balticus), which is round in cross-section

**Forbs**

A forb is a non-grass plant with an annual growth (top). Leaf veins usually are notched. Examples are range flowers and plants that people might call weeds. However, when we are talking about range management, we use the term forb instead of weed because weeds typically are thought of as undesirable plants.

Many of this group of range plants are not pests, for they are valuable as forage, especially for sheep and wildlife. Examples are:
- Yarrow (Achillea spp.), which has perennial creeping rhizomes
- Tapertip hawksbeard (Crepis acuminata), which has perennial roots
- Bull thistle (Cirsium arvense), which has biennial roots
- Tumbling mustard (Sisymbrium officinale), an annual forb

**Shrubs**

A shrub is a woody plant; its stems and buds live over the winter above the ground, and stems branch from near the base. (A tree resembles a shrub in growth form, but a tree has a definite trunk with branches well above the ground.) Examples are:
- Big sagebrush (Artemisia tridentata)
- Rabbitbrush (Chrysothamnus spp.)
- Bitterbrush (Purshia tridentata)

**Half-shrubs**

A half-shrub is a perennial plant that dies back each winter, not to the ground line but to a perennial woody base or a bare ground stem. Examples are:
- Snakeweed (Gutierrezia sarothrae)
- Winterfat (Eriophorum lanata)

By knowing the groups of plants and plant parts, you can use an identification key. A key is an organized listing of plant characteristics according to structure (generally, flower parts). Plant keys are helpful in determining the correct names of plants.

See your county Extension agent or range technician for a key to range plants in your county or state.

**Range plant growth and development**

Grasses and forbs store energy in roots, crowns, and stem bases. Old leaves of grasses and forbs do not return to the soil as they do with trees; instead, they return as organic material to the tops of the plants. They can use this material to produce new leaves and new growth, and they can store the energy in other parts of the plant that will help them over the winter. Forbs also store energy in their crowns. When a forb dies back for the winter, its leaves, crowns, and stem bases remain alive by respiring some of their stored energy.

Perennials undergo dormancy periods of varying length each year. Dormant plants remain alive by respiring some of their stored energy.

Energy or plant food also is consumed by the process of respiration, which continues as long as the plant lives. Perennials undergo dormancy periods of varying length each year. Dormant forbs remain alive by respiring some of their stored energy.

Many factors affect the rate at which this process occurs; on range or pasture, the most important factor that managers control is the time and extent of leaf removal.

Energy or plant food also is consumed by the process of respiration, which continues as long as the plant lives. Perennials undergo dormancy periods of varying length each year. Dormant forbs remain alive by respiring some of their stored energy.

Perennials and forbs store energy in roots, crowns, and stem bases. Old leaves of grasses and forbs do...
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<th>Grasses</th>
<th>Grasslike plants</th>
<th>Forbs</th>
<th>Shrubs (Browse)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grasses</strong></td>
<td><strong>Grasslike plants</strong></td>
<td><strong>Forbs</strong></td>
<td><strong>Shrubs</strong></td>
</tr>
<tr>
<td>Sedges</td>
<td>Rushes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stems</td>
<td>Jointed</td>
<td>Hollow or pithy</td>
<td>Solid; not jointed</td>
</tr>
<tr>
<td>Leaves</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flowers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leaves on 2 sides of stem</td>
<td>Leaves on 3 sides of stem</td>
<td>Leaves on 2 sides of stem; rounded</td>
<td>Vascular bundles usually are netlike</td>
</tr>
<tr>
<td>Floret</td>
<td>Male</td>
<td>Female (may be combined)</td>
<td>Stamen</td>
</tr>
<tr>
<td>Stem</td>
<td>Leaf</td>
<td>Leaf</td>
<td>Leaf</td>
</tr>
<tr>
<td>Floret</td>
<td>Male</td>
<td>Female</td>
<td>Stamen</td>
</tr>
<tr>
<td>Stem</td>
<td>Leaf</td>
<td>Leaf</td>
<td>Leaf</td>
</tr>
</tbody>
</table>

Figure 2-2.—Important range plant groups.
not live after growth stops each year. Therefore, removing the old leaves will not affect the level of stored energy because that energy was transferred from leaves to the storage sites earlier in the season.

Shrubs store energy in roots, crowns, and twigs (buds). Plants' ability to store excess energy varies greatly among species. By the same token, perennial plants may not produce as much energy under some conditions, such as grazing or drought, as would be desirable for normal functioning, yet they do not necessarily die immediately. Understanding the survival abilities of plants on your ranges has much to do with perpetuating their productivity.

Except for evergreens, perennial plants must send up new leaves and start their growth cycle anew each year. The amount and vigor of new spring growth depends on the level of energy stored the previous growing season. Growth after dormancy depletes stored energy; the general pattern of depletion is fairly similar among species. Roots begin growth before leaves, in some cases several weeks before.

Plant reserves must be restored for the plant to maintain health and vigor. The period between the time energy stores are reduced and the time they are recovered is really the most critical time of the annual growing cycle. The plant must retain enough leaf area after grazing to make more growth. This growth comes from photosynthesis within remaining leaves, not from stored energy. Most perennial grasses are still restoring energy up to the time of seed maturity.

Some species, such as bluebunch wheatgrass, must make at least half the season's growth before reaching the energy level the plant had at the beginning of the season. Other species, such as squirreltail (Sitanion hystrix), reach that level by about the four-leaf stage (Figures 2-3 and 2-4).

The greater number of active leaves that remain after grazing, the greater the chance for more growth, assuming enough soil moisture remains.

Research shows that grazing-tolerant plants such as crested wheatgrass have a relatively short critical period, but species that are less grazing-tolerant such as bluebunch wheatgrass have a long critical period. If a plant is closely grazed and especially repeatedly grazed during its critical period, its ability to recover is severely impaired.

The plant needs energy at all times, but three periods are especially critical in its life cycle.

- First is early spring when new growth begins. Energy is drawn out of storage.
- Next is the active reproduction from flower stalk to seed. When energy comes from current production in upper leaves.
- Third is fall regrowth. Energy comes from storage here, too. In addition, plants need energy to replace grazed leaves and to withstand drought.

One reason the ranges deteriorated at the turn of the century was that livestock owners and operators did not understand these processes.

Annual plants produce energy, of course, but their survival mechanism is their seed. Poor growing conditions, especially when combined with close grazing, cause the plant to have less active photosynthetic leaf surface, resulting in slower growth and less viable seed produced.

Perennials can survive quite well without producing viable seed although the level of seed production is a useful indicator of plant health. However, do not expect seed production in dry years.

Managed spring grazing and grazing after plant maturity do not greatly affect energy storage and do not seem to injure plants. Studies show that root growth slows and may stop if enough tops are removed. But removing less than 50 percent of top growth at this time has little or no effect on most species.

If spring grazing is short and ends while enough soil moisture remains to allow ample regrowth, the plant should restore the energy it needs.

Grazing should not occur again until the leaves have made good regrowth. When growing-season moisture is very limited and plants are grazed severely, there will not be enough leaf area left for the plant both to extract remaining available moisture and to restore its energy supplies.

The size of the root system will be reduced, which will affect the plant's ability to grow normally the next year.

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**Figure 2-3.**—Available energy in roots of bluebunch wheatgrass (Agropyron spicatum or Pseudoroegneria spicata) at varying stages of growth.

**Figure 2-4.**—Available energy in roots of squirreltail (Sitanion hystrix) at varying stages of growth.
Low energy reserves, whether caused by past grazing practices or not, also weaken the plant’s ability to tolerate cold temperature. The cell sap’s concentration rises, which lowers the freezing point. Low food reserves result in reduced root growth and decreased drought resistance.

It boils down to this: A plant that is continuously, closely grazed cannot supply its own needs; it is being starved by lack of an active recharging mechanism.

Plants make their growth from buds, which contain meristematic or new-growth-generating cells. Susceptibility to grazing varies greatly from plant group to group and, of course, from species to species.

Buds of forbs and shrubs are on branches and twigs. Whenever buds or growing points are removed before potential full growth is made, the plant’s growth for the season may be impaired. If grazing is rotated, new growth from lateral buds may keep up production.

Grasses are uniquely suited to grazing because their growing point is protected inside the plant for most of the growing season (Figure 2-5). Each stem or culm has a growing point that develops either more nodes and leaves or seed heads. Grass leaves have several parts.

The blade originates from a node, which is where the cells divide and become larger. The sheath extends and pushes the leaf out of the tube. Once the leaf has emerged and unfolded, its growth is complete.

The ratio of reproductive to vegetative or leafy twigs or stems will vary by species. This can affect the forage quality. Grasses have two common growth forms: stemmed and stemless. Stemmed grasses tend to have a high ratio of reproductive to vegetative stems (Figure 2-6). Some stemless species also have a high reproductive-vegetative ratio, but several such as the blue grasses and grasses have a high ratio of vegetative to reproductive stems.

Stemmed grasses tend to be more robust and productive. They also are more numerous in cool-season growing areas. Some species have the ability to grow more or less prostrate and can escape grazing that way.

Figure 2-5.—Anatomy of a grass stem.

Stemless grasses are less susceptible to grazing than are stemmed grasses. Their growing points are at or below ground level for most of the growing season, and their leaves push up through the tube from below ground. The nodes are close together; only later in the growing period do the upper internodes lengthen, so a mature grass appears with mostly basal leaves and relatively few seed stalks.

In stemmed grasses, the first four or five leaves push up as stemless grass leaves do. But then the internodes start to lengthen, and soon the growing point is lifted, whether it produces seed or not. If the growing point is removed, growth stops on that stem. That cannot happen on stemless grass, however, because the growing point is too low to be grazed.

For the stemmed group, all new growth has to come from inactive buds at the base of the grass. With enough soil moisture, such buds may develop, but in most years there is not enough soil moisture left for very much regrowth.

You can manage grazing to capitalize on this factor—for example, you can graze crested wheatgrass heavily enough to remove its growing point. After that, most new growth will be vegetative.

By knowing your major grasses and how they grow, you can set the most advantageous time to graze each area. You’ll also be able to predict the level of use the plants will tolerate and still produce well.
Range ecology and condition: Their relation to management

Most soils form over a long time from weathered rock. The soils are affected by topography or position, by organisms, and by the local climate. These factors in turn affect the soil’s ability to support life.

Soil depth, texture, structure, and color are characteristics the landowner needs to learn about to improve soil and, therefore, plant production. Our management practices can improve or tear down the range soil resource.

Characteristically, range soils are relatively shallow, they occur on sloping as well as level terrain, and they are often quite rocky. The total environment is harsh, and range soils often have been discounted as a resource because they are not cultivated and cannot be cropped.

All aspects of soil are important, but the overriding influence for rangelands of the West is weather—moisture for plant growth, in particular. Moisture-holding capacity and the time that moisture is available to plants strongly influence which plants will grow and how they will grow on a particular location.

The plant community

The ability of a plant species to grow, reproduce, and survive is governed by five basic factors:

- The soil on which it grows
- The species’ location or position (topography)
- How long it has been there
- Other organisms (including people) in the environment
- The climate in the immediate area as well as overall climatic influences

These factors are interdependent. If any factor changes, the plant species on the site may change or, if the species do not change, their growth characteristics may change.

A plant species is adapted to certain conditions. On any given area, the plant species present will change over time. Some species are replaced by others that can grow, compete, and reproduce there. The progressive change is termed plant succession.

Theoretically, change ends at some point; that point is called the climax, a climax plant community, also known as the potential natural community (PNC). Sites are named according to the physical descriptions or the major plant species that form the climax community or PNC. One climax community may be composed of different species from the ones found in another climax community, or the species may be the same but present in different proportions. In either case, the site designation will be different; for example, “Ecological Site A” and “Ecological Site Y.”

Ecological status or range condition

Ecological status, sometimes known as range condition, is a descriptive system that includes the influences that human-caused or other changes can have on the plant composition.

Ecological status is the present state of vegetation and soil protection of an ecological site in relation to the PNC for that site.

Range condition is a term with more than one meaning. We use it here in very much the same way as the term ecological status: namely, it is the present state of vegetation of a range site in relation to the climax plant community (PNC) for that site.

Management can influence plant species composition.

To illustrate, plant species have various tolerances to grazing, fire, and flooding. A species’ reaction to grazing is sometimes described in terms of its being a “decreaser,” an “increaser,” or an “invader.”

For example, if a climax plant community is grazed repeatedly—whether by livestock, wild animals, or insects—some species will decrease, some will increase, and, if grazing goes on long enough, some species (very often annuals) will invade.

The same effect can result from other influences—fire, for example. Some shrubs such as gray rabbitbrush tolerate fire and sprout back; others such as big sagebrush will die but come back later from seed. If both big sagebrush and gray rabbitbrush grow with resident bunchgrasses, and if a fire occurs but doesn’t damage the bunchgrasses, the rabbitbrush will be an increaser under the influence of fire since the sagebrush will be a decreaser.

In time, various kinds of seedlings will come in. If the plant community described above—of big sagebrush, gray rabbitbrush, and bunchgrasses—is strongly influenced by grazing, either before or after the fire, responses to the fire can be different. Some grasses will decrease and some will increase, but both shrubs will increase.

This complex relationship demonstrates the importance of all the interwoven issues of site, weather, species, and management.

A range site’s condition usually is described on a scale that ranges from excellent to poor. A site in excellent condition includes a high proportion of plant species that would be found in the climax or potential natural community (PNC) for that type of site; a site in poor condition includes only a small proportion (Table 2-1).

It is important to remember: The species on the site are a way to “read the range”; through various practices, you can adjust species composition, forage production, and ecological status.

14 Chapter 2. Managing range lands
Table 2-1.—Range site evaluations by ecological status, percentage of potential natural community (PNC), and range condition.

<table>
<thead>
<tr>
<th>Ecological status</th>
<th>% Plant community</th>
<th>Range condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early seral</td>
<td>0 to 25</td>
<td>Poor</td>
</tr>
<tr>
<td>Mid-seral</td>
<td>26 to 50</td>
<td>Fair</td>
</tr>
<tr>
<td>High-seral</td>
<td>51 to 75</td>
<td>Good</td>
</tr>
<tr>
<td>PNC</td>
<td>75 to 100</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

Forage productivity is not always highest in a climax grassland or shrub-grass plant community, but in general on most sites, it will be.

Managing for "excellent" condition may be impractical or undesirable—in fact, it often is. Climax herbaceous plant species are not necessarily the most preferred species. For a grazing operation, "excellent" condition is poor and "fair to poor" condition—when herbaceous plants abound—can be desirable. Early to mid-seral status in a forest site probably is desirable game habitat, too.

Forested plant communities are in a different ecological context. Plant succession is toward trees, so the more the canopy closes in, the closer the site is to excellent conditions (PNC), but the lower the production of the herbaceous understory.

Using the ecological status concept

Let's repeat an important point: Except for forest communities, an improvement in ecological status or range condition often means an increase in forage productivity.

You can measure your progress in managing for high or good condition on all ecological sites. Species composition on the present site is key, where you are now. If you know the successional patterns, you can recognize when you are reaching goals. If you do not know the successional patterns, you can expect to make more progress than is possible for the site and then become dissatisfied with results of what you do not take advantage of the site potential.

Trend in condition on ecological status. Range condition trends are either up, down, or stable. Trend in site condition is determined by measurements taken at two dates, preferably 5 years apart. Be cautious when you interpret what you find.

For example, very good and very poor precipitation years can affect production and species composition. You would expect some recovery in good years and the opposite in poor years. Accurate production records to supplement trend information will help your interpretation.

Management effects. You can manage cattle to influence range condition or ecological status. By knowing inherent grazing preferences and adjusting seasons of use and numbers of stock, you can increase some plant species and decrease others.

It is important to remove grazing pressure so plants can grow back. Cattle management can directly influence the proportion of cool- and warm-season species and even the proportion of annuals to perennials.

Plant communities can be "shocked" into more rapid changes under some circumstances. Using appropriate herbicides has considerable merit. You can spray invading species, such as fringed sagewort (A. frigida) from plains grassland, and speed up succession. You can spray herbicide on some grasslands that are heavy on undesirable forbs, or even fertilize the sites, which allows grasses to increase and hastens succession. Spraying big sagebrush will reduce the brush, which allows not only more ecological stability but also higher forage production.

Fire has an ecological role. Some species tolerate fire and can survive and prosper under periodic burning. Other species do not tolerate fire—western juniper and certain other nonsprouting junipers, for example. They are confined to rocky sites where there is not enough fuel to carry fire. But in the absence of fire, they have spread onto better soils and, over time, they have become dominant.

Rating your range

Perhaps there really is only one good reason for rating your range: You need to know its status in some detail to know whether it really is improving or you just think it is improving. Don't trust your memory. Use a simple, straightforward evaluation on a rather regular basis. You will find a record helpful in planning better management.

Know the status of soils and vegetation on your range:

- Is the surface stable?
- Is there soil movement? By what force? How much and where?
- What's the relative plant vigor and production? Is it satisfactory? If not, can you pinpoint why? Is the reason one you can control?

Rate your own private range and your leased range, especially if the latter is managed by federal agencies. Knowing how to rate should help you greatly when dealing with resource managers. Use the same methods they do, if possible. Or use something similar to the scorecard approach we propose on the following pages.

For long-range management planning, especially in semiarid rangelands, assessing soil conditions is critically important. Most managers want to manage so soil stays in place. We need to recognize that natural forces will move soil downslope, even with good management, and that we have little control over where soil will be deposited after it starts to move.

Consequently, keeping soil in place makes good sense. Evaluating your range will tell you the current situation in some detail but will not tell the cause. Soil can move because of shortage of litter. Unusual or accelerated soil disturbance can be caused by too many animals or by human activities.
Slope and texture also have a great effect. Light-texture (sandy) soils can be moved by wind from plant interspaces to the plant crowns. Heavy-texture (clay) soils heave because of repeated freezing and thawing. When you do the rating, you need to determine what the best situation looks like to determine the amount of deviation.

Pedestalling of plants, where the soil appears to be removed from around the plant, can result from actual soil movement or from freezing and thawing which lifts plants, creating a similar effect. You need to know whether the soil has been moved or whether the plants were lifted up.

Know the difference between desert pavement and erosion pavement. Pavement refers to rocks of varying size on top of the soil. People commonly think the soil was washed or blown away. In fact, rocks protect the surface from high winds and heavy water flows.

Desert pavement is a result of long-time freezing and thawing, so that rocks end up on the surface. Erosion pavement results when surface organic matter is washed or blown away, leaving rocks.

Assess the effects of storms on areas that are similar except that some are grazed and others are not. Record the intensity of storms. If real differences occur, and if the differences appear to be caused by grazing, this will tell you where you need to concentrate your management actions.

To rate a range, you must identify your plants and look at them as intensively as you look at the soil. Look at all the plants—how vigorous or weak they are, whether they are reproducing, whether there are many or few undesirable plants present and, if so, where they are concentrated.

Assess the state of plant health on a least a species-group basis. The rating should tell you how capable the range or pasture is of maintaining the most desirable plants productivity.

Look at the levels of grazing use and decide whether a different plant species is preferable. Determine whether differential grazing has affected vigor.

Whether you use a scorecard or just make notes, record your observations so you can use the same locations in future years. It may be impractical to rate every site, so establish benchmarks. You can make the ratings at any time of year, but it may be better to do them after the grazing season than at other times because then you can assess the impact grazing has had on the site and the site's ability to recover.

A variety rating forms or scorecards require you to make a numerical rating each time you assess the area.

Figure 2-7 is based on a rating form used by the Bureau of Land Management.

Figure 2-8 (page 18) uses a simple, subjective approach; Figure 2-9 (page 19) is an example of how to fill it out.

Regardless of the form you use, remember: It is important to rate your range, to record your observations, and to use them to improve your management.

Grazing to maintain a healthy range

Grazing is the natural means cattle use to get their daily sustenance. When and where cattle graze has a great deal to do with maintaining and improving overall productivity of both plants and animals.

Plants' nutritional qualities vary throughout the year. Cattle, no matter where they are, constantly eat what they prefer and as much of it as they possibly can to meet their requirements. Therefore, managing grazing to meet both animal and plant requirements becomes a challenge that you must master to perpetuate animals, plants, and the soil resource.

There are numerous ways to achieve grazing management objectives. You will need to consider a number of factors to develop and carry out successful grazing plans.

You also will need to know what animals are doing to each plant species each day they are on range and pastures.

Grazing removes leaves and stems. The time of removal, as well as the amount removed, can have a positive or negative effect. If no effect, in a plant and its immediate environment. If the effect is harmful, you need to know in what way it is harmful. With that knowledge, you can design ways to overcome negative effects.

Grazing does to a plant's ability to grow and compete. Also, assess the effects of the lack of grazing on associated plants. For example, cattle almost never graze big sagebrush except perhaps during a rough winter. Ungrazed big sagebrush, therefore, is completely free to compete with the more desired species which are grazed.

Think of grazing in terms of:

- How many animals are in a given area (intensity of use)
- How often they are there (frequency of use)
- At what point in a plant's life history it is grazed (season of use)
- Which plants are being eaten (selectivity of use)

Four periods for plants

On ranges in the West, plant growth can be divided into four periods.

Period 1. Initial growth. Depending on species and available moisture, growth sometimes starts in fall, but in most cases growth begins in spring. Soils are damp and cold. Growth is slow, and leaves contain much moisture. New leaves are high in crude protein, minerals, and energy, but cattle cannot usually get enough new growth to satisfy their intake needs.

Plant growth is less than animal demand unless stocking levels are very low. This period is before traditional range readiness.

(continued on page 20)
<table>
<thead>
<tr>
<th>Category</th>
<th>Rating Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigor</td>
<td>(10 points) Desirable grasses, forbs, and shrubs are vigorous and healthy—plants have good size and color and produce abundant herbage.</td>
</tr>
<tr>
<td></td>
<td>(6 points) Desirable grasses, forbs, and shrubs are moderately vigorous—they're medium size with fair color and produce moderate amounts of herbage; some seed stalks and seed heads are present.</td>
</tr>
<tr>
<td></td>
<td>(2 points) Desirable grasses, forbs, and shrubs have low vigor—they appear unhealthy, with small size and poor color. Portions of clumps or entire plants are dead or dying. Seed stalks and seed heads are almost nonexistent except in protected areas.</td>
</tr>
<tr>
<td>Seedlings</td>
<td>(10 points) Seedlings of desirable grasses, forbs, and shrubs are establishing. Seedlings are in open spaces between plants and along the edges of soil pedestals. Seedlings of invader or undesirable plants are few.</td>
</tr>
<tr>
<td></td>
<td>(6 points) Some seedlings of desirable grasses, forbs, and shrubs may be in open spaces between plants. Some seedlings of invader or undesirable plant species may be present.</td>
</tr>
<tr>
<td></td>
<td>(2 points) Few if any seedlings of desirable grasses, forbs, and shrubs are establishing. Seedlings of invader or undesirable plants are in open spaces between plants.</td>
</tr>
<tr>
<td>Surface Litter</td>
<td>(5 points) Surface litter is accumulating in place.</td>
</tr>
<tr>
<td></td>
<td>(3 points) Moderate movement of surface litter is apparent, and litter is deposited against obstacles.</td>
</tr>
<tr>
<td></td>
<td>(1 point) Very little surface litter remains.</td>
</tr>
<tr>
<td>Pedestals</td>
<td>(5 points) There’s little pedestalling. Those pedestals present are sloped or rounded and are accumulating litter. Desirable forage grasses may be found along the pedestals’ edges.</td>
</tr>
<tr>
<td></td>
<td>(3 points) Moderate plant pedestalling. No evidence of healing or deterioration. Small rock and plant pedestals may occur in flow patterns.</td>
</tr>
<tr>
<td></td>
<td>(1 point) Most rocks and plants are pedestalled. Pedestals are sharp-sided and eroding, often exposing grass roots.</td>
</tr>
<tr>
<td>Gullies</td>
<td>(5 points) Gullies, if present, are stable with moderate sloping or rounded sides. Perennial plants are establishing on the bottom and sides of the channel.</td>
</tr>
<tr>
<td></td>
<td>(3 points) Gullies are well developed with small amounts of active erosion. Some vegetation may be present.</td>
</tr>
<tr>
<td></td>
<td>(1 point) Sharply incised V-shaped gullies cover most of the area, and most of the gullies are actively eroding. Gullies are mostly devoid of perennial plants because gully bottoms are freshly cut.</td>
</tr>
</tbody>
</table>

Total points: Rating: 26-35 = upward; 17-25 = static; 7-16 = downward

Comments:
Figure 2-8.—Sample range-rating form.
<table>
<thead>
<tr>
<th>Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species composition</td>
</tr>
<tr>
<td>Ground cover</td>
</tr>
<tr>
<td>Desirable species</td>
</tr>
<tr>
<td>Undesirable species</td>
</tr>
<tr>
<td>Vigor</td>
</tr>
<tr>
<td>Desirable grasses and forbs</td>
</tr>
<tr>
<td>Desirable shrubs</td>
</tr>
<tr>
<td>Undesirable grasses and forbs</td>
</tr>
<tr>
<td>Undesirable shrubs</td>
</tr>
<tr>
<td>Grazing use</td>
</tr>
<tr>
<td>Poisonous/noxious species</td>
</tr>
<tr>
<td>Notes</td>
</tr>
<tr>
<td>Trend appears static, but range needs improved management</td>
</tr>
</tbody>
</table>

Figure 2-9.—Sample of a completed range-rating form.

For most current information: http://extension.oregonstate.edu/catalog

Chapter 2. Managing rangelands
If some of the previous year’s residue remains, more of the animal’s intake needs will be met, and the grazing effect on the plant also could be lessened. But if more than 1 year’s old growth is present, animals will avoid the plant and concentrate on new plants, putting more pressure on them.

**Period 2.** Plant growth is just about even with animal demand. This usually is a short period, from a few days to a very few weeks at most. Nutritional intake is just about adequate to meet requirements.

**Period 3.** This is the flush period when animal demand usually is less, sometimes greatly so, than the forage supply. Nutrition is high, animals gain well overall during the period but less well as the period ends. In this period, heavy stocking pressure will permit more uniform use of all species; all but the most undesirable ones will be grazed.

**Period 4.** Dormant period. This will certainly be the dry season and may occur during the wet season, also. There may or may not be a late summer to fall green-up, which is a short repeat of Period 1 but not of Periods 2 and 3. Period 4 is the longest of the year.

During this period, nutritional values may limit animal performance. Grazing selectivity will be high, and many plants may go ungrazed. High grazing pressure will be necessary to achieve uniform use on all plant species.

Ingenuity in grazing management is especially needed in Period 4. But if management has been good in the other periods, many of the negative factors can be sharply reduced.

### Some common planning terms

**AUM** Animal unit month. The amount of dry matter needed to fill an animal unit needs for 1 month. One AU is commonly defined as an adult cow with calf less than 6 months old. There is no agreed-on standard weight of forage. Figures of 750 to 1,000 pounds often are used.

**AU equivalents** Various conversion factors used; there is no universal agreement. The following are suggested:

- Cow with calf less than 6 mo. 1.0
- Dry cow 0.8
- Coming 2-year-old 0.8
- Bull 1.25
- Horse 1.5
- Weaned calf 0.5
- Short yearling 0.6
- Long yearling 0.7

**Stocking rate** Area needed to support one animal unit (AU) for 1 month. Expressed as acres per animal unit month (AUM).

**Grazing capacity** Number of livestock that will yield the greatest production without damaging the land, vegetation resource, and/or other values from that resource.

**Carrying capacity** The ability of an area to support a specific animal unit (AU) for a specific period; for example, the summer carrying capacity for yearling steers.

**Overstock** Too much grazing pressure for the amount of forage.

**Overutilized** Too much use for the plants at any given time, generally at the end of the season.

**Overgrazed** Too much grazing pressure over too long a period of time.

**Continuous grazing** Animals unrestricted access to plants in a given area during the grazing season. Does not refer to level of use.

**Season** Grazed for the duration of a particular season. Also called season long.

**Repeated seasonal** Grazed at the same season each year.

**Deferred** Not grazed until the main forage plants have reached a certain level of maturity often the point at which they set seed.

**Rotational** Moving animals from pasture to pasture on a schedule. The schedule may be based on the calendar, on level of use, or on stage of plant growth.

**Rest** No grazing for at least a 1-year period.

**Rest-rotation** Grazing plan incorporating at least one rested pasture on a rotational basis.

**Seasonal rest or relief** No grazing for various periods during the year.

If you need professional help to develop a grazing plan, make sure the plan is more than just a series of dates to move animals from pasture to pasture. You should take direct part in developing the plan, and you should have confidence that it will work.

Use all the plant and animal knowledge at hand. Determine about when the four periods of plant growth will occur in each pasture and tailor the grazing to that.

No one kind of grazing scheme fits all situations best, but there may be some best program for your situation. It could be a combination of deferment, rotation of animals, some seasonal rest, and perhaps some continuous use. All approaches have merit in the right place with the right person. The skill of the manager is more important than any other factor—and skills are learned.

Grazing plans should have objectives for each pasture unit. If no objectives exist, you never will really know how good your management is.

As an example, let’s say you have rated the range in unit X, and the composition is 60 percent less-desirable plants and 40 percent desirable plants. You want to increase desirables from 40 to 60 or 70 percent.

You can do this with a combination of Period 2 and Period 3 grazing with some growing-season deferment. With either a known stocking rate or with an estimated
initial stocking rate based on forage production, you can plan the management of the pasture and see how it fits with other pastures.

Move livestock in relation to plant growth stage and forage utilization, not by calendar. Be certain enough forage is available in the next pasture, or another move will be imminent.

Movements during Period 4 could be the exception to this, if one objective is to graze all pastures each year.

General observations

In upland pastures, stocking pressure or grazing intensity is more important than the kind of grazing schedule developed. Heavy pressure at the “wrong” time, combined with appropriate seasonal rest periods, can improve range productivity. But there is an important question: How much is too much? It is up to you to decide.

In riparian pastures, timing of grazing generally is the most important factor. Appropriate timing must be determined for each riparian area. A cookbook approach often will fail. See the section on riparian pastures in Chapter 5 of this publication.

Pastures generally do not need all-season rest to maintain range forage yields. Grazing may loosen soil, plant seed, tramp litter into the surface, and recycle nutrients. Perhaps most important, it removes the old growth—so if you do not allow animals to remove it, old growth will contribute to less uniform use the following year.

Additional pastures mean more flexibility in ways to achieve maximum safe forage use.

Use stock water as a way to move grazing. Fencing water from cattle or turning off water valves in areas that need relief can be effective in continuously or season-long grazed pastures. Do not discount continuous grazing as long as you can meet your objectives. Excessive stocking pressure has given continuous use a bad name.

It is all right to use repeated seasonal grazing in some cases. Crested wheatgrass, spring-grazed each year, is a good example.

If a plan calls for spending more dollars, scrutinize the level of expected benefit. In other words, what is the point at which your investment stops giving returns? You do not want to go that far.

Cattle can be effective tools to improve ranges by closely managing forage utilization. Yearlings are the best class for this; next are dry cows. Cows with calves are least effective. But you need to maintain good gains on yearlings, so you may restrict their use as management tools to times of adequate forage value.

Move cattle at the early end of the “ready” period rather than at the late end. Performance declines as grazing satisfaction declines.

Do not move cattle until forage is properly used. Then, have more than one pasture to go to. Emergencies can and do arise!

Seasonal grazing relief has real payoff in three periods: in Period 1; in the period from the point that growth buds of perennial grasses are elevating to seed maturity; and in the period of late energy storage.

It is better to graze one pasture correctly and not use another at all in a particular season than to graze both improperly.

Producers should have a hand in developing grazing plans—this is a good way to keep them realistic.

Using forage effectively for beef production

What is the best forage use? You will need to define it for yourself. A qualitative definition might be to graze in a manner that maintains or improves range plant health, while producing the largest amount of use of animal product over a sustained period. A shorter version might be to get the most from the resource while maintaining its productive potential.

Research on number of stock-caffeasfirms that the best use of range forage results from a mixture of the right number of animals (grazing pressure), the correct season of use, the best overall distribution of animals, and the best-suited kind and class of grazing animals. Information learned through range management planning is necessary to apply these four grazing principles correctly.

Studies also show that the amount and form of herbage left after grazing is more important than stopping grazing when you have used a certain percentage of each species. It is important for one primary reason—the greatest economic returns over the years will be at a particular point in terms of residue or herbage left. There is an optimum amount of plant material to maintain the plant community and to provide soil-plant stability. Figure 2-10 (page 22) illustrates the principle when season-long grazing was used over a 19-year period. Note that maximum gains per head, per acre, and economic returns per acre do not occur at the same level of grazing pressure. Developing such relationships for each range unit will help greatly when you design a better overall management program.

So, manage grazing according to how much is left—not how much is taken. Forage plants grow, reproduce, and go dormant throughout the year. Forage quality begins at a highly digestible level in early season, reaches a peak level of nutrient productivity in midseason, and declines during dormancy.

Animals require forage in varying quantity and quality, based on physiological demand. Mixing and matching these three components is the key to obtaining the best forage use. Regardless of location and ecological type, the forage cycle has at least four periods, namely:

1. Early growth—damp soils, high succulence, low daily productivity, when it is easy to have demand exceed supply
Emergency waste feed

2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50

Ungrazed herbage (pounds per acre)

150    200    250    300    350    400

450    500

Figure 2-10.—The best animal production does not mean either maximum gains per unit area or maximum gains per head. Moderate stocking provides most returns in the short run and assures continued high forage yields.

2. Beginning of rapid growth—when demand and supply are about equal
3. Flush of growth—when supply exceeds demand
4. Dormancy—when there is no new growth and feed value is lowered

Highest animal production is in Period 3. Calculate when these periods or phases occur for each range and pasture unit so you can match demand and supply.

Range readiness is that time after which forage plants can safely sustain proper grazing without negative effects. The concept has long been used, but it may no longer be important if grazing management is intensive enough to avoid range deterioration or the lack of improvement in range condition.

A record of forage use by area, coupled with periodic assessments of range condition, is indispensable keys to long-range planning. If good records are available, and if the grazing plan developed for the area works well, you will make future use checks as much to check cattle as forage. Make notes by date and species. Each season is different enough so that building a record will add significantly to your knowledge for use in the future.

Availability of stock water

On level ranges, cattle will go as far as 4 miles for water, but distances of 2 miles will severely limit use. When combined with either steep or long slopes, forage occurring more than 0.5 to 0.75 mile from water will receive very little use unless the range is overused at closer distances.

Class of animal

Younger animals range over steeper terrain and farther from water than does with or without calves. Similarly, dry cows use forage farther from water on slopes, and in timber better than wet cows.

Use of previous grazing management

Well-planned grazing can effectively extend the periods and/or evenness of use. It also may improve forage nutritional value. One example is using relatively short grazing periods in early spring, when animals “top off” forage through concentrated use. Removing stock permits regrowth for use later that year or perhaps earlier the next year. Caution: The more arid the site, the more conservative you should be about using “topping off” during the growing season.

Determining use

Only by knowing which areas get which levels and kinds of use can you plan to make better use of your range resources. Overuse or misuse is the greatest contributor to either range deterioration or the lack of improvement in range condition.

A record of forage use by area, coupled with periodic assessments of range condition, is indispensable keys to long-range planning. If good records are available, and if the grazing plan developed for the area works well, you will make future use checks as much to check cattle as forage. Make notes by date and species. Each season is different enough so that building a record will add significantly to your knowledge for use in the future.

After you remove stock from a pasture, make a use map showing areas of proper use, no use, underuse, and overuse. This will be important when you design the next season's grazing plans. If pastures are large, the use maps help you decide whether you need further range developments.

Providing water in under- or unused areas is like buying more forage. Fencing also may be necessary to accomplish that purpose.
Range developments:
A key to better grazing use

Range developments promote better and more efficient range use by livestock. Range developments are fences, stockwater developments, roads and trails, animal-handling facilities, and stock driveways. Each development serves specific functions, and each should add some economic and management benefit.

Good management is more than having the correct number of watering locations, fences, and roads or trails. Good management is being able to use these developments to best advantage for overall animal and plant production over a sustained period. In other words, adequate range developments don't mean that adequate range management automatically follows.

The need for some kind of development occurs whenever you find that overall range forage use and the best livestock production aren't well matched, even though you may have made substantial use of salting and riding to distribute grazing.

Range developments, like range improvements, require capital investment; thus, they must bring economic benefit. Ask yourself:

- How many AUMs (animal unit months) of unused forage do I have?
- Where is it located?
- When is it available?
- Why don't the cattle harvest it adequately?
- If it isn't accessible, will a road or trail make it so?
- Must stock be fenced into a particular area to force them to use it?

Calculate the value of unused or underused forage based on realistic prices. With this information and costs of particular developments—a 2 miles of fence and a couple of water developments—you can analyze whether you can afford to make the investment.

Water and its sources

In addition to providing cattle with good-quality water, water developments can be an effective way to distribute forage on the range. Regulating cattle access to water will permit better utilization or forage on previously poorly used areas. Location of water is important in controlling the movement, distribution, and concentration of stock. More locations are needed on steep than rolling terrain.

Cattle will not evenly use forage if they have to travel more than 0.5 miles in mountainous terrain and more than 1 to 1.5 miles on level range. One watering facility for each 50 to 60 animal units is desirable if you expect to use the unit all season.

When it is at all possible in rough terrain, locate stockwater on sidehills or just off a ridge, rather than in canyons. Cattle will graze down from water and for a greater distance than they will graze up from water.

The amount of water needed varies by class of stock and season of use. Lactating cows and calves consumed 15 gallons per day in Oregon studies, but dry cows drank 10 to 12 gallons. Yearling heifers need 8 to 9 gallons per day for a summer period but only 6.5 gallons per day if they are watered on alternate days. Water intake is less when cattle graze on green forage in spring and when weather is cool.

For any new development, be sure to determine whether you need to file for a use permit. In a number of western states, the development and use of both surface and groundwater are controlled by state regulations. Before you invest in water developments, consult the appropriate regulatory agencies to ensure compliance.

Consult Figure 2-11 to help determine the cost per AUM for water, given stocking rates for the areas to be served and the cost of developments.

Streams are not considered developments. If streams are only intermittent, consider providing a reservoir. Permits are required for reservoirs.

On perennial streams, the public is concerned about protecting banks and maintaining the water quality. Consequently, use care in grazing timing and intensities on such sites. If you fence the stream separately, provide for water gaps. Cost in construction will pay off in lower maintenance costs. The daily value for each day of maintenance has been estimated as high as 15 percent to less than 5 percent of the initial investment.

Springs: Special development is needed. A flowing spring has great value. Water could be tanked and piped great distances, spreading the value over several thousand acres.

Low-flowing springs, if properly developed, can be very beneficial. For example, a spring flowing at only 0.5 gallon per minute produces 720 gallons per day, or enough for 48 cows and their calves during summer. In all cases,
develop springs and seeps so that stock have no opportunity to trample the source. Sometimes, spring flow can be increased dramatically by removing trees and brush in the vicinity. In several western areas, springs started to flow after brush was controlled.

Frequently, you can locate potential spring developments by consulting current aerial photos or by flying the area. Color infrared film shows the water-loving plants.

**Reservoirs and stock ponds** Success depends greatly on the pattern and amount of precipitation and on the soil type. Ponds often dry up by late summer and fall, so their reliability as a water source is not as great as a spring, stream, or well.

Care in construction is critical. Spillways are necessary. You can obtain specifications from technical agencies. Build reservoirs so that the surface area is as small as possible in relation to depth. High sides reduce wind movement and decrease evaporation. It is often desirable to fence reservoirs and either trough the water out through the dam or build a water gap.

You can control seepage by using materials such as bentonite or special clays or by compacting the reservoir floor. You can obtain information about other techniques, such as salt treatment or plastic liners, from Natural Resources Conservation Service technicians or other technical advisers.

**Wells** Vertical wells are reliable water sources and often can be drilled near the forage supply. Cost of development may dictate how far the water can be extended. In much of the West, wells, storage tanks, and pipelines are major water sources.

Horizontal wells are a relatively new development in the West. Basically, a horizontal well is a pipe bored at a slight angle down into a hillside to tap small, delay flows of water. Water flows by gravity, as with a spring. It is piped and can be controlled with valves and is a high-quality source.

**Hydraulic rams** These age-old devices deserve more use in the mountain West. Water from a spring or other source such as a ditch or stream is directed into a drive pipe to the ram, which lifts it through a delivery pipe. The basic minimum is a water flow of 1 to 5 gallons per minute with a fall of 20 inches or more. The theoretical lift-to-fall ratio is 25 to 1. If you need water at a higher elevation than a spring source, the ram has real possibilities.

**Water catchments** The reliability of precipitation is an important factor. Catchments often are used when precipitation isn’t enough for a stock pond and no other source of water exists. The principle is the same regardless of kind of catchment: Precipitation falls on an impervious surface, is drawn off to a storage tank, and led into a water trough.

Many types of surface can be used: flat rock outcrops, highways and roads, smooth-packed soil (must have enough clay), chemically treated soil (silicone, paraffin wax, sodium carbonate), and mechanical covers (concrete, gravel-covered membranes, asphalt-soaked material, rubber and artificial rubber, and sheet metal). Eastern Oregon studies show precipitation can be collected by using metal sheeting on a frame, shedding rain water into circular tanks of various sizes. Such developments can be placed anywhere the materials can be transported.

Table 2-2 gives some guidelines for effectiveness and costs. If you want to use catchments, you’re advised to get technical help.

**Pipelines** A great deal of range forage opened up with the advent of PVC (polyvinyl chloride) and plastic pipe. Water generally is piped by gravity. Pipe should be buried—it will work well above ground but will not last as long. You can turn water on and off as you want, a definite advantage in influencing grazing distribution.

**Hauling** This generally is considered as the last alternative in providing stock water because of cost, effort, and inconvenience. Costs have ranged as high as $10/AUM, depending on the amount hauled, distance, and terrain.

However, hauling can distribute water to areas that otherwise would go ungrazed. Stock may get to drink more often, and generally do not have to travel as far when you haul water.

Because of the cost of hauling water, consider your need for the forage carefully. You must maintain roads in good condition. Thus, very rough country is not conducive to water hauling. Above water tanks often to encourage even grazing.

**Fences** Although water location by itself is an excellent way to improve or manipulate grazing distribution, it is difficult to put a rotational grazing plan into effect without using fences to control livestock. Animal behavior will indicate where fences should and should not be. Consider the natural boundaries or barriers to livestock movement, and build fences only for specific purposes.

Every producer has developed, or will develop, guidelines for building fences. The following are general considerations:

- **Build along the contour whenever possible.** The fence will be stronger, and cattle will not crowd it as badly.
- **Do not fence down a drainage bottom; rather, split it at an angle.**
- **Fence by site whenever possible.**
- **Do not fence up and down slope but at an angle.**
- **Always remember the fence’s objective.** You want to visualize how it will work before you build it.

Consider suspension fences when terrain will permit. You can reduce substantially the cost of both construction and materials. When suspension fences are properly made, they actually turn cattle better than conventional barbed wire ones. The principle—spooking the animal through both
Table 2-2.—Water costs for various water-harvesting treatments.\textsuperscript{12}

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Runoff (percent)</th>
<th>Estimated life of treatment (years)</th>
<th>Initial treatment cost/yard</th>
<th>Annual amortized cost/yard\textsuperscript{a}</th>
<th>Water cost per 1,000 gal\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock outcropping</td>
<td>20–40</td>
<td>20–30</td>
<td>$ &lt;0.01</td>
<td>$ &lt;0.02</td>
<td>$ 0.22–0.45</td>
</tr>
<tr>
<td>Land clearing</td>
<td>20–30</td>
<td>5–10</td>
<td>0.01–0.02</td>
<td>&lt;0.01</td>
<td>0.30–0.45</td>
</tr>
<tr>
<td>Soil smoothing</td>
<td>25–35</td>
<td>5–10</td>
<td>0.05–0.07</td>
<td>0.01–0.02</td>
<td>0.25–0.71</td>
</tr>
<tr>
<td>Sodium dispersant</td>
<td>40–70</td>
<td>3–5</td>
<td>0.07–0.12</td>
<td>0.01–0.02</td>
<td>0.13–0.45</td>
</tr>
<tr>
<td>Silicone water repellants</td>
<td>50–80</td>
<td>3–5</td>
<td>0.12–0.18</td>
<td>0.02–0.04</td>
<td>0.22–0.71</td>
</tr>
<tr>
<td>Paraffin wax</td>
<td>60–90</td>
<td>5–8</td>
<td>0.30–0.40</td>
<td>0.05–0.07</td>
<td>0.50–1.49</td>
</tr>
<tr>
<td>Concrete</td>
<td>60–80</td>
<td>20</td>
<td>2.00–5.00</td>
<td>0.14–0.48</td>
<td>1.31–3.00</td>
</tr>
<tr>
<td>Gravel-covered membranes</td>
<td>70–80</td>
<td>10–20</td>
<td>0.50–0.70</td>
<td>0.04–0.10</td>
<td>0.45–2.26</td>
</tr>
<tr>
<td>Asphalt fiberglass</td>
<td>85–95</td>
<td>5–10</td>
<td>1.00–2.00</td>
<td>0.14–0.48</td>
<td>1.31–3.00</td>
</tr>
<tr>
<td>Artificial rubber</td>
<td>90–100</td>
<td>10–15</td>
<td>2.00–3.00</td>
<td>0.21–0.41</td>
<td>1.21–2.57</td>
</tr>
<tr>
<td>Sheet metal</td>
<td>90–100</td>
<td>20</td>
<td>2.00–3.00</td>
<td>0.17–0.26</td>
<td>1.14–2.26</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Based on the life of the treatment at 6 percent interest.

\textsuperscript{b} In a 20-inch rainfall zone.

the movement of the wire when touched and the sound from wind—works well.

In country where deep snow packs are a problem, the let-down or lay-down fence has merit. This means a fence that you let down in fall and put up in spring. Yearly maintenance costs less compared to conventional fences, where wires often are broken and posts pilled or bent over. Construction costs will be somewhat higher. The wires are on the ground during winter, so their life will be somewhat shorter.

Roads and trails

It is no secret that cattle use roads and trails just as humans do. Putting roads into steep, of steep and timbered terrain will aid grazing distribution. Where commercial timber harvesting occurs periodically, roads and grazing go well together.

Roads and trails can make gathering cattle much easier. As with other range developments, answer first what you want them to determine whether developing more roads and trails will achieve\textsuperscript{a}.

Consider carefully the potential negative impacts of roads and developed trails. They can serve as corridors for weed encroachment and they can contribute to water-quality problems through channelization of runoff and as sediment sources.

Other developments

Corrals and handling facilities, stock driveways, and provision for shade require little discussion. The modern beef producer works stock several times each year. Doing some of that on the range is necessary. Construct a facility where several pastures join. Include a scale so livestock performance by pasture can be determined.

Ways to increase forage production\textsuperscript{13}

Range improvements are changes managers make to improve forage quantity and quality.

Through the range planning process, you will have identified problems and the opportunities for correcting them. You probably will consider some form of range improvement. Make a thorough economic analysis of each problem and its alternative solutions. A number of techniques are available to do this.

One that all producers can use was developed by range management staff at Utah State University (see Utah Agricultural Experiment Station Research Bulletin 466). It shows how to compare various improvement practices.

You need to project total income and total costs over the life of your range improvement project. From this, you can determine the rate of return for each practice. Correct assumptions are vital to the success of this approach. You need to understand clearly what production and management advantages and disadvantages will result from specific practices.
Because conditions vary greatly, obtain technical assistance for your study of the alternatives. Some Extension agents and specialists and some Natural Resource Conservation Service technicians are trained in this field. They may know of alternatives you had not thought about.

**Overall considerations**

Improving ranch productivity through range improvements has four main components:

- Selecting the most appropriate practice or practices for each site and situation
- Managing the resource after you have improved it
- Maintaining productivity by retreating if necessary
- Integrating and managing improved areas with the other resources of the ranch

Consider improving the sites with highest potential first. Often these will be in the worst ecological condition, perhaps abandoned cropland or areas near water. They may require seeding.

Alternatively, depending on the practices you might use, consider improving areas in better ecological condition before tackling the poor and fair ones.

Good range responds to treatment more rapidly than poor range and should have greater biological stability. However, the total amount of response may not be as great as from sites in poorer condition.

Improved grazing management is a range improvement practice. Range vegetation can improve or decline, depending on the grazing management it receives. Consequently, keep grazing in mind as an improvement practice as well as a way to maintain forage production and use.

Maintaining use on all areas is essential. Lack of use in years when there is too much grass may lead to loss in the following years.

Many ranges have been improved initially through brush management or seeding, but productivity has not been maintained. The causes of range deterioration in the first place need to be well understood. If they are not, range improvement may not last as long as expected.

After range has improved by whatever practice, apply a grazing strategy that maintains the productivity engendered by the improvement. Grazing strategies can have good impacts or detrimental impacts on plants.

Finally, most improvements need follow-up. Understanding the kind of site gives large clues to the kinds and amount of follow-up needed. Often, you can repeat practices for follow-up. For example, using fire on big sagebrush. If many seeding, emerge, repeat burns as necessary.

Prescribing the correct practice or set of practices for the various ecological sites requires good technical knowledge. If you believe you do not have that yet, do not be embarrassed to ask for some assistance.

**Controlling undesirable plants**

A number of practices control plants. All result in opening the plant community to some extent. Closing the plant community with desirable species is the goal. This needs to take place correctly and fairly rapidly. Therefore, the conditions under which these practices apply need to be clear.

Do not expect some desirable native plants to come back in rapidly just because you remove the bad ones, unless enough desirable ones already are present. If they are not, consider seeding the desired species along with controlling the undesirables.

Some of the most successful seedings incorporate spraying sagebrush ahead of planting. Herbicides for chemical fallow employ the same principle.

Controlling undesirable plants, in and of itself, has several advantages and some disadvantages.

- Range improvement will accelerate under the right conditions.
- Often water yields and availability improve.
- Stock have more access to forage and are easier to handle when you control trees and brush.
- Poisonous plants may be controlled.
- Weed seeds may be reduced.
- Fire hazards should be less and often plant control improves habitat for game animals as well as livestock.

Plant control alone might not be appropriate when site potential is too low or when costs are too high and can’t be spread out over a long enough time, when erosion hazards are serious, or when spray drift would cause problems.

Each general category of plant control has both advantages and disadvantages. A partial list is given here for each category.

**Manual and mechanical control** Obviously, this means getting at the plant physically. Thus, the approach applies primarily to shrub and tree species. Manual controls include hand grubbing or chain sawing. Mechanical controls, usually bulldozing or dragging with a heavy chain, often are used because no other practice is either effective or economical.

Advantages and disadvantages are not clear-cut. Depending on the technique, you might get high selectivity (bulldozing) or low selectivity (chaining). Mechanical control often is used to prepare seedbeds before seeding.

- **Advantages**
  - Timing usually is not critical and can be when ranch labor is available. However, some plants are more or less sensitive at particular times of year—for example, rotobeating sagebrush in the fall generally is less successful.
  - Generally considered most convenient method.

- **Disadvantages**
  - You may not have the desired equipment.
  - Costs may be rather high.
  - Frequently, soil is disturbed enough to require seeding (an advantage if you want to seed).
  - Terrain may be too steep.
Chemical This method has been phenomenally successful in improving ranges. Use only chemicals that are registered by the Environmental Protection Administration (EPA) for the specific application you intend to make.

It is more and more likely that most chemical application will be made under contract by licensed applicators. This in itself does not relieve you, the rancher, of liability—you still must follow label instructions for the chemicals. If you use a contractor, you will use less ranch labor than in the past, at least for spraying.

Chemicals come in a wide variety of forms and can be applied in liquid form (sprays or injections into trees) and solid form (primarily granules).

Advantages

• Very site-specific
• Fast and easy to apply
• Generally low to moderate cost
• No erosion hazard
• Selective as to species
• Terrain not limiting as a rule
• Generally some moisture conservation benefits
• Ranch labor not needed, generally
• Safe if done properly

Disadvantages

• Timing is very critical for many herbicides
• Weather and environmental conditions can limit, for example, soil moisture too low
• No chemicals yet for several major species
• Damage to crops in area

Prescribed fire When conditions for burning are accurately prescribed and adherence is predictable. Fire can be used as an overall part of a management program as well as just for range improvement—for example, to periodically burn off old forage residue to encourage better livestock distribution. Fire is environmentally accepted.

Studies now are revealing more about times of fire tolerance as well as susceptibility of various rangeland species. The techniques, overall, are being developed to make burning a skillful management technique.

Advantages

• Relatively low cost
• Forage plants preferred after burning
• Good seedbed preparation in white ash (shrubs and trees)
• Releases nutrients for plant growth—forage plants may be more nutritious
• Controls insect populations—insects prefer old residue, which fire removes
• Improves game habitat
• Opens up areas for access

Disadvantages

• Liability if fire escapes
• Need good preparation—that is, often more than just fire lines
• Often damages nontarget species as well as targeted ones
• Timing important
• Dangerous
• Some erosion hazard on steep slopes
• May not burn evenly—not as site-specific
• Often, vegetation isn’t dense enough to carry fire
• Smoke management (air quality) is an increasing concern and must be considered in many areas

Biological Grazing is a form of biological control. Insects and diseases, however, more often are considered primary for this overall approach. Many attempts are made to discover insects and plant diseases that will attack only one undesirable plant species. Only a few examples of good success occur.

To be considered a biological control, the organism must be specific for the host plant and be controllable. Most such organisms are not native to the problem area.

Some natural biological control takes place. Notable is the sagebrush defoliator (Aroga websteri). Unfortunately, no one knows what factors control populations of the defoliator. It is unpredictable, and populations ebb and flow through time. Two parasites work on both the larvae and pupae stage.

Undoubtedly, biological control agents will be found for more and more undesirable weeds in the future. However, it is unlikely that this form of control will be allowed on native species unless the control organism itself can be controlled effectively.

Range seeding

Seeding is second to brush control in terms of number of improved rangeland acres. Producers turn to seeding for range improvement because it can offer at least as much, and usually more, palatable and nutritious forage than unseeded native range can—often at times when native species are less palatable and nutritious.

Seeding is indicated in many situations, but most seeding is done for one or both of these reasons: There is a
need for forage that the present species composition and site characteristics cannot fulfill; and the current ecological condition is poor but site potential is high.

In such situations, your first candidates should be those sites with deepest soils, moderate to no slopes, and sandy loam to loamy surface soil. Seeding success is limited when annual precipitation averages less than 9 inches, particularly if soils are saline or alkaline. Opportunities to improve such sites are limited mostly to improved grazing management unless you can augment soil moisture.

As with any other range improvement practice, schedule seedings far in advance. Because finances generally are limiting, a schedule might include seedings spread over several years.

In species selection, the primary consideration is: Will it establish, grow, and reproduce under the conditions on this particular site? Such characteristics as drought tolerance, winterhardiness, and season of growth are very significant.

Once you identify generally adapted species, consider their other characteristics. Will a species be productive when you want to use it? How much use will it take, and how does this vary from season to season? What is its relative palatability? Will your cattle eat and like it? Is its forage value enough to promote desired levels of animal performance?

You must plant seed in some way. Broadcast seeding, except immediately following a forest-type fire, usually is not successful. Seed must have soil or some water-holding or retaining material around it to germinate and establish. You need to remove competing vegetation, prepare a shallow and firm seedbed, and seed at the proper season.

Rate of seeding, depth of seeding, width of drill rows, season of seeding—all these points need attention to accomplish success. Attention to detail can mean the difference between phenomenal success or absolute failure.

Fence seeded pastures separately from other range land to permit grazing management. Do not graze until the plants are well established—usually, when they develop seed.

There is one exception to the initial stand has many weeds, which is cheated so, grazing the land for a few days with a large enough herd will significantly aid weed control and stand establishment.

Grazing when soil moisture is available, and remove stock long before moisture is gone. Such short-duration grazing should not exceed about 10 days. Close management will result in a strong stand.

If forage is continuously grazed at least once a year, old growth will not build up, and use should not be poor. Frequently, the entire pasture is not seeded. After 2 years of nonuse, grasses in the pasture will not be nearly as palatable as newly seeded grasses.

Consider this in a grazing management program. Although many of the seeded species are quite tolerant of grazing, paying attention to amount and time of grazing pressure will be economically important.

Mechanical range improvement

In areas with intense storms during the growing season, a good deal of water is likely to run off even when vegetation cover is good.

A number of practices can solve the problem on rangeland. All are designed to aid range improvement by decreasing water runoff, conserving soil moisture, and increasing efficiency of water use.

Practices include contour furrowing, contour terraces, ripping, pitting, and water spreading. We can recommend only furrowing, pitting—and perhaps water spreading—as economical. They work well for medium- to heavy-texture soils but do not show much promise for sandy soils.

Contour furrows: These are furrows 2 to 5 feet apart and about 8 inches deep laid on the contour. Newer equipment places small dams in the furrow at intervals. Water is held at its source, increasing soil moisture storage at relatively low cost. It is most applicable to medium to medium-fine texture soils.

Pitting: Pits are relatively shallow depressions in the soil surface. The objective is to hold water where it falls. Production on shortgrass range increased 30 to 50 percent after pitting. With a change to midgrass, mostly western wheatgrass, life of plant is limited, however, because sediment builds up over time.

Water spreading: This form of irrigation diverts water from areas of concentration to nearby relatively flat, smooth areas to augment the natural moisture. You will need a good knowledge of runoff characteristics to decide whether water spreading is feasible, since you will have to construct dikes to funnel the floodwaters over the land.

Often, the area should be seeded and perhaps even fertilized because the moisture regime, on average, will be better than it was before water spreading.

An important consideration is the probability of floods each year. The cost of system development must be repaid by increased productivity, and the number of floods per year strongly influences the system's profitability.

Range fertilization

Fertilization must produce returns the year the fertilizer is applied. From that standpoint, it is a different kind of range improvement practice.

In areas that receive less than about 15 inches of annual precipitation, the plant's limiting growth factors are mostly weather-related. Nitrogen increases a plant's ability to use water, but fertilizer cost may not justify the increase. Also, additional levels of plant nutrients often do not produce an economically significant response in native species in arid to semiarid environments.

Fertilizers are not effective unless growing season moisture occurs, which generally limits their use to the Great Plains and mountain valleys. Species such as crested wheatgrass have been fertilized economically with nitrogen.
in precipitation areas less than 15 inches, but results are erratic from year to year.

Benefits of fertilization include increased forage yield, higher nutritive value and forage quality, a somewhat longer green forage period, and increased soil moisture efficiency.

As a rule, the species composition will be affected by nitrogen fertilization. Areas with both cool- and warm-season grasses probably will shift toward more cool-season grasses if the area is fertilized either in fall or early spring.

However, where both annual grasses and perennials are fertilized, annual grass yield will increase to the detriment of the perennials. Nitrogen and sulfur are commonly deficient in western semiarid areas. Phosphorus may or may not be deficient. Obtain soil tests to determine the major deficiencies.

Grazing animals must be on hand to consume the extra forage from fertilization. If you are in an area of consistently good late spring moisture and could use more forage then and in summer, fertilization, especially of seeded pastures, could be desirable. You could stock the range with animals to that expected level of forage production.

Conversely, if moisture is consistently the most limiting factor, relate your stocking level to the average, or slightly below average, forage supply. Fertilization would stimulate more forage only in the above-average moisture years when more forage generally is available than can be used anyway.

Consequently, fertilization on dryland ranges, whether native or seeded, often is of questionable value. Mountain meadow vegetation, whether seeded or not, should respond to nitrogen and sulfur, and perhaps phosphorus also, depending on the legumes present.

Legumes need relatively more phosphorus than sulfur than do grasses and grasslike plants. Thus, to help legume production, you must satisfy the need for phosphorus.

With the cost of a fertilizer certain to increase, the practice of fertilization requires close economic scrutiny. Usually, you can profit by fertilizing irrigated hay meadows and pastures.

Dealing with drought

Drought can occur as growing-season dryness, winter drought, or both. In the intermountain West, drought occurs 1 out of every 4 or 5 years. Regardless of how we define drought, dealing with it is an extremely serious proposition.

If you do not plan for drought, your beef operation may not survive. Even when you do plan for it, you must make serious adjustment.

To manage successfully in the face of drought, you will need to know how drought affects plants, cattle, and their management—and what options exist to help you avoid the extreme consequences of both ruining the range and selling the cattle.

Effects on plants

Forage production decreases dramatically. Plants with shallow roots are affected much more than deep-rooted ones. Annual-plant production may be practically nonexistent. High-ecological-status ranges will be less seriously affected.

Perennials are dormant longer than normal. Very little is known about plants' ability to store carbohydrates under abnormally dry growing conditions. It is possible that no carbohydrates are stored at all, but that really is not known for a fact.

To ensure the greatest potential for health, plants probably should receive as light a grazing as possible and practical during the growing season.

Roots make up 50 to 60 percent of most range plants. If any deep soil moisture exists at all, a healthy, deep-rooted plant may be able to get it. Roots cannot penetrate dry soil to get at deeper moisture.

The length of drought has a large bearing on plant health. Perennials continue to respire when the dormant, so the size of their energy reserves is even more important than normally. When drought continues more than 1 year, plants may begin to fail up.

As the plant community opens, it becomes more susceptible to invasion by annuals and lower-value plants. When droughts are so severe over a period of years, this could happen even with light or no grazing.

Perennial ability to recover after drought seems to be closely related to the degree of grazing pressure before and during drought. Use above 60 percent of current growth can decrease some plant species' ability to recover, according to a study in Oregon. However, light use (25 percent or less) seemed to have a beneficial effect. Moderate use (25 to 60 percent) seemed not to affect production of several major species.

The degree of use seems to affect the plant's ability to start growing after drought; early growth was slower on moderately and heavily grazed plants compared to lightly grazed and ungrazed ones.

Nutritive values of individual plants during and shortly after a shortened and dry growing season actually may be higher than normal, since there is no dilution effect of nutrients by much top growth. But the following dry season often is longer than normal, and forage value probably will deteriorate at the same rate as in a normal year. This results in less overall forage value, although more as a result of lowered quantity than of lowered quality.

Effects on cattle and management

Unless you reduce stocking pressures in accordance with forage availability, weaning weights may be reduced seriously. Research shows near-normal weights when stocked in relation to reduced forage supply.

Having enough stock water will aid a cow in lactation. Since lack of water often is as serious as lack of feed, you may have to tolerate some weaning weight reduction.

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Upsetting the cows’ ability to breed on time seriously affects future production. When cows do not get adequate nutrition during lactation, they respond by missing heat periods, or—at best—they will breed but will not conceive.

Drought in the several months after calving can delay a cow’s breeding for 3 months or longer. You can provide cows with good feed to keep them on schedule. If you do not, you are facing several years of reduced production from cows who breed late and so calve late the following year. Late calves always are lighter. A cow that calves 3 months late, even if she could be managed to breed back one cycle early per year (which is not probable) would take at least 4 years to get back on schedule. Most producers would find these cows too uneconomical to keep.

During drought, normal water supplies (reservoirs and ponds) may not be available. Coupled with less stream and spring flow, this will result in inadequate animal distribution and lowered performance and range condition. Although unused forage may be in the farthest reaches of pastures, the probability of harvesting it is low.

Management options
Before you can look at options, you must have a clear picture of all available resources.

- Inventory your own available feed supply and where it occurs.
- Assess availability and cost of alternative feed supplies.
- Evaluate your livestock inventory.

Droughts mean reduced stock numbers. If you have to sell, keep only healthy, early to mid-aged, productive cows. Cull out the late calvers, regardless of age. Keep future replacements.

Cow-calf-yearling operations have more management flexibility to make destocking decisions. You would have to sell yearlings anyway, thus you could simply make that decision earlier in the marketing cycle.

Determine whether you have any possibility of developing more water or whether additional feeding will be required. Even temporarily, to make better use of your range feed.

Taking action at the beginning of a drought can be critically important, later. Your options will depend on levels of past grazing use. Animal adjustments will be necessary regardless of the option, unless there is a real abundance of unused, available forage.

Light-moderate history Reduce grazing load to match forage supply. Continue light to moderate use, allowing plants to maintain their present level of vigor.

Heavy grazing history Defer use if at all possible. Range plants probably have reduced root systems, and they need to make as much growth as possible. Later, after dormancy, you could allow light grazing.

You cannot defer use if you do not have any feed alternatives. Your options are fewer:

1. Reduce numbers as much as you can, at least for early-season grazing.

2. Spread grazing load uniformly. Graze a plant only once. It will have little opportunity to regrow if you graze it repeatedly.

3. Stock water will be a real problem:
   - Graze first the areas whose water sources may fail later in the season.
   - Haul water, if necessary, but expect high costs.
   - Drinking on alternate days will not lower production of dry cows and yearlings, but a lactating cow needs water daily, or calf gains will be reduced by 50 percent or more.
   - Lactating cows drink 15 gallons a day in summer.
   - Cows drink more water when forage is dry, as it will be during drought.

   - If you supplement, cattle should hustle for themselves better. If you substitute, they will not.
   - Do not let the cattle condition serve as an index of range use. Animal performance can remain stable, or even improve, while the range is being hurt.
   - Wean calves early and feed them at home or at another feed lot. Do not sell them.
   - Calf performance will stay up.
   - Cows will not get as poor; if they already are poor, they will not stay as poor.
   - In extreme drought, wean calves early and treat them like dairy calves. This will be better than suffering both poor calf and cow performance.

If you have alternate feed, consider these options.

- Graze annuals heavily. Production from annuals may not be much, but they can be grazed heavily and still reproduce.
- Graze crested wheatgrass, if available. It can tolerate grazing better than native plants.
- Stay on hay meadows longer if you can stand the impact of a potentially lower hay supply. If irrigation water will be less than normal (it probably will be), concentrate it on your best-producing areas and graze the remainder. If you have a firm water supply, you might graze the entire area and delay growing the hay crop farther into summer when good weather should mean more rapid growth.
- Feed crop by-products, if available.
- Feed hay longer. Strongly consider this. Delayed breeding may be avoided, and calf performance should stay up.
After the drought

Resist the temptation to restock until you are certain plants have recovered enough to permit it. Plants with a light to moderate grazing history will recover their productive ability fairly soon, perhaps the first year under above-average weather conditions. Heavily grazed plants will take longer to recover, and some species will not recover if heavy grazing continues. Plants have to be given the opportunity to get enough energy to improve their vigor. Keep in mind that under "natural" grazing, wildlife numbers would be reduced as the result of drought and would not increase again until some time after the drought, when increased quantity and quality of forage would improve wildlife reproduction and survival.

Make drought management plans

• What parts of your normal-year plans can be used during drought?
• Maintain all watering facilities and develop more if possible.
• Keep some reserve feed.
• Keep good production records on your cows. If you have to reduce, records will really help in determining sale animals.
• Monitor your grazing impacts on your pastures. If it seems you are heading into a drought year or period and demand is exceeding forage supply, make adjustments as early as possible. You have much more control and management flexibility early than you will have later.
Managing upland watersheds in grazed semiarid rangelands

Michael M. Borman
John C. Buckhouse

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Several plant and soil factors are important to livestock grazing in the upland areas of a watershed. The bulk of the scientific rangeland management literature of the past of 50 years has been directed toward upland areas.

Before the early 1800s, prior to European settlement, most of the arid rangelands of the West were in varying states of change and equilibrium. Fire, floods, and periodic overgrazing by wild herbivores occurred, but ample time passed between such disturbances to maintain relatively stable plant communities (subject to longer term, climate-induced changes).

After settlers introduced domestic horses, sheep, and cattle, extensive, severe overgrazing brought about a period of deterioration. No one knew about rangelands, carrying capacities, plant ecology, or soil genesis. Further, the vast rangelands were "unowned" due to prevailing public policies, prompting a "tragedy of the commons": There was no reason for one settler to conserve forage because a neighbor or itinerant grazier would take what was left. In a matter of decades, the ecological balance was damaged.

Fortunately, a period of learning and some adjustments in grazing practices began after the turn of the century. At first, it was a few forward-looking souls who decried the desecration. Men like Sampson, Leopold, Lowdermilk, Stoddart, Pinchot, and Roosevelt were latter-day voices crying in the wilderness.

Later, they were joined by government agencies and finally, at the time of the Dust Bowl and Great Depression of the 1930s, by a growing cadre of resource professionals and lay people who recognized the links between land health, good land management, and economic stability.

Current perspective

Since the 1960s, and especially in the 1980s and 1990s, that movement has become even more popular. Professional land managers, environmental organizations, and landowners are coming together to ensure that all our resources—such as water, wildlife, timber, forage, and recreation—are considered as land management and treatments are planned and implemented.
Most rangeland resource professionals believe that the ecological health of rangelands today is the best it has been in this century. It appears we are on the right track. However, many upland rangelands remain in an ecological condition that renders them less productive than they could be.

Many riparian areas are eroded, degraded or, at best, held in a relatively low stage of development, while their associated uplands vegetation may be trending toward higher and later ecological succession.

Clearly there still is much important work to do.

**Management opportunities**

How can landowners manage grazing to maintain watershed productivity? Options tend to settle into several categories:

- The number of animals (stocking rates)
- The timing and duration of animal use
- The distribution of animals

**Number of animals or stocking rates** For a given amount of forage-producing capability, a more or less definite grazing capacity exists for the various kinds and classes of animals, including wildlife. However, management needs to be flexible to accommodate the variability of forage production associated with year-to-year climatic variations and longer term cycles.

**Timing and duration of animal use** As we learn more about the science of grazing and plant physiology, we are finding how critically important the timing and duration of grazing can be. The amount of rest a plant needs depends largely on when, as well as on how much, it was grazed.

Many grazing systems have been developed, all of which have some pattern of grazing and rest. There is no one best system, and all must be monitored and modified through time. In other words, each must be designed for a specific set of climatic, soil, and topographic conditions, along with managerial objectives. After careful consideration, you can make a site-specific grazing prescription.

**Animal distribution** Aspects of animal behavior also play a role in proper rangeland management. Different species, sexes, and classes respond differently to increasing steepness of terrain, distance from water, and density of tree and shrub cover. To make a grazing prescription work, you must be able to account for these animal behavior differences and responses to ensure that the range is not overused in one area and underused or even unused in another. Herding, riding, fencing, trail construction and maintenance, salt placement, water developments, and animal selection and training are all tools to this end.

**A key premise**

It is quite important that you understand these grazing concepts. When you consider them all carefully in developing a plan and putting it into effect, you enhance productivity and stability.

Finally, you need to make the connection between grazing management and watershed management. In watershed management, the premise is simple: Precipitation should infiltrate into the soil at or near the spot where it falls to the earth. It is important to remember, however, that the ability of a site to accomplish this varies depending on soil characteristics, topography, seasonal distribution and intensity of precipitation, and other factors.

As infiltration improves, soil moisture is increased. Associated benefits likely will include one or more of the following: enhanced plant growth and development, subsurface water flow, and groundwater recharge, more active springs and seeps, and prolonged stream flow. As infiltration increases, overland flow is decreased, reducing the amount of soil erosion.

The main way to enhance infiltration is to manage vegetation. A grazing scheme prescribed to enhance plant production will do just that.

Remember these key points:

- Healthy roots enhance the movement of water into the soil, and the organic matter they deposit enhances the water-holding capacity of the soil.
- Healthy living tissue breaks up raindrops, provides shade and cooler soil temperatures through cover, and stabilizes the soil.
- Dead and decaying plant tissue (litter) also protects and enhances the soil—a point we tend to forget.

Managing livestock to enhance plant vigor, with an eye to managing litter, is the key. With thoughtful management, the uplands will flourish. With improper management, they will decline and erode.

Much is at stake. As W.C. Lowdermilk wrote nearly 50 years ago, "A nation can no more support a civilization on a declining resource base than an individual can build a house on shifting sands."
Stream temperature amelioration through subsurface (interflow) delivery of water

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35 Methods and results from eastern Oregon field study
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If you've ever entered a cave during the hot summer months, you remember how refreshingly cool the temperature was. And if you entered that cave during a bitter cold winter’s day, you noted how pleasantly warm it felt! These experiences describe what we have quantitatively measured in this experiment. Subsurface temperatures are ameliorated (moderated) compared to those above ground. In temperate zones, the earth’s mantle generally is between 45 and 55°F, winter and summer, respectively.¹

The relatively constant temperature of a huge mass is a very efficient “heat sink” for water. Subsurface water in winter is delivered to the stream at temperatures near 45°F, providing a very important biological benefit to the stream’s flora and fauna. Conversely, during the warm summer months, subsurface flows are delivered to the stream at about 55°F—again providing a very important benefit to the stream’s flora and fauna.

Methods and results from eastern Oregon field study

HOBO temperature data loggers were placed in-stream above irrigation diversions, in the ditch, in the subsurface (interflow) reaches of the irrigated meadow, and in-stream within the irrigated meadows. In addition, depth-to-groundwater measurements were obtained using a series of access wells across the sites. Finally, rate-of-flow measurements (expressed as Q) were obtained above water diversions, below the water diversions, in the ditches, and in the lower reaches of the streams. (Q was obtained using the standard method of multiplying velocity by area.)
When interflows were active (during the periods when irrigation was active), water was delivered to the stream through the subsurface, representing “effluent” groundwater conditions. Later, irrigation was shut off, groundwater levels dropped, and the capillary flow of water reversed itself, flowing from the stream toward the riparian zone, representing “influent” groundwater conditions.2

During irrigation, when interflows were active and effluent groundwater conditions prevailed, water in the stream flowing through the meadows was 1.8 to 5.5°F (1 to 3°C) cooler than above the diversion where interflow was not being sustained (Figure 4-1).

Implications

One landowner told us, “When you irrigate, the ground gets wet.” And so it did. That soil moisture came subsurface as interflow in contact with the earth’s mantle and its great capacity for heat exchange. When the waters rejoined in the stream, their combined flows were cooler than they would have been without this subsurface component.

Yet there still are many unknowns. This experiment was conducted and replicated using a head-ditch irrigation system where all irrigation water “subs” from the ditch to the meadow as subterranean flow. In many respects, this system reacts much as we imagine a series of beaver dams and water runs across a meadow would react. Would flood irrigation behave the same way? How about sprinkler irrigation?

Obviously further research is appropriate. Yet an intriguing thought remains: Can we manage in such a way that we mimic nature, providing both the economic and environmental sustainability we all desire? It would indeed seem possible if we only will put our energies to learning how these systems actually function.

Conclusions

The theme repeated throughout this guide is: The essence of watershed management is the soil’s ability to capture, store, and beneficially release precipitation. It is obvious that water temperature relationships add yet another illustration of the logic of that theme.

Although the field study that enabled us to measure this relationship involved irrigation, irrigation itself is not the issue. The key is getting the water into the ground. In agricultural systems, irrigation may be a positive factor. In wildlands, infiltration improvements most often will be through managing vegetation to maximize that “capture of precipitation.”
A significant part of watershed management in recent years has dealt with riparian areas. Although riparian areas typically are 1 to 2 percent of the total land area, they contain a disproportionately high percentage of wildlife habitat and recreation areas. Managing riparian areas is critically important when our goal is improving or maintaining high water quality for all kinds of uses.

Riparian areas: Perceptions in management

Until a few years ago, the phrase "riparian zone" was used primarily by researchers and managers in the arid Southwest. Their primary concern was the role of streamside vegetation (phreatophytes) in water loss from streams. Such is no longer the case. Today, throughout eastern Oregon and other parts of the west, people with diverse backgrounds and interests are taking notice of riparian zones for a variety of reasons.

Riparian zones or areas have been defined in several ways, but we are essentially concerned with the often narrow strips of land that border creeks, rivers, or other bodies of water. Because of the zones' proximity to water, their plant species and topography differ considerably from those of adjacent uplands. Although riparian areas may occupy only a small percentage of the area of a watershed, they represent an extremely important component of the overall landscape (Figure 5-1, page 38). This is especially true for arid-land watersheds, such as those in eastern Oregon. Even though our comments focus on issues related to riparian zones in eastern Oregon, similar concerns exist for riparian areas throughout the West.
Riparian areas can be the most important part of a watershed for a wide range of values and resources. They provide forage for domestic animals and important habitat for approximately four-fifths of the wildlife species in eastern Oregon. Where streams are perennial, they provide essential habitat for fish and other aquatic organisms. When overbank flows occur, riparian areas can attenuate flood peaks and increase groundwater recharge. The character and condition of riparian vegetation and associated stream channels influence property values. Other values associated with riparian areas, such as aesthetics and water quality, are also important but difficult to quantify.

Interest of the public, landowners, and natural resource agencies in management of riparian areas is increasing. However, we are concerned that much discussion is mis-directed, and that installing permanent instream structures in rangeland riparian areas without changing vegetation management will be counterproductive over the long haul. In addition, we suggest that several important issues that are not being addressed need to be subjected to the rigor of public discussion. Thus, the objectives of this paper are to:

1. Promote awareness and discussion of riparian issues by and among livestock owners, land managers, environmentalists, biologists, and the general public.
2. Identify the characteristics and benefits of productive riparian systems.
3. Encourage managers of public and private rangelands to reconsider the effects of traditional grazing practices and of recent efforts to control channels structurally.

What are the problems?

The influence of European man in eastern Oregon's riparian areas began with the influx of fur trappers in the early 1800s. At that time, many streambanks apparently were lined with woody vegetation such as willow, aspen, alder, and cottonwood. For example, the Indian term "Ochoco," which was used to name a mountain range in central Oregon, means "streams lined with willow." Widespread beaver trapping initiated changes in the hydrological functioning of riparian associated streams. As beaver ponds, which had effectively expanded floodplain, dissipated erosive power of floods, and acted as deposition areas for sediment and nutrient-rich organic matter, were not maintained and eventually failed. As floods gave way, stream energy became confined to discrete channels, causing erosion and downcutting.

Homesteaders and ranchers followed the trappers. Grazing practices on the rangelands of eastern Oregon were similar to those throughout much of the West and relied primarily on yearlong or season-long (April–October) use. These practices allowed livestock to concentrate foraging in riparian areas rather than on the adjacent hillslopes. As a result, many riparian areas in eastern Oregon are in a state of disrepair and degradation. Streams that were a perennial water source for early settlers may no longer flow in late summer. Channels that once handled spring runoff and summer freshets easily now are unstable and eroding.

Where channel gully erosion was unabated, extensive deep gullies now remain as monuments to a lack of appreciation of how riparian areas function and maintain themselves. Many riparian areas are of marginal or no value for livestock forage, yet their present state and lack productive habitat for fish, other aquatic organisms, and wildlife. They may no longer dampen flood peaks or assist in recharging subsurface aquifers. Once productive wet meadows are occupied by sagebrush, cheatgrass, or plants typical of the adjacent uplands. Any attempt to generalize about riparian areas and streams obviously ignores the exceptions that exist. We nevertheless believe that historic patterns of land use have left most riparian areas of eastern Oregon in a far less productive state than their natural potential.

Part of the problem with riparian area management is perception. When changes are dramatic, such as during a large flood, the consequent damages are attributed to "acts of God," even by nonbelievers. Even an observant person living along a creek may not detect the subtle changes in stream character and vegetation composition that are occurring with time.

While each generation may be aware only of seemingly small and incremental changes, the cumulative effect of these changes over long periods of time can be substantial. Many people have never seen a "healthy" rangeland riparian area, since degradation was widespread before many of us were born. The whole picture may not be obvious even to oldtimers, because many changes occurred before the turn of the century. Attempts to learn what pre-settlement stream systems and riparian areas were like by searching the early literature are not always successful. Journals of early fur trappers and ranchers, however, do give glimpses of how riparian areas may have looked originally—glimpses showing that significant changes have occurred.
The fallacy of floods and the fortitude of vegetation

We often assume that floods inevitably have undesirable impacts. While flood damage may be great in watersheds with deteriorated riparian and upland areas, floods are not always catastrophic. Streams typically transport large amounts of sediment during floods, and sometimes channel changes are swift and desirable. However, on streams with sufficient diversity and cover of riparian vegetation, bank building through the deposition of sediment occurs during high flows.

The exact species composition of riparian vegetation varies from area to area and depends on elevation, soils, geology, topography, and climate. Generally, plants with strong root systems are required to hold streams and riparian zones together. In eastern Oregon, the willows, sedges, and rushes fit this requirement admirably. Their stems provide roughness and resistance to flow. At high flows these species bend but do not break, and they are extremely effective at trapping sediment transported by the stream. Their root systems, in conjunction with other herbaceous vegetation, usually can resist a stream’s erosive power. The importance of these species in maintaining bank stability and in filtering and depositing sediment has long been underrated; they are essential to the integrity of stream channels and associated riparian areas.

Vegetation is important for summer stream flow

Riparian studies historically have been associated with efforts to reduce evapotranspiration ("water losses") by removing streamside vegetation (primarily shrubs and trees). Such management practices were primarily intended to increase streamflow. While trees and shrub can evaporate more water over the course of a year than might evaporate from bare soil, this simple scenario ignores the more important beneficial hydrological consequences that shrubs (and trees, in some cases) can have in riparian areas.

Woody species often provide local channel stability and resistance to channel erosion so that other species (sedges, rushes, grasses, and forbs) can become established. As vegetation becomes established and total biomass increases along a stream, channels typically begin to aggrade; i.e., channel elevation will increase as sediment is deposited within and along the banks of the channel (Figure 5-2). With continued sediment deposition and bank building, particularly along low-gradient channels, water tables rise and ultimately may reach the root zone of plants on former terraces or flood plains. Species composition and community structure of vegetation occupying terraces or flood plains change dramatically, becoming dominated by typical riparian species. It should be noted that accelerated soil erosion from upland areas is neither needed nor desirable to produce the sediment necessary for bank

![Diagram of riparian areas](https://example.com/diagram.png)

**Figure 5-2.** General characteristics and functions of riparian areas.

(A) Degraded riparian area:
- Little vegetation to protect and stabilize banks, little shading
- Lowered saturated zone, reduced subsurface storage of water
- Little or no summer stream flow
- Warm water in summer and icing in winter
- Poor habitat for fish and other aquatic organisms in summer or winter
- Low forage production and low forage quality
- Low diversity of wildlife habitat

(B) Recovered riparian area:
- Vegetation and roots protect and stabilize banks, improve shading
- Elevated saturated zone, increased subsurface storage of water
- Increased summer stream flow
- Cooler water in summer, reduced ice effects in winter
- Improved habitat for fish and other aquatic organisms
- High forage production and high forage quality
- High diversity of wildlife habitat
building. Natural erosion rates typically provide enough sediment for successful recovery of a riparian area.

An aggrading channel and a rising water table have many benefits. More water is stored during wet seasons, and slow release of this water may allow a stream to flow during the driest of summers. Hence a paradox: Establishment of additional vegetation in degraded channels can cause a stream to flow throughout the summer. Summer flows have improved in a variety of streams in eastern Oregon where riparian vegetation has been allowed to recover and stream channels have begun to aggrade. Such responses are happening in areas that receive, on the average, only 10 to 15 inches of annual precipitation. The important point is that streamside vegetation provides the key to improving the productivity and stability of riparian systems. This vegetation also is critical in reestablishing perennial flow in degraded channels, where the slow release of water from increased subsurface storage can more than offset the amount used by streamside vegetation.

To graze or not to graze

Adverse changes in streams and riparian vegetation can result from a wide variety of causes; for example, changing climatic and precipitation patterns, more frequent flooding, altered beaver populations, heavy streamside grazing, improper use of upland watersheds or adjacent slopes, and road construction close to channels. On a geologic time scale, persisting uplifting of terrain may cause streams to entrench. Yet, when we look at all the factors that can and do influence the present condition of riparian areas in the West, livestock grazing is unquestionably a significant factor. Since grazing is intrinsically associated with the problems, it also is fundamentally important in the solutions. Grazing management provides a major opportunity to improve riparian areas without large expenditures of money.

In the past, rangeland management and research have focused largely on trying to understand and increase productivity from upland areas and plant species. Because the riparian community occupies such a small portion of a watershed (less than 0.5 percent of eastern Oregon ranges), it may have been assumed that riparian plants responded to grazing pressure similarly to upland species. Unfortunately this is not the case. Species in "recovered" riparian areas are numerous and diverse in their requirements and responses to grazing, and our understanding of how these species interact and function as communities is limited. We do know that continuous heavy grazing of riparian areas can cause longlasting detrimental effects.

Grazing needs to be closely managed in both riparian areas and uplands for recovery of degraded streams to begin. Timing is particularly crucial for riparian areas. Allowing vegetation to grow all summer, only to graze it heavily in the fall, can eliminate chances for recovery. Spring grazing in some eastern Oregon riparian areas allows for vegetation regrowth throughout the summer, so vegetation still provides stability to channels and banks during periods of high runoff. This grazing strategy also allows for rest during the growing season of upland plants.

Grazing fees and riparian condition

Because riparian areas usually are limited in size, allotment administration usually includes them in adjacent landforms and vegetation types.

The importance of narrow riparian areas in allocation of animal unit months (AUMs) for an allotment thus becomes relatively insignificant. For example, riparian areas on public lands in eastern Oregon comprise, on the average, about 4 acres of land along each mile of stream. Because streamside zones are subsumed in the adjacent uplands, they typically are allocated at the same intensity of forage use, often only one AUM for every 13 to 16 acres.

Assuming a public-land grazing fee of $1.25 per AUM, the revenue from grazing in riparian zones is approximately 35 to 40 cents per mile of stream. Riparian vegetation actually is grazed more intensively than the other portion of an allotment, and at a rate much greater than one AUM.
per 13 acres. Consequently, forage on the rest of the allotment often is underutilized. As a result, the overall health of riparian zones continues to decline because of concentrated livestock use along streams.

Efforts are made in almost every session of Congress to raise livestock grazing fees. With respect to riparian areas, however, the dollar value of an AUM should not be the issue. Instead, we need to focus on management of the land. Riparian management will not improve just because more is charged to use these lands. Perhaps no fee should be charged when management is improving the riparian area, but a high fee for areas where current management precludes recovery. We need to concentrate our efforts on improving riparian vegetation and companion resources—that's the real issue.

**Grazing strategies and riparian recovery**

Some people consider the current condition of riparian areas to be acceptable; however, we suggest that it is not acceptable along many streams. The continued use of grazing systems that do not include the requirements of riparian vegetation will only perpetuate riparian problems.

Ranchers and managers of public lands need to select riparian areas for long-term demonstration sites where nontraditional grazing strategies can be tested and the results compared with naturally recovering systems. These strategies should be directed toward the recovery of both biological systems (vegetation diversity and structure) and physical systems (channel characteristics and hydrology) and should entail various seasons of use, levels of utilization and exclusion, classes of livestock, and so forth. Such demonstration areas would provide important reference sites against which the characteristics of riparian systems managed in the standard manner can be evaluated. Describing and monitoring changes in characteristics and streamside vegetation should be an important component of these demonstration studies.

Demonstration areas that are established need to be continued over several years, for the recovery of riparian areas is not always rapid. This is required for Mother Nature to work her magic, and changes may not be obvious within the first few years. Where a channel currently is beginning a cycle of erosion, seed sources for native riparian species are absent, and channel gradients are steep, or silt loads are high, recovery may require decades or longer. From the perspective of future generations, perhaps the actual rate of recovery is relatively unimportant, as long as management is nudging streams and riparian systems in the “right” direction.

Recovery can be extremely rapid along low-gradient streams that traverse alluvial valleys where streams carry substantial loads of silt during high flows. As production of vegetation increases, these areas may seem to be productive and stable systems once again. However, initial vegetation "expression" (Figure 5-3a) should not be confused with vegetation "succession" (Figure 5-3b). As vegetation succession progresses, the plant diversity in riparian areas increases greatly. Channel characteristics also change. Wide shallow channels, with either flattened banks or steep eroding cutbanks, are replaced by narrower, deeper, and more stable channels with well-vegetated banks.

**AUMs and ecosystem health**

Recently there has been considerable debate about excluding livestock from riparian areas as the solution to the “riparian problem.” In some cases, such a drastic change may be the most appropriate way to begin recovery. For many streams, however, total livestock exclusion is not necessary; livestock grazing and healthy riparian systems can coexist even during recovery. Although the season and intensity of use need to be controlled carefully, experience in eastern Oregon is beginning to show that the number of available AUMs in many riparian areas can increase as recovery occurs.

When vegetation succession starts and the riparian system begins to function properly, it moves toward a more productive and healthy ecosystem (Figures 5-3a and 5-3b). At this point, all the benefits of a healthy riparian area will...
begin to reappear, including increased AUMs for livestock, improved habitat for wildlife and aquatic organisms, more stable channels, improved water quality, a shift toward perennial streamflow, and reduced flood peaks (Figures 5-4 through 5-7). Allowing grazing only at certain seasons is an investment in the health of the riparian system, and this investment will pay off in improved future productivity.

Once recovery is underway, it is tempting to relax management prescriptions and return to previous grazing practices. Early successes in forage production may intensify the pressure to increase AUMs immediately. It's hard to leave "unused" forage along a healthy riparian area, but it must be left to maintain the integrity of the system. A few years of grazing at inappropriate times can quickly undo what may have taken years to establish.

Each stream has unique combinations of channel morphology, streamside vegetation, hydrology, geology and soils, and so forth. The vast array of conditions may lend credibility to the concern that the pattern of riparian recovery observed on certain streams may not occur on other stream systems. Our knowledge of recovery rates is indeed imperfect, and quantitative predictions are not always reliable on a site-by-site basis. Additional research on arid-land riparian systems certainly is needed to improve understanding of many questions, such as the following:

1. Which riparian areas have the most potential for vegetation response (increased productivity and species diversity)?
2. In which areas will vegetation succession occur quickly, and what pathways will this succession take?
3. Which streams have the greatest capacity for storing subsurface water and regulating streamflow?
4. Which streams have the greatest potential for filtering and storing sediment and improving water quality?
5. Which riparian areas have the greatest potential for increased AUMs, and how can the preferred timing and intensity of use be determined?
6. To what extent will wildlife and fish habitat improve?

These major gaps in our knowledge illustrate tremendous opportunities for research and innovative management as we move toward understanding the function of riparian areas and the wide array of benefits they provide.

It is perhaps a sad commentary that, with few exceptions, researchers and managers have ignored opportunities for managing riparian areas. Some managers, preoccupied with a lack of knowledge about the ultimate potential of riparian sites, may use this as a rationale for taking no action at all—this is folly. Perhaps the major question to be addressed, given our current state of the art, is: are we allowing succession to occur?

**Structures and streams**

Many proponents of improved riparian management would like to spend large amounts of money to correct riparian problems. Additional funds are needed to assist in changing grazing strategies, but merely spending large amounts of money to build instream structures (e.g., sills, gabions, dikes, check dams, and rip-rap) or to structurally modify channels seldom will "solve" riparian problems. Building expensive instream structures without solving the problems associated with management of riparian vegetation allows managers to sidestep difficult decisions.

By placing permanent structures in a channel, we are attempting to lock the stream into a fixed location and condition. However, alluvial streams naturally develop and function by continual channel adjustments as flow and sediment loads vary. These incremental changes allow streams to withstand the wide range of dynamic forces that occur as flows fluctuate rapidly during storm runoff. None of the changes in channel characteristics and riparian vegetation shown in Figures 5-3 through 5-7 resulted from structural additions to the streams. Even where structural
additions to a channel may help recovery, we often install structures in sections of stream where they are not needed, because we rarely allow several years of vegetation recovery before identifying where they might do the most good. Improvement of riparian areas cannot be expected without changes in grazing management.

In the rush to install expensive and often counterproductive structures, we have ignored what should be the primary management focus—restoring streamside vegetation. In contrast to structures, riparian vegetation can maintain itself in perpetuity as new plants continually replace those that die. Riparian vegetation allows streams to function in ways that artificial structures cannot replicate. The resiliency that these plants provide allows riparian systems to withstand a variety of environmental conditions.

Figure 5-6. A wide, entrenched channel system that has incised 5 to 15 feet into silty clay deposits. (A) shows the area before it was excluded from grazing; (B) shows the same area 16 years later. Note the expanded riparian area as the water table influences vegetation composition across the entire bottom. Perennial stream flow does not occur during relatively dry summers either upstream or downstream of the enclosure. Within the recovered section, however, the stream now flows continuously even during dry summers.

We have presented several issues and concerns that can significantly affect the approach to managing riparian areas. Private landowners and lessees and managers of public lands need to consider the effects of current management activities on riparian areas. All riparian areas cannot be improved immediately to improve the functioning of riparian systems to arrive at productive and self-perpetuating riparian areas.

A word of caution is appropriate. As we focus on restoring and enhancing riparian areas’ unique attributes, we must not forget the need to manage upland areas properly. They occupy up to 99 percent of eastern Oregon’s rangeland watersheds and are an essential component of any land-management program. They also influence profoundly the ultimate character of the downslope riparian areas.

Finally, we need to identify where and why riparian areas are poor as a result of the actions described above. This will provide us with a clearer understanding of why riparian areas are poor and how to improve them. This will require that we provide some kind of management plan for each riparian area.

In the view at the crossroads, we have presented several issues and concerns that can significantly affect the approach to managing riparian areas. Private landowners and lessees and managers of public lands need to consider the effects of current management activities on riparian areas. All riparian areas cannot be improved immediately to improve the functioning of riparian systems to arrive at productive and self-perpetuating riparian areas.

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Figure 5-7. Vegetation and channel conditions (A) before and (B) after 8 years of exclusion from grazing. Water now flows throughout the summer in a formerly ephemeral channel. The channel bed in (B) is gravel but previously was primarily fine sediments (sils and clays). These fine sediments now are being deposited at high flow—for example, on the left bank. The stream no longer is actively eroding the steep cutbank in the background, along the right side of the stream.

Chapter 5. Managing riparian areas
We are at an important crossroads in the management of riparian areas. Members of the livestock industry can provide leadership in understanding and solving complex riparian questions. Their support is critically needed for studies that will have long-term payoffs.

More important, they need to support changes in grazing strategies and other uses in managed riparian areas. A fresh start at establishing dialogue among ranchers, land managers, biologists, hydrologists, environmental groups, and the general public is mandatory.

If confrontation politics continue, grazing riparian areas on public lands may be eliminated, and we may lose the option of managing riparian systems for livestock production.

The American public is becoming increasingly involved in both public and private land-use issues, even though most people live in urban areas well away from rangelands. If the riparian management issue were placed on a national ballot today, is there any doubt which way the vote would go? The timing is ripe for ranchers and other land managers who operate on private or public lands (riparian vegetation does not know the difference) to initiate management strategies that will allow our stream and riparian systems to approach their productive potential.

Riparian response to certain grazing management practices

The concepts of forage production for livestock consumption, wildlife habitat, stream bank erosion, fisheries, and water quality all seem to hinge on the critical riparian zones of wild-land watersheds. Many user groups have vested interest in these areas, and the emotional fervor with which they defend their concerns can be awesome.

We will attempt to evaluate several scientific investigations and to give numerical values to the riparian system's response to certain livestock grazing management practices.

Importance of riparian zones

Riparian issues have become a focal point in natural resource planning. It is now fairly common to recognize riparian zones as the focal point of watershed wildlife, recreation, and livestock production concerns.

Satterland emphasized land uses and their impact on quantity, quality, and timing of streamflows, all of which relate directly to riparian areas.

Thomas pointed out the importance of riparian zones to wildlife by stating, "Of the 378 terrestrial species known to occur in the Blue Mountains, 285 are either directly dependent on riparian zones or utilize them more than other habitats."

He further pointed out that stream margins are disproportionately important for forest and range uses. These margins frequently contain the most highly productive timber and forage sites.

Roath found that cattle use in a forested grazing allotment in eastern Oregon was disproportionately heavy in the riparian zone. Only 1.9 percent of the land area was classified as riparian, but it accounted for 81 percent of the herbaceous vegetation removed by livestock.

Wildland recreation also closely correlates to water; riparian zones often contain great scenic value and favorite sites for camping, fishing, and hiking, etc.

Degradation caused by abusive practices

Meehan and Platts put numbers to the known relationships between livestock grazing and water quality, quantity, and fish habitat. Citing some 60 papers, they demonstrated an obviously damaging relationship between the condition of the riparian system and abusive grazing. It is clearly shown that overgrazing has caused significant negative changes.

However, the following questions must be considered:

- What constitutes overgrazing on any given system?
- To what degree do climate and geologic events operate independently of grazing?
- What positive effects might we expect from initiating grazing systems, changing the season of grazing, and managing animal behavior?

These questions must be considered, and appropriate management plans must be prescribed on a site-specific basis.

Season of use

One of the landmark riparian zones that we often hear about in the Pacific Northwest is Camp Creek, located in northeast Oregon's Blue Mountains. A riparian restoration effort on Camp Creek involved fencing a stream corridor and periodically observing the resulting changes.

Claire and Storch noted that when Camp Creek was fenced in 1964, the streamside had no shrub canopy; exposed stream banks were common. By 1974, the condition of the stream outside the fenced area was unchanged, but alder and willow communities proliferated on the inside.

They also noted that maximum water temperatures outside and downstream from the fenced area averaged 12°F higher than samples taken within the fenced area. They found that daily water-temperature fluctuations averaged 27°F outside compared to 13°F inside the fenced area. The entire riparian area aggraded, which raised the water table and provided subsurface flows into the stream throughout the year. Also, the channel was narrower and deeper, which provided less exposure to atmospheric warming influences and more contact with cool soil.

Game fish made up 77 percent of the population within the fenced area but only 24 percent of the population outside. In 1968, Camp Creek was opened to livestock grazing again. The fenced area now serves as a special-use pasture, providing late-season (after August 1) livestock grazing that is carefully monitored.

Ten years after grazing was reintroduced, the authors could not identify any measurable change in fish population that had resulted from this type of livestock use.
These observations—though not reported elsewhere and not as complete as we would like—suggest that riparian zones have a remarkable ability for rapid recovery. Once in good condition, they are capable of supporting managed livestock grazing. In this case, late-season use was the prescription. However, this was a site-specific prescription. In other locations, other seasons of use have been more appropriate.

Grazing systems

Hayes studied three meadows and their associated streams in the Idaho batholith. One meadow was ungrazed, and two others were grazed under a rest-rotation management system. He reported that rest-rotation grazing in the meadows did not significantly alter channel movement.

He found that during spring discharge, degradation was significantly greater along ungrazed stream banks than along grazed stream banks.

Hayes suggested that ungrazed or unburned meadows may in fact suffer from a lack of vegetative vigor and thus be susceptible to undercutting. He noted, however, that some degradation, attributable to livestock during the grazing season, was present in the grazing meadows.

Johnson reported that season-long grazing in mountainous areas increased the use of the meadows, especially in the riparian zones, into the latter part of the season. Hayes speculated that because the probability of bank degradation increases as livestock concentrations intensify along stream banks (especially late in the growing season when vegetation is reaching maturity), a rest-rotation livestock system would avoid such concentrations at critical times.

Buckhouse, Skovlin, and Knight investigated a number of livestock grazing practices on Meadow Creek in the Blue Mountains of Oregon and discovered that the relative stability of that system hadn't statistically changed after 2 years of systems grazing at a level of 3.2 hectares per AUM.

Bohn and Buckhouse followed up the Buckhouse, Skovlin, and Knight study using the same plots, after the grazing systems had been in place for 8 years. Among the grazed treatments, the amount of bank retreat (erosion) tended to be numerically greater as the number of animals per length of stream increased. Season-long grazing proved to be the most destructive.

In a separate analysis, Bohn and Buckhouse studied infiltration rates, sediment production, penetrability (using a penetrometer), and bulk density on the same Meadow Creek sites. They found, first, that rest-rotation favored the hydrologic parameters they measured and, second, that deferred rotation and season-long grazing did little to enhance—and sometimes hindered—hydrologic response.

Grazing prescriptions must be made on a site-specific basis. Plant community response to grazing and soil response to livestock impact will be the primary determinants.

Streamside vegetation

Roath noted that the riparian zone accounted for a disproportionate amount of forage production and consumption, yet he reported the stream banks to be stable in his study location near John Day, OR.

He noted that Kentucky bluegrass (Poa pratensis) was the dominant grass in that riparian zone, and he speculated that it exerted major control over the relative stability of the associated vegetation communities.

He concluded that since Kentucky bluegrass has been demonstrated to be highly tolerant of defoliation, grazing at an intensity that would reduce and maintain the grass at a stubble height of about 1 inch had small impact on vigor and cover.

In addition, Roath noted that those riparian zones that were deferred until late August showed a much lower livestock use on the herbaceous component. He speculated that this was caused by a combination of low palatability relative to that found on shady slopes and cold-air accumulation areas of the meadows.

He suggested, therefore, that herbaceous components in the riparian zone could be manipulated by changing seasons of use in order to match relative succulence and palatabilities of the hillsides and riparian vegetation.

In 1994, Rasmussen resurveyed 17 miles of the approximately 400 miles of stream that originally had been surveyed in the late 1970s and early 1980s. Results were negative of changes in grazing management from season-long to a season of use appropriate for the site. Improvements were dramatic on low-gradient streams. Riparian area increased as much as threefold. Vegetation cover increased substantially. Riparian vegetation shifted from herbaceous communities dominated by upland species such as Kentucky bluegrass to communities dominated by riparian species such as sedges and rushes with willows where site conditions permitted. Bank stability was substantially improved because of the increase in sedges and rushes.

In Nevada, Manning et al. demonstrated that sedgedominated communities had 10 and 5 times, respectively, greater root length per unit of soil than did upland-grass-dominated communities. The greater root-length density provides greater soil-holding capability. These results suggest that a change from an inappropriate to an appropriate season of use can result in a positive change in riparian vegetation and an improvement in riparian condition.

Animal behavior

In a separate analysis, Roath also investigated cattle behavior patterns. He found that livestock, much like big game, have a distinct home range. Of the animals he studied, one group had a home range that encompassed only upland areas.

While additional work is necessary to more fully quantify the social structure and learning processes associated with choosing these home ranges, it is interesting to
consider the ramifications. For example, would it be possible—through breeding, training, and/or herd culling—to establish a group of animals that actually preferred and selected upland rather than riparian sites while foraging?

Conclusions

We can draw several conclusions from these studies.

1. It is clear that riparian zones are important focal points for most of the products and uses associated with many natural ecosystems.

2. It has been shown that abusive land-use practices can degrade these areas. Abusive practices that cause such degradation could be improper forestry practices, grazing, road construction, or farming.

3. The inherent capacity of degraded riparian zones to recover is remarkable. It is likely a function of the richness of nutrient and soil resources or the relatively higher moisture that is available in this zone.

4. It appears that by using tools available to range managers—such as controlling grazing intensity and season of use—livestock grazing can be compatible with the other uses and values of these unique and important areas.

The value of healthy riparian areas

The transition areas between the aquatic ecosystem and the nearby, upland terrestrial ecosystem are called riparian areas. They are identified by soil characteristics or plant communities that indicate free or unbound water, and they include the wet areas in and near streams, ponds, lakes, springs, and other surface waters.

Water means life in the desert.

In Nevada, riparian areas produce more vegetation per acre than any other part of the range. They are the proverbial oases in the desert that attract humans, livestock, and wildlife.

Riparian vegetation stands out from the surrounding desert landscape. It has scenic qualities that make people want to relax and spend some time. Recreation sites feature spartan areas for camping, picnicking, or sightseeing. Many of these recreation sites include water-related activities such as fishing, boating, and swimming. Riparian vegetation provides shade, seclusion, beautiful wildflowers, and relief from the apparent monotony of arid landscapes.

At some time of the year riparian vegetation provides feed for most of Nevada's livestock. Many ranches would be out of business without the abundant, nutritious forage provided by hay lands, meadows, or the diverse array of shrubby, riparian plant communities. Riparian vegetation is not only the most productive, it also stays green much longer in the year than upland vegetation. Therefore, it can promote increased weight gains in livestock when used at the right season.

Cattle Cattle use riparian areas for more than just forage. The water in riparian areas often sustains livestock while they forage upland ranges that humans could not harvest in any way other than by livestock grazing. Because riparian areas have water, shade, and forage on fairly level land, they frequently focus livestock activity on a small percentage of the pasture. Riparian areas usually are less than 1 percent of any large, Great Basin range pasture. Most large riparian areas, such as wide hay meadows, are privately owned and intensively managed.

Wildlife Wildland use riparian areas more than any other single habitat. Big game usually go to riparian areas for water and to browse or graze on riparian plants. These plants also may provide cover to hide from predators or the sun. Small mammals, reptiles, and amphibians abound in the thick undergrowth near water. They provide prey for raptors (hawks and owls), coyotes, foxes, and other predators. Many raptors and other birds use riparian vegetation for nesting or feeding. More than half the vegetation living on rangeland need riparian areas or use them for some critical period of their lives.

Water Water in riparian areas is used downstream as well as on-site. Water is a scarce resource in the desert and can be the limiting factor controlling such things as livestock herd size, wildlife population, hayfield acreage, or the size of cities. Water also provides habitat for trout and other fish.

Often, the amount of water may not be as important as its quality or the time it is available. Floods from snow melt or thunderstorms—too much water coming too fast—may even cause damage. Riparian vegetation plays many roles in determining the quantity, quality, and timing of water.

Vegetation Vegetation improves water quality by filtering out sediments and nutrients from flood flows. When plants reduce water velocity, sediments drop out of suspension. Vegetation improves the quality of water that stays within the riparian plant community. These plants also may provide cover for wildlife species, including birds and mammals. Riparian vegetation provides shade, seclusion, beautiful wildflowers, and relief from the apparent monotony of arid landscapes.

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Streams that meander through a wide flood plain are often deep and narrow. They provide the best trout habitat. Vegetation is why these streams have banks strong enough to remain stable. If something happens to weaken riparian vegetation, the stream may widen and become shallower.

A shallow, wide stream does not provide fish habitat as good as the deep, narrow stream it replaced. Shallow streams catch more sunlight and warm up. Warm water does not hold as much dissolved oxygen, which may eliminate trout. Wide, shallow streams also provide less hiding cover. The fish that do survive do not live long enough to grow very big. Riparian vegetation often improves fish habitat directly by shading the stream and by providing cover.

**Stream erosion**

A stream may cut through its meanders when stream bank vegetation is stressed and no longer can prevent bank erosion. This shortens the length of the stream and increases the velocity of the water.

If too many meanders are cut, the faster moving water with more power to erode its channel likely will begin to cut deep into the flood plain of sediment that has been building over time. Soon the water is deeply confined in a straight channel and cannot reach the old flood plain even during floods.

Channelized streams like this frequently carry tremendous sediment loads as they erode away the banks on their new, unprotected channels. On the old flood plain, riparian vegetation which depended on a high water table soon dies out. This also can happen when a head cut works its way up through a meadow, forming a gully.

**Gully erosion**

Gully erosion or downcutting of streams is a serious problem for riparian areas because water is the ultimate source of the areas' high values.

With water, riparian areas are the last resilient of all range ecosystems. When they are stressed, their species composition changes. Sometimes even the weeds die out, leaving bare soil; but with protection from stress, the plants recover. With abundant water the needs of riparian plants are easily met, and plant succession usually is rapid. Without water, riparian areas cease to exist. Even if water remains available but amounts are reduced, the species of plants may change radically. If a gully begins to cut into a meadow, large and small rocks can be used effectively to armor the head cut. This prevents it from cutting upstream by allowing the water flowing over the rock to dissipate energy. Existing gullies can be stabilized with small check dams of loose rock.

**Hydrology**

Any stream achieves a balance through time. The balance depends on many factors, including width, depth, gradient, sinuosity, confinement, particle size of channel materials, sediment load, and sediment size.
the stream erodes deeply into its bed, leaving the riparian flood plain high and dry.

Old meadows that now produce little vegetation but sagebrush and weeds can be found throughout Nevada. They are part of the cost people now pay for our predecessors' ignorance of how to conserve range. Now that problems have been identified, solutions must be found.

Management

Proper management pays dividends more quickly on riparian areas than on any other part of the range. The combination of high payoff and high return to management input has made riparian areas the focus of much action and some controversy in recent years.

William Platts, a fisheries biologist widely acknowledged for having discovered many of the problems common to cattle grazing in pastures with riparian zones, makes four noteworthy points in response to the question "Can we graze riparian areas?"

First, he says, yes we can graze riparian areas.

Second, we ought to be able to increase the AUMs of forage harvested in riparian areas without damaging fish and wildlife habitat.

Third, we do not yet know how to do this in all areas because riparian areas and their management situations are so diverse.

Finally, according to Platts, if we do not set our management act together, the public will not let us graze riparian areas because of the high resource value and the potential for damage from improper grazing.17

The challenge for range managers is to use the high potential for returns with proper riparian management to increase livestock forage and in the process increase values for other users as well.

Diversity The tremendous diversity of riparian areas means that no one treatment or system of treatments will work everywhere. Some riparian areas respond best to proper management of the surrounding allotment or pastures others must be managed as separate units.

Different riparian zones have different potentials. Some will produce trees, shrubs, or nesting habitat for wildlife, including raptors (predatory birds), and others will produce lush meadow vegetation as their best crop.

Most riparian areas support diverse vegetation types, each of which may encompass only a small area. Some streams can support productive fisheries; others cannot.

The role of ranchers Ranchers must be involved with other riparian managers to develop the best plan. Nobody knows the allotment, cattle, and management alternatives better than an experienced rancher. In some respects riparian management is not a large problem; it just takes someone out there looking for problems and solving them. In that way it is no different from any other grazing management situation. The point is, fencing cattle out of riparian areas is not the only solution to riparian grazing problems.

There are many tricks to grazing management that help keep cattle distributed in a pasture. Any rancher or range conservationist has some that work for his or her cattle or country.

Pushing cows into new territory and getting them situated is a continual chore. Grazing managers have known for a long time that in wide open country with big pastures typical of the western range there is no alternative to riding. If a rancher is not out there riding, he or she won't see the problems developing soon enough to prevent them. The problems that ranchers did not prevent are the ones that have many concerned citizens talking about national legislation today.

Fences Perhaps the worst-case scenario from national legislation requiring "projects" and "action plans" is that well-meaning people will interpret these words to mean "build exclosures."

Riparian exclosures have been a menace to many ranchers. They mean range unused, problems in animal movement, and animal maintenance hassles in the floodplain. On the other hand, exclosures can take the pressure off a trout stream, spring, or bog so that appropriate use can be made of the rest of the pasture. The job of ranchers and other range managers is to solve riparian problems before the exclosures are built and to prove via monitoring that their solutions are effective.

Riparian pasture

A riparian pasture is an alternative to a riparian exclosure. What are the differences?

An exclosure is narrow and is not designed for any grazing use. A pasture is large enough to be grazed efficiently. An exclosure fence is near the stream and often needs repair after spring flooding and the fishing season. A pasture fence is on or near the side hill; it may be harder to build but needs less repair. The area fenced may differ by tenfold yet the amount of fence materials needed may be nearly the same.

A riparian exclosure may increase cattle management difficulties, but a riparian pasture increases grazing management options. However, a riparian pasture concentrates livestock use, and a few days can make a great difference in level of utilization. Riparian pasture management must be closely watched and may be labor intensive.

Grazing systems

Some range management plans call for division fences that cross a stream. In steep country, putting the fence in at a low angle sometimes helps to coax cattle gradually up hills. If cross-fences are in, or in some country even if they are not, there's the option of using different grazing systems such as deferred rotation, rest-rotation, short duration, or time control. Each works in some country. None of them works everywhere.
Season of use

Another management tool is the season of use. In some areas, turning cows out earlier helps because the cows graze hillsides while they're still green.

One grazing plan may call for grazing earlier in the spring when cheatgrass is green, not only solving a riparian problem but a fire hazard problem as well.

Later grazing works better in some areas because stream banks have dried and firmed up so trampling doesn't damage fish habitat. It may be important to graze in the summer when grass is still green and palatable if willows or aspen suffer from fall grazing.

In addition, careful planning of seasonal grazing in riparian pastures can be used to increase the green-feed period and increase calf weights. In some low-elevation areas, winter grazing is an alternative to hay costs and results in less stream-bank damage.

Kind or class of livestock

Well-herded sheep cause little or no problem in riparian areas. Yearling cattle may be much more willing and able to forage widely and to get out of the bottoms than cows with calves. The same can be said of certain breeds. Even within breeds, and within a herd, some cattle are bottom crawlers and others are ridge climbers. If allowable use is measured in riparian areas, then bottom crawlers set stocking rate below what ridge climbers can safely graze.

Range improvements

Range improvements can alter livestock distribution. Cattle will go up country much more quickly if they know there is something up there worth going after. The chance to graze on cheatgrass before flowering will pull livestock to the dry sites, but the trick is keeping them there when forage preference switches.

Burned areas long have been known to attract grazing as have fertilized range and seedings, at certain times of the year and if they don't get too dry. If the seedings are grass, then the season of use is early and short at most elevations. If the seedings are some deep-rooted forbs such as a falfa or shrubs such as four-wing saltbrush, they may be diverted into mid to late summer.

If, of course, any forage will be of little value without water and salt-licks. A lot of bad grazing habits start when cows come to the stream looking for a drink or a salt lick.

Coordinated resource management and planning (CRMP)

Coordinated resource management and planning (CRMP) is an ideal approach for solving riparian problems. It uses the expertise of many professionals and locally involved citizens to develop a site-specific appraisal of problems and to develop solutions.

The more others think they are helping to solve a problem, the more they will want to find evidence of the improvement. But more important, a coordinated resource management and planning approach ensures that everything decided on is practical. It has to be practical if it is CRMP because if it isn't practical, everyone will not agree; and if everyone does not agree, it is not CRMP. No participant has perfect knowledge, but all can share the knowledge they do have and help develop a reasonable approach.

Monitoring

Any plan should be monitored to see it is implemented as planned and to see whether it works. Monitoring means observing what happens and keeping records of actual use, growing conditions, and events such as floods and beaver dams that change things. Monitoring involves riding the allotment with one or more key members of the planning team and looking for problems, such as damage to the resource and underuse or nonuse of forage. Also, monitoring includes taking pictures, especially of areas where improvement is targeted.

Recuperation

Riparian areas are called fragile by many. Anyone who has looked has seen areas that look mistreated, but if the water table remains where it should be, riparian vegetation is the most resilient on the range.

Many range and ranch managers probably are a little miffed by it all the hubbub because they've seen their riparian areas improve over the years. But, do they have pictures to prove it? By all means pictures should be taken showing the problems that are being solved so the next generation can learn from current experience, apply more refined management, and talk convincingly to concerned citizens and agency biologists.

Riparian pastures

Range managers have increased their attention to riparian values in recent years. Areas once considered sacrifice areas now are considered critical for grazing management. This causes a problem in many pastures because cattle tend to concentrate in or near riparian areas. To obtain proper use in riparian areas, much upland forage no longer may be grazed.

Management practices can accomplish practical livestock production and proper management of upland and riparian areas. These include implementing grazing systems, developing hillside water, improving nonriparian vegetation, fencing, salting, excluding riparian grazing, and building riparian pastures. Each practice is most appropriate with certain conditions.

Optimum settings for riparian pastures

Putting in riparian pastures is most efficient if existing pastures are large and cannot be managed for both upland and riparian objectives. These pastures generally include substantial amounts of upland and riparian forage.

Chapter 5. Managing riparian areas
Commonly, upland forage is not grazed until after heavy use in riparian areas, and rotation grazing or range improvements will not resolve livestock distribution problems.

**Concentration of cattle in riparian areas** Cattle tend to concentrate in riparian areas if:
- Water is not well distributed
- The land near riparian water is steep or rocky, especially if all the water is riparian
- Salt is placed in or near riparian areas
- The weather is hot, and riparian shade is available
- Nonriparian forage is less palatable than riparian forage
- The herd is composed of cows with calves as opposed to yearlings
- Individual animals develop behavior patterns that favor riparian areas
- Animal distribution is not maintained by herding, and/or
- The grazing season is long

**Seasonal differences**

The effects of livestock grazing vary by season. In spring, upland forage is palatable and water more available throughout large pastures. This reduces riparian use. Although using riparian areas in spring can cause physical damage to stream banks and meadows. Soil compaction can be an important problem in moist (but not saturated) clayey soils.

Generally, cattle use riparian areas increasingly as the summer progresses. Use peaks during periods of prolonged drought or intense heat. In late summer, forage preference switches to include more shrubs. This is the time associated with most willow, aspen, or cottonwood grazing. When fall rains moisten dry forage, a cold front in spring is critical, or cold weather creates frost pockets in riparian areas. Cattle again disperse.

**Fence construction**

Riparian pastures are designed to be grazed although some need a few years of recovery first. Riparian pastures generally are much larger than exclosures. Normally their fence is built far enough away from the stream and riparian vegetation that the pasture includes upland. In fact, if there is not enough upland range included in the pasture, the upland may be overgrazed.

The cost and amount of fence required for riparian pastures may not greatly exceed that needed for riparian exclosures. Side fence lengths actually can be shorter because the fence can be straighter. A riparian enclosure fence might need to be stronger and need more maintenance because it is within or close to the riparian area.

The top wire on both riparian pastures and riparian exclosures should be smooth, not barbed, because riparian areas provide big-game habitat and water for surrounding upland, big-game habitat. Riparian areas in antelope habitat also should have a smooth bottom wire that is no less than 16 inches off the ground. Deer generally go over fences, but antelope go under.

**Riparian objectives**

Defining good reachable objectives for riparian values is perhaps the most technical and important part of riparian management. When setting riparian objectives, the manager should either:
- Use stream and riparian classification methods to identify similar riparian settings and then compare areas grazed differently, or
- Identify current problems that obviously are caused by livestock and then seek to eliminate at least some of the direct impact.

On streams that already have cut down to base level or have well-armored beds, manage for the recovery of riparian vegetation so that steep or overhanging stream banks can form and endure. These provide deep, cool pools, shade, and shelter for fish. Slow, shallow streams may become so warm that cold-water fish, such as trout, cannot survive.

Streams that are not well armored with rocks may depend on riparian vegetation to stabilize stream meanders. On these streams the most important objective is preventing the stream from straightening and then downcutting, causing a gully.

**Managing pastures for riparian objectives**

How to manage riparian pastures depends largely on vegetation needed to stabilize the stream bank or provide other riparian values.

Steep streams typically need willows or trees with strong root systems. Flat streams can maintain stable banks with strongly rooted grasses, rushes, or sedges. Streams controlled by large cobbles and boulders don’t need vegetation for bank stability.

The vegetation may be important, however, for forage, cover, or beauty. Some streams are naturally unstable. Their confinement and high gradient generate tremendous energy during high water, and vegetation has little or no effect on stream form.

**Shrub-lined streams** Streams that depend on shrubs or trees can be severely impacted by heavy late summer, fall, or winter grazing or by frequent sheep grazing. They should be grazed in a rotation of spring and early summer use. A rest-rotation or deferred rotation system that includes prolonged or intense periods of late-season use should be avoided. Two years of rest, or grazing during a noncritical season, cannot make up for a grazing impact that removes 3 years of growth on woody species.

**Grass-, sedge-, and rush-lined streams** The effects of improper grazing may show up more quickly and be difficult to reverse along streams that depend on grasses,
sedges, and rushes. On these streams, rotation grazing that includes late-season use sometimes works well. Early-season grazing works well if overall livestock distribution favors nonriparian areas and if sediment can be trapped in last year’s regrowth and stabilized by new growth.

**Recovering gullies** Sediment can build stream banks and raise the bottoms of old, wide gullies. Some gullies fill and widen sufficiently to allow the stream to meander across a broad floodplain. This greatly reduces the force of flood water and allows it to soak into the soil.

Stable banks along low-gradient, meandering streams form deep, narrow channels that can provide good fish habitat while the floodplain provides water storage and flood control.

**Midsummer use**

Midsummer use for a short time, rotated between years, offers several advantages. By midsummer:

- Stream banks generally are firm.
- There still is sufficient soil moisture and warmth for riparian vegetation to regrow before winter.
- Sediments in spring flood waters have been trapped by last year’s standing dead regrowth.
- Herbaceous species still may be green, and forage preference has not yet shifted to woody species.
- Livestock can most benefit from green feed after upland range has matured.

A short season minimizes grazing of regrowth and achieves, but does not exceed, proper use levels. Use of this time can be heavy if the season is very short and there is moisture available for regrowth. Use can be prolonged if moisture available for regrowth. Use can be prolonged if

**Location and size**

Ideally, riparian pastures should be located and designed to fit the livestock production operation. The could be used for bulling, weaning, pregnancy checking, shipping, gathering, or grazing pastures. Labor can be saved by locating them where cattle automatically will use them in the normal sequence of rotation. Topography and cattle numbers have a great influence on size and location. Several settings, series of riparian pastures can be set up for sequential or rotation grazing. Riparian pasture fences also may divide large pastures, allowing the implementation of a large-scale rotation grazing system.

**Riparian grazing management: An alternative to range readiness**

The concept of range readiness has been an important tool for improving upland ranges in the Mountain West. Uncontrolled grazing during the late 1800s and early 1900s caused deterioration of many of these ranges. By simply using the concept of range readiness to defer cattle grazing during early stages of plant growth, range managers have been able to improve many deteriorated sites. Unfortunately, overuse of the range readiness idea for upland sites has led to overgrazing in some riparian areas.

Range readiness is defined as the stage of plant growth at which grazing may begin under a specific management plan without permanent damage to vegetation or soil. Range readiness is a tool that range managers use to learn when safe grazing may begin. Two factors may define a condition of range readiness: soil moisture and plant growth.

Soil high in clay or organic matter may compact more easily if grazed when soil moisture is high. Soil compaction can damage plant and watershed health. Compaction may restrict root growth and seedling emergence, and decrease water infiltration and soil permeability. Thus it can reduce range productivity and increase runoff and soil erosion. If soil is sandy or relatively light in texture and has organic matter, soil moisture and soil compaction are less of a factor.

In addition to soil moisture, a plant’s stage of growth or condition at the time of grazing also affect how healthy the plant will be after grazing. Maintaining healthy forage plants, many range sites can be kept in good condition or improved.

**Safe grazing times**

Because range plants perform different functions at different times of the year, grazing affects plants differently depending on the season of use. The amount of plant foliage remaining, the length of time for regrowth, and the growing conditions before the plant is regrazed also make a big difference.

Deferring grazing until range readiness helps to keep pasture from getting ahead of grass growth. Deferring use allows the grass to make substantial growth before grazing. This is common where pastures are grazed all season or spring-long. If this pattern of grazing continues year after year, desirable grazed plants will die unless utilization levels are very light and grazing is well distributed in the pasture.

Defferring grazing until range readiness helps to keep grazing from getting ahead of grass growth. Deferring use allows the grass to make substantial growth before grazing. Then most individual plants withstand only low or moderate use before and during the critical boot stage. In some pastures, range readiness is when stems are 4 to 5 inches tall.

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19 The concept of range readiness has been an important tool for improving upland ranges in the Mountain West.
By overcoming the most detrimental effects of repeated season-long grazing, vast acreages of upland range have improved. However, delaying cattle grazing until range readiness encourages overuse of riparian areas.

**Seasonal use patterns**

Cattle use different parts of most large pastures and different plants at different times of the year. They tend to seek out plants that are most palatable and nutritious, and they go to places where life is easy.

When plants are just beginning to green up in the cool spring weather, cattle prefer warm, south-facing slopes. As the growing season progresses, many areas of the uplands provide an ideal combination of palatable forage, access to water, and comfortable resting spots.

Riparian areas at this time may be too boggy and cool. Also, in many places riparian forage is slower to grow and less palatable in the spring than upland forage. It may be too "washy" (turgid with water) for the grazer to consume enough nutrients.

As upland forage matures, its total digestible nutrients decrease. Toward the end of the rapid-growth season, the nutritional quality and palatability decline rapidly. This accelerates as soil moisture dries up.

Shallow-rooted annuals complete their life cycle and dry up sooner than the more deeply rooted perennials. But the pattern is the same anywhere summers are dry. Many water sources also dry up as the season progresses.

When upland forage becomes less palatable than riparian vegetation, cattle naturally prefer the still-green streamsides or meadows. This is especially true if these areas have the only tree canopy for shade from the hot summer sun and provide the main source of remaining water. Cattle may be less attracted to the riparian area if biting insects abound. If ephemeral streams or ponds provide the livestock water in a large pasture, the grazed part of the pasture further decreases as waters dry up.

The later in the summer cattle graze a pasture, the more they tend to graze in or near the riparian areas. Therefore, it is important to carefully state objectives and to make sure that management suits each of the many pastures a herd of cattle grases over the course of a year or a rotation grazing cycle.

**Grazing systems**

Grazing systems have been created to counter the negative effects of grazing for long seasons or at the same time of year everywhere.

Most grazing systems use measures to avoid overuse during the season of greatest grazing damage, from the boot stage through seed ripening. Rest-rotation, short duration, rotation of deferment, time controlled, high-intensity low-frequency, and seasonal are examples of grazing systems. Many rotation grazing schemes can be adapted to provide flexibility needed to manage riparian and other range pastures.

**Planning for grazing management**

It no longer seems appropriate to sacrifice riparian values in order to easily harvest upland forage. However, in altering current practices to meet new management objectives, it would be folly to create new problems or to miss opportunities to coordinate resource management. Riparian areas reflect management of the whole watershed. Optimum management must encompass the entire ranch enterprise and landscape ecology.

Many interested parties should participate in setting management objectives. These should pertain to the whole unit including private lands and public land that is grazed as part of one ranch operation. Fish, wildlife, and livestock never know whether their habitat is private or public.

**Upland considerations**

When planning cattle moves, timing the removal of livestock from one pasture may be more important than the timing of stocking another pasture. In spring, upland pastures can recover from grazing quite well when soil moisture remains or regrows near the dates for moves by considering the local climate, and adjust as weather and plant development mandates.

Many pastures that have been deferred in spring until range readiness could be grazed earlier. If that would extend the grazing period and lead to excessive regrazing, a rotation system could be worked out that allows for recovery in other years. In many pastures, however, this will just change the use pattern and allow more safe use without riparian damage. Utilization pattern mapping can quickly address this question.

**Riparian considerations**

If grazing one pasture earlier means grazing another later, and if this would further shift the use to riparian areas, perhaps creating a riparian pasture is warranted. A riparian pasture is small enough to be managed solely for the purpose of meeting riparian objectives. Prescribed grazing in the middle of the summer may be quite acceptable in a riparian pasture. The added control provides for safe utilization, a short season of use, and plant recovery with adequate soil moisture. If a riparian pasture is infeasible, an exclusion fence may be cheaper.

Other ways to avoid or compensate for periodic excessive grazing caused by uneven distribution include rotation of grazing or periodic rest. Streams that depend on herbaceous vegetation to maintain channel morphology may respond better to these alternatives than ones requiring woody species such as willows. Woody species can be grazed back into the previous year's growth, a loss that may exceed recovery during other phases of the rotation.

Herding cattle into new areas of fresh forage helps avoid distribution problems in some pastures. Herding tends to work better in pastures with many waters and many pockets of palatable forage.
Winter grazing is an alternative in some low-elevation pastures. Cattle then may use willows more for shelter than forage. Winter grazing also may be an attractive alternative to feeding expensive hay.

Paying the bills

The incentive to increase the level of management may come from the desire to create win-win solutions on land managed for multiple use. Riparian areas that receive only an acceptable level and timing of livestock use may provide better habitat for fish and wildlife, better water quality and timing of flow, fewer or less severe downstream floods, and a visual resource that is prized by recreationists.

The rancher also may benefit from added weight gains or an increased stocking rate. Cattle kept on the uplands while they are green and then allowed to graze a riparian pasture are on green feed for an extended period. Added livestock carrying capacity also comes from more fully utilizing upland forage that had previously been ungrazed because of poor distribution.

However, improved riparian areas need more intensive management. That in turn increases costs, generally in both labor and range improvements, which may be offset only partially by increased production. The challenge is to create solutions that are efficient, coordinated, and fair.

For further reading


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Forests and watershed management in eastern Oregon

Stephen A. Fitzgerald

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Forests of central and eastern Oregon, which occupy the middle and upper elevations of most watersheds, are important for storing moisture, mostly in the form of snowpack. Moisture stored in upland forested areas is released later in the season as the snowpack melts, usually long after lower elevations have released much of their available moisture.

Therefore, forests in the upper elevations are extremely important for sustaining stream flows late in the summer season—for irrigating pastures and crops, for domestic water consumption, and for wildlife.

The activities of forest managers and woodland owners can have a great effect on water quality and quantity. This chapter discusses how forests influence the hydrologic cycle within watersheds and how to manage forested areas to maintain water quality and quantity.

Climate and soils

Forests are typed according to soil type and climate zones. The climate of central and eastern Oregon is continental, with warm, dry summers and cool, moist winters. Eighty percent of the rainfall is from late fall through early spring. Air masses originating over the Pacific Ocean move east over Oregon, bringing with them abundant moisture.

The Cascades greatly affect rainfall patterns in eastern Oregon. Moisture levels at the crest of the Cascades are 60 to 100 inches, much of it stored in deep snowpack. East of the Cascades lies a rain shadow, where moisture levels fall to 7 to 8 inches within 20 miles of the crest. Farther east, air masses again rise over higher elevations of the Blue Mountains, dropping additional moisture.
Temperature extremes and moisture levels greatly affect the types and distribution of vegetation. Forest vegetation occupies the middle and upper elevations where temperature and moisture are more favorable for their growth; various dryland range species such as grasses, sagebrush, and juniper occupy the warmer and drier low elevations.

Soils of eastern Oregon are highly variable. In central and eastern Oregon, soils are greatly influenced by past volcanic activity from the Cascades. Soils directly east of the Cascade crest are primarily pumice, originating from volcanic eruptions of Mt. Mazama (Crater Lake) and Newberry Crater, about 6,800 and 2,000 years ago, respectively. Many small eruptions came from these volcanic mountains and from numerous cinder cones that dot the landscape.

Thus, soils in this region often are layered, and each pumice layer corresponds to a volcanic event. Pumice soils are extremely porous and have high infiltration rates and low water-holding capacity. Trees and other deep-rooted vegetation often tap moisture and nutrients in buried soil horizons.

To the northeast, in the Blue Mountains, soils also are influenced by volcanic deposits and subsequent erosion. Much of the soil in this region contains some volcanic ash and fine pumice. Soils associated with the thicker deposits of ash have high moisture-holding capacity and support some of the more productive forest land in eastern Oregon.

Forest types

Eastern Oregon has three general forest types: ponderosa pine, mixed conifer, and subalpine (Figure 6-1).

Low elevations in eastern Oregon are mostly grass and rangeland areas. Western juniper is common in this zone. Moisture accumulation (rain and snow) varies from about 5 to 12 inches and is stored in the thin soil mantle.

These areas are important for livestock grazing and for wildlife. Juniper "forests" have little commercial value and are considered undesirable because their relatively high demand for water can lower grass production, range carrying capacity, and watershed condition on many sites.
Ponderosa pine forest

As moisture increases, sagebrush and juniper give way to the ponderosa pine forest type. Here, total annual precipitation (rain and snow) is 12 to 18 inches. These drier ponderosa pine forests represent the lower limit of the commercial timberline in eastern Oregon.

Sagebrush and juniper are common understory components in the transition zone between western juniper and ponderosa pine vegetation types. Suppression of natural ground fires has allowed shrub and juniper to invade beneath the fire-resistant pine.

Mixed conifer forest

Above the ponderosa pine type lies the mixed conifer forest. Annual precipitation ranges from 20 to 35 inches. Here ponderosa pine, Douglas-fir, white and grand fir, and western larch are common tree associates. White pine and western redcedar (eastern Cascades) also can be found. In colder areas, such as frost pockets, lodgepole pine dominates. The mixed conifer type is the most extensive and productive forest type of eastern Oregon.

Subalpine forest

At the higher elevations (above 5,000 feet) is the subalpine forest type. Here, Engelmann spruce, subalpine fir, and lodgepole and white pine are most common. On the east slopes of the Cascades, mountain hemlock and Pacific silver fir also are found.

This zone receives the most precipitation, stored primarily in heavy snowpack. This forest type is the most important for moisture storage, yet it occupies the smallest area of all forest types of eastern Oregon.

The hydrologic cycle in forests

The hydrologic cycle in forests has four major phases: interception, infiltration, storage in the soil profile, and transpiration.

Interception

Water moves from the atmosphere to the ground and is absorbed into soil (Figure 6-2). Vegetation—trees, grasses, or shrubs—intercepts some of this moisture (rain or snow) on foliage surfaces. Foliage intercepts some 10 to 15 percent of total rainfall and returns it to the atmosphere by evaporation. So a significant portion of the total precipitation never reaches the soil—where it could infiltrate and contribute to plant growth or streamflow.

Moisture that penetrates the forest canopy also is intercepted by the litter layer (decaying needles and other organic material) that blankets the soil surface. The amount of water intercepted and stored in this layer can be considerable. The litter layer also is an important source of nutrients, and it acts as a protective cover to protect the soil from erosion during heavy rains.

Infiltration

Moisture that reaches the soil surface infiltrates, and is absorbed into, the soil profile. The soil acts as a sponge, holding some of the water in place between soil particles, against the force of gravity. The infiltration rate is determined by a number of factors including soil type (texture and structure) and the amount of disturbance to the top soil layer. In undisturbed soils, the infiltration rate usually exceeds the maximum amount of rainfall.

However, soils high in clay or compacted to a significant degree have reduced infiltration rates that can be exceeded during heavy storms. The result is that water moves overland, which can lead to erosion and sedimentation into streams.

Soil moisture storage

Once water has entered the soil profile, either it is temporarily retained between soil particles or drains from the soil. Vegetation can use moisture retained within the soil profile during the growing season, when rain is scant.

When rain enters the soil profile in the fall, after the summer drought, almost all water is retained in the soil profile. As the soil becomes recharged with moisture it will reach saturation, a point beyond which the soil cannot hold the moisture against the force of gravity. This point also is known as field capacity.

Depth and type of soil

The amount of water the soil can hold depends greatly on the depth and type of soil.
Soil depth determines the amount of water that can be stored below ground within the watershed. Deep soils are large volumes of soil with considerable pore space, capable of retaining more total moisture than shallow soils of the same soil type.

The type of soil—its texture and structure—determines its porosity, the size of pores between soil particles. Therefore, soil type affects both the rate at which water can infiltrate and the total amount of water that can be stored. Fine and medium soil textures with a wide range of pore sizes, such as loams, retain more than sandy soils, which have a coarse texture.

At the other extreme, fine soils such as those dominated by clays have pore sizes so small that water is too tightly held between soil particles for plants to be able to extract it (Figure 6-3).

Transpiration

Water stored in the soil profile acts as a large reservoir. Because little rain falls during the summer, this reservoir is important for sustaining tree and plant growth through this dry period.

Trees take up water through extensive root systems. Water moves through the root system, carrying with it essential dissolved nutrients. Water and nutrients are transported to the foliage, where they are used in photosynthesis and plant maintenance.

In a process known as transpiration, excess water passes through pores (stomates) in the leaves and needles and from there evaporates into the atmosphere. Transpiration moves a substantial amount of water from the soil to the atmosphere. Evaporation is the primary mechanism that creates the "suction" needed to extract water from the soil and move it up through the plant.

Plant moisture stress. As plants use up readily available soil moisture, it becomes increasingly more difficult for the plant to extract the remaining moisture, which is tightly bound between soil particles. Plants cannot meet their demands for moisture, then, by closing stomates, which slows the evaporative pump. Although this serves to conserve moisture within the plant, it also stops growth. The photosynthetic process has been effectively shut down.

In eastern Oregon, trees begin experiencing moisture and heat stress in early to mid-July, depending on the aspect (that is, whether they are growing on a north or south slope), amount and type of soil, and the amount of precipitation received before the growing season. Foresters commonly see a decline in diameter and height growth at this time.

Leftover water

Water not intercepted and transpired from leaf surfaces, or taken up and transpired by forest vegetation, eventually percolates down to a stream channel and/or underground aquifer.

Effects of forest practices on watersheds

Harvesting activities can greatly affect water quality and quantity. Although most people view harvesting as just severing trees from their roots, it is the associated activities that have the greatest effect on water, particularly on water quality.

Road and skid trail construction to bring logs out of the forest and site preparation, including slash burning, are the primary activities that can affect water quality. The degree and duration of the effect depends on the severity of the treatment and the amount of area affected.

Effects of timber harvesting activities are not all detrimental. Harvesting can improve water yields from watersheds by removing trees that consume water and by affecting the placement and storage of the snowpack.

Increasing water supplies by manipulating forest vegetation is a technique that is being closely studied in many areas of the arid West. The next section describes it more fully. Also, a number of publications on proper road building and timber harvesting, and their potential impacts, are listed at the end of this chapter.

Roads

Road-building activities can have a great impact on water quality. Roads that are poorly constructed can be constant sources of sedimentation into streams. Stabilizing mineral soil on road cuts should be a high priority.
Avoid sidecasting material into or near streams. Properly located roads are kept away from stream courses so runoff from the road surface doesn’t flow directly into the stream.

It is important to use buffer areas between road and stream to reduce sedimentation directly into streams. If stream crossings are necessary, design them carefully to handle storm runoff. Careful road planning and layout can minimize potential erosion and extend the life of the road.

Finally, a program of regular and emergency (heavy storms or snowmelt) maintenance can avoid many erosion problems related to roads.

**Logging**

Extracting trees or logs from the woods with heavy equipment, such as crawler tractors and rubber-tired skidders, can affect soil properties that influence runoff. Moving heavy equipment over the soil surface can expose mineral soil and compact a large portion of the area unless you plan and conduct the operation carefully.

Excessive soil displacement, soil exposure, and compaction reduce infiltration rates. This promotes overland flow and increases erosion and sedimentation.

If you keep skid trail areas to 10 to 15 percent or less of the total area, you can significantly reduce impacts to water as well as safeguard the productivity of the site. It also is important to minimize soil compaction when you pile slash with heavy equipment.

**Fire**

Burning is a silvicultural tool widely used in eastern Oregon forests. Burning in clearcuts and other harvested areas reduces the amount of slash and prepares the site for either planting or natural regeneration.

Fires that are “cool” effectively reduce slash loads and associated fire hazard, yet they leave a considerable amount of organic matter on the site. This is important for long-term nutrient cycling, and it also protects the soil from erosion.

Extremely hot burns, which consume the slash and the top organic soil layer, expose soil to rainfall impact—and may create a nonwettable soil layer. Both factors can decrease infiltration. On steep slopes, hot burns are more likely to increase erosion and sedimentation into streams below.

**Are there opportunities to increase water yield from forested areas?**

Research throughout the West shows that timber harvesting can increase streamflow in specific instances. Removing trees over a portion of the watershed not only reduces the amount of water and snow intercepted by foliage but also reduces the amount lost through transpiration. Therefore, theoretically, more water is available to contribute to streamflow (Figure 6-4).

**Amount and pattern of timber harvest**

The amount and pattern of timber harvest in a given watershed determines the amount and duration of water yield increases.

For example, in the spruce-fir forest of the central Rocky Mountains, the largest increases in water yield occur when 30 to 40 percent of the watershed is harvested in small clearcut patches (2 to 5 acres) evenly distributed over the watershed. This pattern of cutting not only reduces transpiration and interception losses within clearcut areas but also affects snowpack accumulation, retention, and melting.

Mid to high elevations in eastern Oregon also could yield water increases if they are harvested in this manner. However, the size of increase could be different from that in the central Rocky Mountain area because of differences in soil, vegetation, geology, and moisture accumulation.

Partial cutting, such as shelterwood harvests and thinnings, produces smaller increases because it removes fewer interception and transpiring surfaces (trees and understory vegetation). Removing 20 percent or fewer of the trees may result in no significant increase in water yield because potential savings may be used by neighboring trees.

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Figure 6-4.—Relative sizes of components of the forest hydrologic cycles, before and after timber cutting.\(^3\)
Timber harvesting effects on snowpack accumulation and retention

Timber harvesting affects snow capture, retention, and melt. Studies in watersheds of the central Rocky Mountains show that snow deposition can increase 15 to 35 percent in openings of various sizes. These increases were attributed to reduced snow interception, reduced evaporation from tree crowns, and changes in the overall distribution of snow within the watershed.

Most of the increase in snow deposition in openings comes from a redistribution of snow from the surrounding uncut forest into the openings; therefore, net snow accumulation within the watershed usually is unchanged. However, in some cases, thinning dense young stands of trees has shown increases in snow deposition because of reductions in snow interception and evaporation on tree crowns.

Snow retention is a function of opening size. Openings in the forest canopy of three to five tree heights ($H$) in diameter are most efficient for snow deposition (Figure 6-5). Clearcut patches larger than the three- to five-$H$ size begin experiencing snow scour from increased wind into the larger openings (Figure 6-6).

In addition, as openings become larger, the surface area of the snowpack increases, and exposure to solar radiation increases, which accelerates evaporation of the snowpack.

Aspect, slope, and tree cover are three factors that greatly influence timing of melt. Snowpack on steep southerly exposures begins melting earlier than on comparable slopes on northerly aspects. Snow in openings created by timber harvesting likewise melts earlier in the season because of increased exposure to solar radiation and evaporative processes.

In addition, because the earlier snowmelt occurs at a time when transpiration demands are low, more water is available for streamflow (Figure 6-7).

**Duration of water increases**

Water increases depend on how much of the forest cover is removed within a watershed, and how fast other vegetation (including young trees) reestablish on the site.

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**Figure 6-5.**—Snow retention as a function of size of clearcut. $H$ is the height of surrounding trees.

**Figure 6-6.**—Peak water equivalent in the open and the downwind forest, expressed as a deviation from the norm or upwind forest. Also shown is the relative wind speed observed at the site.

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The increase generally will be greatest the first few years after harvest and will gradually diminish as the vegetation reestablishes. Increases have been shown to last up to 30 years. Thus, to sustain water yield increases, portions of the watershed would need to be systematically harvested over time.

**Summary**

Potentially, we can increase water yield in the interior Northwest. What areas hold the greatest potential for water increases? That seems to be in the mixed conifer type, where both precipitation and transpiration rates are relatively high, and in the high-elevation, spruce-fir type, where snowpack can be manipulated.

Only small to moderate water increases can be expected in the ponderosa pine type because it is warmer and receives less moisture—available moisture is slightly greater than evapotranspirational losses.

Although it has been demonstrated that water yield can be increased, the more important question is whether this objective realistically can be achieved given ownership patterns and current land management objectives. Most of the upland forested areas are managed by the U.S. Forest Service and the Bureau of Land Management—which have multiple-use objectives—so it is unlikely that large water yield increases will occur through forest manipulation.

To date, public sentiment has supported reduced harvest levels within watersheds because of wildlife, recreational, esthetic, and other concerns.

Water yield increases will occur only if a significant portion of the watershed is harvested. This is not in line with current public values. In special watersheds, such as those that supply water directly to municipalities, maintaining or increasing water yield could be the primary management objective. However, this would occur on a very limited number of watersheds.
For further reading

The following publications are available from the Oregon State University Extension Service.
Contact Publication Orders, Extension & Station Communications, 422 Kerr Administration, Oregon State University, Corvallis, OR 97331-2119. For orders of 100 copies or more of a single title, please call 541-737-2513 for a quote on reduced rates.


Figure 6-7.—Average hydrographs for Fool Creek Watershed, CO. The solid line is the average for 1940-1955, before timber harvest. The dotted line is the average for 1956-1971, after timber harvest.6

Other publications


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http://extension.oregonstate.edu/catalog

Chapter 6. Forests and watershed management in eastern Oregon 61
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For most current information:
http://extension.oregonstate.edu/catalog
Vegetation on upland sites will respond to the kind of grazing management applied. That also is true for riparian vegetation, which is affected not only by the site but also by the nature of the stream system. The relationships discussed in this chapter will help you create better site-specific grazing prescriptions and thus be able to predict generalized responses.

Important physical characteristics of stream systems are: gradient, size and kind of rock, depth to bedrock, and type of soil. They are the factors that determine whether or not a stream and its associated riparian zone have the potential to respond to management.

Some stream systems have a relatively low potential for change. For example, a steep, stable, rock-lined riparian zone does not have very much potential to erode or to trap sediment, even if sediment were in the water. Conversely, a low-gradient stream that is erosive and carries high sediment loads has potential for both positive and negative change.

Grazing management can either help or harm. Figure 7-1 (page 64) illustrates the general relationships between natural stresses and those induced by human management. The natural stresses of a stream system include prevailing climate, gradient, soil, rock, and water flow. In Figure 7-1, natural stress ranges from stable to unstable on the horizontal axis. Stress that human beings impose includes grazing intensity, season of use, logging practices, mining activities, and road systems. That type of stress is represented on the vertical axis and can range from minimal (at the bottom) to dramatic (at the top).

This point is important: No two stream systems are alike. Each has its own ability to withstand natural and/or human-induced stress. A stream system's potential for recovery—and, thus, for changes in the riparian zone—relates directly to the degree of stress and whether it's natural or human-induced.
Basically, there are two kinds of stream systems in terms of their erodibility characteristics: those that are vertically unstable (Figure 7-2) and those that are laterally, or horizontally, unstable (Figure 7-3).

As each kind of stream becomes degraded, it goes through definable stages of change. Recovery can occur but generally takes longer on laterally unstable systems.

Also—and this is very important—when the stream system is in certain stages of change, some management practices are much less effective in permitting recovery. This is especially true in vertically incised or eroded channels. Since these channels frequently do not have a flood plain into which high waters can escape, they continue to erode their banks and bottoms during peak flows. Small engineering structures such as check dams are useless because they cannot withhold the forces of the concentrated floods.

The last section of this chapter, “Prioritizing streams for rehabilitation and riparian management,” provides more detail on these erosion processes and suggests approaches to solutions.

Grazing systems

We will describe in general terms seven types of grazing systems. You will need to consider them in light of the goals you have set and how well any system would fit in with the rest of your grazing operation. You also can refer to the section “Grazing to maintain a healthy range” in Chapter 2 for more information about grazing systems.

**Season-long grazing** Graze during the entire plant-growing season. In the interior Northwest, that is grazing from early or mid-spring to mid- or late summer. In the California annual grasslands, it is from fall to winter.

**Rotation grazing** This implies two or more pastures that are grazed in some sequence. Each pasture is, however, grazed at some time each year. Pastures may be grazed later in the year.

**Deferred rotation** Selected pastures are not grazed until plants reach a certain stage of development such as flowering, seed set, or seed shatter. The deferred pasture is rotated among the other pastures each year.

**Rest-rotation** To qualify as a rest, a given pasture must remain ungrazed for a full growing season.

In a three-pasture rest rotation system, one pasture is grazed early in the growing season, another deferred until after seed formation, and the third rested all year. The type of grazing use of a given pasture is rotated so that at the end of 3 years, each pasture has had each grazing treatment.

**Early growing season** Restrict livestock grazing to the early growing season and completely remove livestock before soil moisture is depleted. The adequate soil moisture and favorable temperatures allow plants to complete their reproductive cycle during the rest of the growing season.

**Late growing season** Allow livestock to graze after the vegetation completes its reproductive cycle. Remove livestock before fall rains saturate soils.

**Dormant season** In the interior Northwest, this is late fall and winter. In the California annual grasslands, however, it may be in July, August, and/or September.

Vegetation responses to grazing

Plants react to the various stresses placed on them. So do grazing animals. Understanding basic grazing behavior helps to design effective management prescriptions. Many riparian zones have, or could have, a mixture of herbaceous and deciduous woody vegetation. Managers want a variety of plants because they are necessary for a stream system to recover and reach its potential. A mixture of plants has the benefits of increased forage, reduced erosion, high water quality, and good wildlife habitat.

Woody riparian vegetation (willow or alder) is discouraged by late-season grazing. At that time most grasses, sedges, and rushes have completed their reproductive cycles and are entering or are in a dormant stage. Consequently, they frequently are unpalatable, dry, and low in protein and energy content. The woody vegetation, by contrast, is still green and succulent, palatable, and high in protein and energy content. Naturally, large animals (domestic or wild) prefer to graze on it. Consequently, heavy late-season grazing will discourage shrubs and woody vegetation.
Maintaining or improving the woody vegetation component generally is desirable. Early-season grazing does not appear to harm woody production as long as herbaceous plants are abundant and growing actively.

There is some evidence that summer use levels of less than 50 percent on herbaceous vegetation among streams keeps woody vegetation from being grazed significantly. Knowing when grazing animals change from herbaceous to woody vegetation allows you to develop a grazing strategy that keeps stock on forage that is conducive to their health and performance.

For example, the commonly used three-pasture rest rotation grazing system usually does not promote improved woody riparian vegetation, even though it may be very positive for the herbaceous component. The reason is that too much of the woody vegetation is used the year the pasture receives late-season grazing, which makes the lighter use of the 2 previous years a waste of effort.

However, there are a number of variations to rest rotation grazing; for example, five- and even seven-pasture systems. Some of the more elaborate schemes may well have managed the levels of stress and recovery periods in such a fashion that the shrubs prosper.
Following are some general comparisons between season-long grazing and appropriate use of any other grazing system to promote herbaceous material and plant community vigor.

- Season-long grazing is detrimental to both herbaceous and woody vegetation. Animals can graze each plant species and individual plants at their most susceptible growth stage multiple times without any planned rest.
- Rotation or deferred rotation grazing seems to combine the attributes of simplicity and plant protection to promote herbaceous growth.
- Late-season grazing, before fall rains, also generally promotes herbaceous vegetation health. In addition it may reduce soil compaction and promote habitat for ground-nesting birds.
- Dormant season and early-season grazing may promote both shrubs and herbaceous vegetation. However, you must be alert to potential problems such as lower nutritional value; you may need to provide supplements for your livestock. In addition, soil may be compacted, depending on soil texture and moisture and frost conditions. A big economic advantage, however, may be the opportunity to reduce winter feed costs by grazing at this time.

Figure 7-4 shows the general relationships among basic grazing systems, stream system characteristics, and human-induced stress levels. The matrix gives an idea of how a “typical” stream type might respond to a given management step.

For example, suppose you had a steep, gravel- and cobble-lined stream that carried little sediment, and you want to build banks by eliminating livestock use.

- Enter the matrix under “Natural conditions” at the far left column,-low-sediment load.”
- Move down until you intersect the desired “Management stress” category at the left—in this example, “No grazing.”

The answer is that lack of grazing probably will not help build banks. This makes sense: If the stream carries little sediment, there is very little opportunity for bank building, with or without livestock present.

A word of caution: It simply is not possible to devise a foolproof generalized approach. Please interpret this matrix with care. It can be a guide to help you create site-specific grazing prescriptions, but it is not a “by the numbers” recipe.

What you should aim for is prescription grazing—management designed for your specific site, plant community, and set of goals. You must evaluate every ecosystem for its unique combination of natural and human-induced factors, and you must manage it by a prescription rather than by a “blanket” grazing policy.

Prioritizing streams for rehabilitation and riparian management

The history of land use in the American West has left today’s land managers with many riparian problem areas. Many streams were altered by overuse of riparian vegetation, roads, trails, straightening, dredging, or watershed alteration. Many streams downcut and some are becoming gullies. Some have been gullies for decades.

Streams suffering from inappropriate management practices gradually may change over a period of many years, during which riparian vegetation with access to a high water table may respond rapidly to improved management. Restored riparian vegetation then quickly helps heal stream banks.

However, as change occurs some streams pass a point of no return and become gullies. When a stream passes this threshold, it must progress through certain steps to its long-term recovery. These steps are very different from the “normal” condition of the stream.

As years pass, additional streams experience big runoff events that trigger important long-term changes in stream morphology. In the intermountain West this happened to many streams in the early 1980s. Successive winters with heavy snow produced abnormally prolonged periods of high flow.

As a stream approaches the threshold of gully formation, there can be substantial effect during a flood under either of the following conditions:

1. Stream bank vegetation has been weakened and can no longer hold the stream bank well enough to prevent serious bank erosion, or
2. The forces working on stream banks and channel bottoms become too great because the stream has straightened and become too steep or downcut and has lost access to its flood plain.

Function of riparian vegetation

Some plant communities dominated by Nebraska sedge (Carex nebraskensis) average more than 100 feet of roots and rhizomes per cubic inch of soil near the soil surface. It is no wonder that Nebraska sedge and other broadleaf sedges have a reputation for stabilizing sediment and binding stream bank soil. It is not uncommon to see stream banks that are stable because of the tough sod produced by plants that thrive with a high water table.

Besides binding soil that otherwise would erode, vegetation provides roughness at the water–land interface. This decreases water velocity and decreases the energy available to transport sediment. The filtering effect of riparian vegetation is partly responsible for deposits of fine, fertile soils on many flood plains such as mountain meadows. Within the active channel, vegetation also traps and stabilizes sediment on point bars. Streams recovering from bank erosion then become narrower.
### Natural Conditions

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= increase  ↓ = decrease  ⇔ = no change

**Slope:**
- Flat = 0–2%.
- Moderate = 2–4%.
- Steep = greater than 4%.

**Sediment load:**
- High = turbid waters; bank and bottom materials usually are clays, silts, and fine sands.
- Low = clear waters; bank and bottom materials usually are coarse sands, gravels, cobbles, and boulders.

Figure 7-4.—Generalized relationships among riparian vegetation response, grazing management practices, and stream-system characteristics.
Low-gradient streams (less than 1.5 percent) with flood plains naturally meander. Meanders form as a balance of bank erosion on the outside turns and sediment deposits on the inside turns. For meandering streams to remain stable, the rate of these two processes must stay about equal. If the outside turns erode faster than the inside turns capture and stabilize sediment, a narrow, deep stream will become wider and shallower. A stream that provided good habitat for trout may become too silted, exposed, and warm.

As the stream widens, the stream pattern changes. It may break through meanders; if so, the broad sweeping curves of the new channel will decrease stream length. The shorter stream still must drop the same elevation. Therefore, as the stream straightens the slope steepens, and water velocity increases. Stream energy thus is expended over a shorter length of channel and may accelerate erosion.

Function of flood plains

Narrow meandering streams commonly flood a broad plain, adding to a high water table (Figure 7-5). A high water table provides abundant water to vegetation, which in turn provides bank stability upon which stream morphology and the high water table depend. The broad, flat flood plain is necessary to dissipate energy during floods. It also stores floodwater for future stream flow.

Tractive force, or water’s ability to detach and carry sediment, is directly related to depth of flow and stream slope. Therefore, as a stream floods, it has increased energy available for erosion largely in proportion to the increase in depth. A stream that can spread out over a broad flood plain increases depth only slightly during a flood. Therefore, it can withstand floods of tremendous magnitude with little erosion. Floods on such streams generally will deposit fine sediment on the flood plain and build stream banks.

Gully erosion

Any net loss of channel material, such as bank erosion, causes a stream to lose some access to its flood plain. As a stream loses its opportunity to dissipate energy over a flood plain, the more confined stream begins or accelerates the process of downcutting. Often, one or more headcuts move upstream. Eventually the stream may become totally confined in a deep, narrow gully (Figure 7-5b). The concentrated energy of flowing water then causes rapid erosion.

Immediately after gully development, the stream width is the same as the gully bottom width. The old flood plain is a terrace—essentially, there is no flood plain. During this phase, erosion is rapid and mostly downward until the stream reaches local base level or an erosion-resistant layer. Thereafter, the concentrated energy continues to do work by eroding the gully walls. It also prohibits vegetation from stabilizing the active channel, which becomes wide and shallow (Figure 7-5c).

The water table that previously supported dense vegetation on the old flood plain often is lowered as a result of downcutting. Riparian vegetation then is replaced by drier species such as sagebrush and cheatgrass. Over-steepened gully walls typically support little vegetation because they are naturally unstable and dry.

Recovery

As the erodible gully walls spread farther apart, the new flood plain in the bottom expands (Figure 7-5d). As the flood plain widens, it grows vegetation, dissipates energy and collects sediment. Energy dissipation allows vegetation to grow stronger. It then can shape the active channel and form meanders and overhanging banks (Figure 7-5e). Eventually the gully may fill and the terraces again become a flood plain.

Prioritizing streams

Land managers must accept the land use that has proceeded them. By understanding history, they can better appreciate the trend of their landscapes and the potential of those landscapes to respond to management.

In an evolving landscape, it is not useful to compare present conditions with some alternative. Instead the likely results of one option must be compared to the likely results of another. This must be done in individual settings to determine if possible or proposed actions will be worthwhile. It also must be done in many settings at once to determine where and how limited resources can do the most good.
Land managers must avoid simply attacking that which is most ugly. Efforts to rehabilitate a new gully may be expensive and risky. Efforts to prevent a gully or rehabilitate an old gully with a widening flood plain may be cheaper and provide more benefit.

**Highest priority stream reaches**

Highest priority streams still have and use their flood plain (Figure 7-5a), but could, through improper management, lose access to it through downcutting. Streams that still rely on water-loving stream bank vegetation will respond to improved riparian management most quickly. This is due to the vegetation's resilience that comes with water and nutrient availability and the energy dissipation by the flood plain.

Proper management is critical in stream valleys that are long and deeply filled with erodible sediment. These streams have consistently depended upon vegetation for stream bank and meander integrity. Once headcuts form, they are very difficult to heal with vegetation. The time to act is before the threshold is exceeded and the gully begun.

**Lowest priority stream reaches**

The lowest priority streams, even if they are the ugliest, are unlikely to respond to management. Stream energy is concentrated and management inputs are likely to be wasted if a stream has downcut and is totally confined in the bottom of a gully (Figure 7-5b).

Protection or careful management may permit riparian vegetation to grow at the base of the gully wall. However, its ability to control erosion or alter channel morphology likely will be minimal while the gully is narrow. The opportunity for benefits to exceed costs is lowest in the early phases of gully evolution discussed above. The benefit–cost ratio for management increases as the gully bottom widens.

**Increasing priority stream reaches**

The ability of riparian vegetation to produce a narrow stream channel, good for cold-water fish, appears to increase dramatically as the time the gully bottom becomes wider than the active channel (Figure 7-5d). At this time the flood plain forming inside the gully can begin to dissipate flood energy. Riparian vegetation and management then become significantly more important.

The benefit–cost ratio of investments increases more with gully widening if the benefits are measured on site. These benefits include improved fish habitat, riparian vegetation, and aesthetics. To the degree that sediment is a concern downstream, the rate of gully widening (erosion) becomes more important. Eventually, though, the gully must widen to become stable. However, if sediment downstream is a big problem, the benefits from preventing the gully in the first place could have paid for some rather intense management.

**For further reading**


A watershed’s primary functions are to capture, store, and safely release water within its ability to do so based on site characteristics. Management practices within the context of vegetation and soil types can influence the ability of the watershed to function properly. The extent to which these three components work together (or against one another) can determine the overall health of the system.

It is important to thoroughly evaluate which tool or combination of tools would be appropriate. Consider the following process:

1. Develop long-range goals. Short-term “fixes” may not adequately address the problem of a deteriorating watershed. For example, instream structures may be a satisfactory approach in the riparian zone, but they do not address the problem of eroding uplands, poor infiltration rates, and excessive evapotranspiration from undesirable vegetation.

2. Identify positive and negative aspects of the current watershed condition.
3. Identify all possible techniques that could be used to achieve long-range goals and objectives.
4. Design and implement a management program that utilizes a technique or complementary combination of techniques identified above.
5. Monitor results of the program. Adjust management as needed. Continue to monitor and adjust.
We have designed this chapter with you, the user, in mind. We do not provide engineering specifications but have tried to indicate the features of each tool, the benefits to the watershed, the planning and design considerations, and the maintenance requirements. A few management tools require the service of a licensed engineer for correct design.

Each tool aids one or more of the three principal functions of a watershed: capture, storage, and safe release of water. A check mark next to a function tells you it is a goal you can achieve through that tool.

We also include a caution statement for each tool. It is designed to remind you of an important point: Constructing or implementing a single structure or practice often will not be sufficient by itself—you may need to make other, complementary management changes.

Virtually all these management tools are site-specific. As an example, when you plan an instream structure, you must consider:

- Size of stream
- Gradient
- Soil characteristics
- Volume of water at peak flow
- Timing of peak flow

Further, when you implement a management tool anywhere in the watershed, consider:

- Soil characteristics
- Precipitation
- Management goals and objectives
- Condition of the vegetation

Financial aid often is both desirable and necessary in order to do some of the work. Your county Extension agent or Natural Resource Conservation Service technician can help you locate appropriate kinds of financial resources.

Grazing management

- **Capture**
- **Store**
- **Safe release**

**Features** Managing grazing animals to maintain or improve vigor, composition, and density within the plant community. If current grazing management is responsible for lower-than-desired riparian condition, then a change in grazing management to something more appropriate is likely to be the only management tool needed.

**Planning and design considerations** Grazing must be coordinated with the timing of precipitation, plant growth, and plant form. Soil moisture, stage of plant growth, and timing of peak stream flow are the key factors in determining when to graze.

Response to a given grazing strategy varies by ecological unit (see “Developing management strategies for your range” in Chapter 2). To form a site-specific grazing prescription, you must tailor your grazing strategy to your specific site and to your management goal(s) for it.

**Maintenance requirements** Grazing management must be monitored for effectiveness. Adjustments may be needed to achieve goals.

**Benefits**

- Increased infiltration, decreased overland flows, and enhanced nutrient cycling of plant communities.
- May delay sexual maturity of seed production, thus improving viability.

**Caution** Livestock grazing must be implemented on the basis of the watershed's condition rather than on animal husbandry considerations. Plant community and soil conditions must dictate when and how animals should be used. Livestock serve as the "harvester" of herbaceous material.

Harvesting before the proper time negatively influences yield of the plant community, which in turn impacts infiltration and subsurface and overland flows.

Animal distribution modification practices

- **Capture**
- **Store**
- **Safe release**

**Features** These practices control season, timing, and distribution of animal use. Such things as fencing, salting, water development, riding, herding, and trail development fit in this category.

**Planning and design considerations** Consider type, class, and species of animal to be manipulated. Geographic and topographic features greatly impact animal movement. Water availability and its distribution are critical factors to consider.

Labor and material costs will vary depending on the selected control method. Design management areas to fit ecological units. Manage unlike vegetative zones separately; for example, uplands vs. riparian areas.

**Maintenance requirements** Seasonal inspections or as required to accomplish management goals.

**Benefits**

- Encourages infiltration of precipitation and soil protection through proper plant growth, development, and density.

**Caution** Managing the vegetation—which includes controlling livestock and people’s recreational uses and an understanding of fish and wildlife needs—is required to assure the success of these practices. When you develop a water source, you must follow state water laws.
Juniper control

- Capture
- Store
- Safe release

**Features** Reduce juniper tree numbers and/or cover if the trees are detrimentally influencing the watershed and associated vegetation.

**Planning and design considerations** It is crucial that the site be suitable for herbaceous production once trees are removed; for example, that seed sources and residual plants are available, and soil characteristics and fertility are favorable.

Site characteristics dictate appropriate control methods, which may include burning, chaining, chainsawing, chemicals, and bulldozing.

**Maintenance requirements** Constantly survey for reinvasion, and control any small trees that do appear.

**Benefits**
- Improved infiltration due to increased herbaceous plant densities.
- Increase in soil moisture due to lower tree density and cover.
- Less precipitation loss via tree-canopy interception.
- Decreased overland flows and therefore less potential erosion due to enhanced herbaceous ground cover.
- Downed trees provide climatic microsite conditions for improved herbaceous plant establishment. Scattering limbs may be needed on some sites.

**Caution** If an adequate seed bed or source of herbaceous seed is not available to immediately colonize the site, this practice will decrease soil stability. Successful vegetation management includes controlling livestock use, and people’s recreational use, and also understanding wildlife needs.

Sites with higher potential are more likely to respond positively. If soil erosion is a problem on low-potential sites, carefully evaluate the potential to slow erosion rates through a juniper treatment program.

**Gradient-stabilizing (drop) structures**

- Capture
- Store
- Safe release

**Features** These structures are built low across the stream channel and keyed into banks and bottom. It is imperative to include an overflow outlet at the center of the channel and a downstream apron to protect the stream bottom and banks.

**Planning and design considerations** The height of the structure is less than the average 2-year peak flow. Aprons can be constructed from a variety of materials such as concrete or rock. Downstream length of an apron depends on stream velocity; material must be large enough to dissipate energy without being moved. The structure itself is more or less impermeable, and it is most useful in small (first- or second-order) tributary streams on straight reaches.

**Maintenance requirements** Annually inspect apron, overflow, and key.

**Benefits**
- Energy is safely released, and some sediment is trapped upstream.

**Caution** This practice does not stand alone. Trapped sediment is a growth medium for vegetation that will help trap more sediment, protect the stream bank, and store water.

Managing the resulting vegetation includes controlling livestock use, people’s recreational use, and understanding fish and wildlife needs. Be sure to follow state water and fill-permit laws when you implement this practice.

**Jetties**

- Capture
- Store
- Safe release

**Features** Jetties are heavy physical barriers designed to still the water behind them. They are keyed into the bank and project out into a portion of the stream channel.

**Planning and design considerations** This structure must be properly keyed into the stream banks and bottom. Jetties may be constructed from a variety of materials (for example, logs or rock) but must be heavy enough to resist water pressure.

They are most applicable on larger (greater than third-order) streams with low gradients. The length of the jetty or distance into the stream is in relation to stream width; see your local Natural Resource Conservation Service technician for guidance on this point.

**Maintenance requirements** Annually inspect the key; rebuild it if storms have weakened it.

**Benefits**
- Stilled pool behind the structure protects downstream banks; also, some sediment trapping.
- Vegetation will reestablish on the downstream banks, allowing banks to build up and stabilize.

**Caution** This practice does not stand alone. Trapped sediment is a growth medium for vegetation that will help trap more sediment, protect the stream bank, and store water.

Managing the resulting vegetation includes controlling livestock use, people’s recreational use, and understanding fish and wildlife needs. Be sure to follow state water and fill-permit laws when you implement this practice.
Herbaceous plantings in uplands

- √ Capture
- √ Store
- √ Safe release

**Features**
Planting may be necessary if existing vegetation is either inadequate or undesirable for the watershed to function properly. Planting improves infiltration, thus increasing the watershed’s storage capability and safely releasing water through subsurface flows.

**Planning and design considerations**
Selected plant materials must be adapted to the site and suited to management goals. Give special attention to both above- and below-ground growth characteristics, timing of growth, and resource capture so that the community functions properly and is resistant to the intended land use (including grazing or browsing) as well as to the invasion of undesirable plants.

**Maintenance requirements**
There must be a long-term commitment to maintain a proper balance between the vegetation and animals’ use of it. Invasions of undesirable plants must be monitored and corrective measures considered.

**Benefits**
- Increases effective use of water for plant growth and development, soil moisture storage, and subsurface flows.
- Helps to improve animal distribution throughout the watershed.
- Decreases overland flows and erosion potential.

**Caution**
Seeded plants’ survival is affected by how well they were selected and planted and by the competition they get from other plants at the site.

Managing the resulting vegetation includes controlling livestock use and people’s recreational use, and understanding fish and wildlife needs.

Woody vegetation plantings in riparian zones

- √ Capture
- √ Store
- √ Safe release

**Features**
Through root binding and physical armor- ing, woody streamside vegetation protects stream banks against erosion caused by high water flows and/or ice.

**Planning and design considerations**
Plant materials selected must be adapted to the site. Site characteristics such as soils, water table, drainage, and season of planting are critical. It may help to apply root-growth-inducing hormones to planting stock. Consider potential use by domestic animals and wildlife, and provide adequate protection to ensure good establishment.

**Maintenance requirements**
There must be a long-term commitment to maintain a proper balance between the vegetation and animals’ use of it.

**Benefits**
- Protects stream banks.
- Helps trap sediment.

**Caution**
Success depends on the experience of those doing the planting, site selection, suitability of the plant materials, competition from other plants, and wildlife use such as deer and elk browsing and beaver cutting.

Managing the resulting vegetation includes controlling livestock use and people’s recreational use, and understanding fish and wildlife needs.

Head-cut control devices

- √ Capture
- √ Store
- √ Safe release

**Features**
These devices dissipate energy at the headcut in order to stop channel cutting upstream. Rock placement begins above the cut, continues through the cut where it protects the sides, and ends well below the cut.

**Planning and design considerations**
The rock-to-soil interface is critical. The size of material used should maximize the rock-to-soil contact; that is, rocks should be large enough to handle the water’s energy, but there should not be big spaces between rocks where water could channel through and erode the soil on the stream banks. On a degrading channel, this is the first structure to build.

**Maintenance requirements**
Annually inspect the structure to ensure that the rock-soil interface is maintained and that cutting has not occurred behind or on the sides of the control device. Also inspect to see that new nick-points or cutting spots have not been created at the toe of the control device.

**Benefits**
- Controls headward expansion of gullies.
- Preserves water table integrity.

**Caution**
This practice does not stand alone; you also must manage the source of the runoff. Head-cut structures are designed to prevent further cutting of the stream channel from a nick-point until vegetation can stabilize.

Managing the resulting vegetation includes controlling livestock use and people’s recreational use, and understanding fish and wildlife needs. Be sure to follow state water and fill-permit laws when you implement this practice.
Herbaceous plantings in riparian zones

Capture
✓ Store
✓ Safe release

Features If existing vegetation cannot protect the site, vegetation must be planted to protect and stabilize stream banks and adjacent floodplains through improved top growth and root production.

Planning and design considerations Select plant materials adapted to the site and to meet management goals; for example, palatability, season of use, control of noxious weeds, and stream bank stabilization. Consider downstream implications of “escaped” plant materials such as seed.

Maintenance requirements There must be a long-term commitment to maintain a proper balance between the vegetation and animals’ use of it.

Benefits
• Vegetation traps and stabilizes sediments.
• Herbaceous plants may create an environment that also favors establishment of certain woody species.

Caution Success depends on the experience of those doing the planting, site selection, suitability of the plant materials, and competition from other plants.

Managing the resulting vegetation includes controlling livestock use and people’s recreational use, and understanding fish and wildlife needs.

Cut-tree riprap

Capture
✓ Store
✓ Safe release

Features Protects banks from high water and acts as a physical barrier to grazing animals. Modifies microclimates, dissipates water energy, and reduces water velocities.

Planning and design considerations Most useful on low-gradient, high-sediment streams. The butt end of the tree must point upstream. Place trees along the stream’s outside curves where cutting action is most likely.

Use trees large enough to resist movement in the water and make certain the butt of the tree is securely tied into the stream bank. Remove some tree limbs to assure good trunk-to-soil contact, which will minimize the stream cutting behind the tree placement. Retain root wads for stability whenever possible.

Maintenance requirements This is a low-maintenance practice. Monitor the area for sedimentation and vegetation establishment.

Benefits
• Traps sediments, prevents stream bank erosion, and enables vegetation to reestablish on the stream edge.

Caution This practice does not stand alone. Trapped sediment is a growth medium for vegetation that will help trap more sediment, protect the stream bank, and store water.

This practice actually may slow recovery if it reduces the stream’s natural tendency to achieve sinuosity. Also, sediment from cut banks may be needed to help build banks and to narrow the channel downstream.

Managing the resulting vegetation includes controlling livestock use and people’s recreational use, and understanding fish and wildlife needs. Be sure to follow state water and fill-permit laws when you implement this practice.

Sediment-trapping devices

Capture
✓ Store
✓ Safe release

Features These low devices extend across the channel. They generally are permeable, designed to slow but not to stop water at low flows and to safely permit over-the-top water passage at higher flows.

Planning and design considerations The structure’s height should be less than the 2-year peak flow average. It is more critical to key the structure into the stream banks than into the bottom of the channel. The structure’s overflow outlet must be at the channel’s center. The width of the overflow outlet should take into account the eventual meander of the stream: The greater the width of the overflow outlet, the greater the potential meander (and the less the stream’s energy will be concentrated).

These devices are most useful on low-gradient, small-volume streams carrying high sediment loads. The need for downstream aprons depends on channel and flow characteristics. A greater variability in flow indicates a greater need for an apron.

Construction material can include rock, fencing materials, and wood debris. Consider a staggered placement of second-generation devices when the original ones are half full of sediment.

Maintenance requirements Annually inspect keyed banks and monitor how well the vegetation is growing in trapped sediments.

Benefits
• Traps sediment, dissipates water energy, and extends time of water recharge from water table to stream flow.

Caution This practice does not stand alone. Trapped sediment is a growth medium for vegetation that will help trap more sediment, protect the stream bank, and store water.

Managing the resulting vegetation includes controlling livestock use and people’s recreational use, and understanding fish and wildlife needs. Be sure to follow state water and fill-permit laws when you implement this practice.
Shrub management

- Capture
- Store
- Safe release

**Features** Reduce the numbers and/or cover of undesirable woody vegetation if it is harming the proper functioning of the watershed.

**Planning and design considerations** You must be able to accurately predict how existing herbaceous plants will respond to shrub control. If there are not enough desirable herbaceous species to use the soil moisture and nutrients released from shrub control, you may need to do some seeding.

Choice of shrub management method—such as brush beating, burning, or herbicides—and appropriate follow-up seeding or management can vary greatly. Choices will be influenced mostly by economics on private land and by legal constraints on public lands.

**Maintenance requirements** Most shrub species cannot and should not be eradicated. Shrubs can provide other values such as nesting habitat for birds and both cover and food supply for fish.

Monitoring increases in shrub species populations, combined with increased knowledge of their role in watershed health and stability, should indicate when any control is desirable.

**Benefits**

- Infiltration improves due to increased herbaceous plant densities.
- Soil moisture increases because there are fewer shrubs to take it up.
- The reduced shrub canopy allows more moisture to reach the soil surface.
- Enhanced herbaceous ground cover reduces erosion potential.

**Caution** Allow adequate time for either existing or planted herbaceous species to become well established before allowing use. Follow-up vegetation management includes controlling live tox use and people's recreational use, and understanding wildlife needs.

**Improvements you can expect in fish and wildlife habitat**

The foregoing management tools can have various impacts on fish and wildlife habitat. In general, we believe that properly applying each management tool can promote the following benefits if the site allows.

**Grazing management**

- Improve wildlife habitat and feed quality.
- Provide for forage green-up early in spring.
- Encourage plant tillering.
- Enhance forage and habitat for waterfowl.
- Improve nestling habitat for some birds.

**Fencing**

- Improve feed quality for wildlife.

**Juniper control and shrub management**

- Improve forage quality and vegetation diversity.
- Downed trees provide cover for small, nongame animals.

**Gradient-stabilizing and sediment-trapping devices**

- Increase pool formation.
- Potential insect population increase on decomposing logs.
- Resting and habitat locations for waterfowl.

**Jetties**

- Improve pool-to-riffle habitat for fish.
- Provide a spot for fish to live during low-flow periods.
- Improve potential for overhanging vegetation, which can buffer stream banks from the water's energy, and also help provide some food for fish.

**Herbaceous plantings**

- Improve vegetation diversity.
- Improve forage production.
- Enhance seasonal feed (winter range).

**Woody plantings in riparian zones**

- Improve fisheries by manipulating the microclimate to improve insect habitat.
- Improve cover for wildlife and insect populations.
- Food for big game and other wildlife.
- Nesting sites for some bird species.

**Water developments**

- Improve distribution of wildlife.

**Cut-tree riprap**

- Improve fisheries by manipulating the microclimate to improve insect habitat.
- Provide cover for birds and nongame wildlife.
Regulations governing Oregon's watershed restoration work

Clint C. Jacks

Who regulates developments?

Local involvement  City and county regulations on upland and riparian developments vary greatly. They may consist of a planning staff's administrative review of the public notice generated from state and federal permitting processes, or they may involve a quasijudicial conditional-use process, zone change, or plan amendment by the local planning commission.

Separate permits for land use and waterway activities also may be required. Because local requirements vary greatly, you must contact your county or city planning office to determine local regulations.

When state and/or federal permits are required, most often local planners are involved in the review process. Normally, neither state nor federal agencies will issue a permit for an activity that is not permitted locally.

State involvement  States have a number of agencies that have some authority to regulate watershed restoration work. Laws cover all waters, including not only large lakes and perennial rivers but also small natural ponds, intermittent streams, overflow channels, and wetlands.
Water use permits

Oregon Water Resources Department
Washington Department of Ecology
Idaho Department of Water Resources

Forest practice rules

Oregon Department of Forestry
Washington Department of Natural Resources
Idaho Department of Lands

Permits for working in streams and riparian areas

Oregon Department of Fish and Wildlife
Washington Department of Fish and Wildlife
Idaho Department of Water Resources and Idaho Department of Fish and Wildlife

Fire permits

State fire marshals in each state
County and/or municipal fire districts

Federal involvement

Section 10 of the federal Rivers and Harbors Act of 1899 gives authority to the U.S. Army Corps of Engineers to regulate navigable waters.

Federal authority was broadened with the passage of the Clean Water Act as part of Environmental Protection Agency (EPA) governing laws. Specifically, Section 404 regulates disposal of dredged or fill material in "waters of the United States."

The Corps administers Section 10 and Section 404 programs; it also is responsible for wetland determinations, and approves or disapproves each permit proposal.

The EPA staff will review each public notice and provide comments whenever they believe the permit may not comply with the policy of Section 404 of the Clean Water Act.

A number of other federal laws are involved in every decision the Corps makes on Section 10 and/or Section 404 permits. They include the National Environmental Policy Act (NEPA) and the Fish and Wildlife Coordination Act.

Federal lands under the Forest Service and the Bureau of Land Management are administered according to each agency's rules and regulations.

No special permission is needed for authorized activities covered under a nationwide permit, provided the activities meet certain conditions. Authorized activities include:

1. Bank stabilization, if the stabilization activity is all of the following:
   - Less than 500 feet long
   - Necessary to prevent erosion
   - Limited to less than an average of 1 cubic yard per running foot placed along the bank
   - A single and complete project
   - Uses only clean material free of waste material, unsightly debris, etc.

2. Fill material in streams with flows less than 5 cubic feet per second, provided less than 1 acre of U.S. waters is affected.

3. Fill material that both:
   - Does not exceed 10 cubic yards as a part of a single and complete project.
   - Is not used for stream diversion.

Important contacts

Regulations change over time, so it is important to stay current on regulations that pertain to your proposed management tools. The following sources of information will help.

County or city planning departments: Each county and city has a planning department whose staff are the most knowledgeable about local regulations. In addition they are a good source of information for state and federal processes.

Local Soil and Water Conservation Districts (SWCDs) The SWCDs have close working relationships with the Natural Resources Conservation Service, which makes the SWCDs a good source of current regulations, technical help, engineering assistance, and guidance to possible sources of funding for grants and cost-share programs. SWCDs are listed in the state section of your telephone book.

If you are in a locale that has established a Watershed Council, the council can be a useful source of information about related watershed activities and about potential funding sources. The councils often work cooperatively with the SWCDs.

Natural Resource Conservation Service (NRCS) The NRCS is a federal agency, but staff in local NRCS offices know a lot about local and state regulations as well. They also work closely with Farm Service Agency. Some NRCS offices cover more than one county. Find the office nearest you by looking in the U.S. Government section of the telephone book under the heading of the Department of Agriculture.

Cooperative Extension Service offices Extension's role is to provide educational information for the wise use of natural resources. County Extension agents maintain contacts with statewide Extension specialists and others, and through these contacts they can provide valuable information to landowners about planning and implementing management strategies.

Extension offices are listed in the county government section of the telephone book.

State Fish and Wildlife departments State Fish and Wildlife personnel often have firsthand knowledge of local conditions and can provide technical assistance in managing streams to enhance fish and wildlife habitats.
Notes and acknowledgments

Chapter 2
1 Adapted from Bedell, T.E. 1980. Developing management strategies for your range. Oregon State University publication EC 1036.
6 Adapted from Bedell, T.E. 1992. Grazing to maintain a healthy range. Oregon State University publication EC 1041.
7 Adapted from a form developed by the USDI Bureau of Land Management, EIS, Drewsey Resource Area, OR.

Chapter 4

Chapter 5
17 Personal communication to author.

Chapter 6

Chapter 7
(Note: Some definitions are drawn from a glossary developed by the Society for Range Management. Italicized terms are defined elsewhere in this glossary.)

Adaxial—on the same side as or facing the axis, e.g., the axil of a leaf.

Animal month—a month's tenure on the range by one animal of a specified kind and class. Not synonymous with Animal unit month.

Animal unit (AU)—considered to be one mature cow of approximately 1,000 pounds, either dry or with a calf up to 6 months old, or their equivalent, based on a standardized amount of forage used. See also Animal unit equivalents, below.

Animal unit equivalents—an expression of the energy requirements of a particular kind or class of animal relative to one AU. Generally speaking: cow with calf younger than 6 months = 1.0 AU; dry cow = 0.8; coming 2-year-old = 0.8; bull = 1.25; horse = 1.5; weaned calf = 0.5; short yearling = 0.6; and long yearling = 0.7.

Animal unit month (AUM)—the amount of dry forage required by one animal unit for 1 month based on a forage allowance of 26 pounds per day. Not synonymous with Animal month.

Auricle—an ear-shaped appendage of a plant. The structure occurs in pairs laterally at the base of the leaf blade in some grasses and laterally at the sheath apex in others.

Biota—all the species of plants and animals within an area or region.

Blade—the expanded portion of a flattened structure such as a leaf or flower petal. The blade of the grass leaf is the usually flattened, expanded portion above the sheath.

Boot stage—that point in grass growth when the plant sends up a seed stalk.

Capillary action—in watershed management, movement of water in soil in response to a given potential gradient. More appropriately referred to as capillary conductivity or hydraulic conductivity.

Capture—in hydrology, catching and retaining precipitation at or near where it falls.

Carrying capacity—the maximum stocking rate possible consistent with maintaining or improving vegetation or related resources. Carrying capacity may vary from year to year in the same area due to fluctuating forage production. See also Grazing capacity.

Check dam—a small dam designed to provide a stable, erosion-resistant step in a stream channel to reduce the upstream gradient and to trap and store sediment.

Climax—(a) the final or stable biotic community in a successional series, which is self-perpetuating and in dynamic equilibrium with the physical habitat; (b) the assumed end point in succession. See also Potential natural community.

Climax plant community—(See Potential natural community)

Collar—the outer side of a grass leaf at the junction of the blade and sheath.

Continuous grazing—livestock’s grazing a specific range unit throughout a year or for that part of the year when grazing is feasible. Not necessarily synonymous with yearlong grazing because seasonal grazing may be involved. Does not refer to level of use.

Culm—the stem of a grass.
**Decreaser**—a plant species of the original or climax vegetation that will decrease in relative amount given continued disturbance to the norm, e.g., heavy defoliation, fire, drought. See also **Increaser** and **Invader**.

**Deferment**—delaying livestock grazing on an area for enough time to allow existing plants to reproduce, new plants to establish, or existing plants to restore vigor. See also **Deferred grazing**.

**Deferred grazing**—using deferment in grazing management of a unit but not in a systematic rotation including other units.

**Ecological site**—a kind of land with a specific potential natural community (PNC) and specific physical site characteristics, differing from other kinds of land in its ability to produce vegetation and to respond to management. See also **Range site**.

**Ecological status**—the present state of vegetation and soil protection of an ecological site in relation to the potential natural community (PNC) for that site. Vegetation status is the expression of the degree to which the kinds, proportions, and amounts of plants in a community are those of the PNC. Soil status is a measure of present vegetation and litter cover relative to the amount of cover needed on the site to prevent accelerated erosion. See also **Range condition**.

**Eutrophication**—in a body of water, the increase of material and organic nutrients that reduces the dissolved oxygen, producing an environment that favors plant over animal life. Eutrophication is a special problem for cold-water fish such as trout that require highly oxygenated water.

**Evapotranspiration**—a combination of the processes of evaporation and transpiration.

**Field capacity**—the percentage of water remaining in a soil 2 or 3 days after it was saturated and after free drainage has practically ceased.

**Floret**—in grass, the lemma and palea with the enclosed flower. A floret may be perfect, pistillate, staminate, or sterile.

**Forage cycle**—the cycle of forage production beginning with initiation of growth through a generally short-term rapid flush of growth to cessation of growth at maturity. At maturity, forage supply determines whether grazed or not, until the next growth cycle begins.

**Forb**—any broadleaf herbaceous plant other than those in the Gramineae (or Poaceae), Cyperaceae, and Juncaceae families.

**Frequency of use**—rate of repeated grazing on the same plants during a grazing period.

**Glume**—the pair of bracts usually at the base of the spikelet.

**Grazing capacity**—number of livestock that may be sustained on a given area based on total forage resources available, including harvested roughages and concentrates. See also **Carrying capacity**.

**Head cut**—progressive downcutting of a channel in an upstream direction until the channel adjusts to the new base level or until an impermeable substrate stops further movement upstream.

**Increaser**—a plant species of the original vegetation that increases in relative amount, at least for a time, given continued disturbance to the norm; e.g., heavy defoliation, fire, drought. See also **Decreaser** and **Invader**.

**Infiltration**—the flow of a liquid into a substance through pores or small openings. See also **Percolation**.

**Intensity of use**—in grazing, (a) the amount of animal demand placed on the standing forage crop; (b) the resulting level of forage plant defoliation made during grazing.

**Internode**—portion of the stem or other structure between two nodes.

**Invader**—a plant species that was absent in undisturbed portions of the original vegetation on a specific range site but that will invade following disturbance or continued heavy grazing. See also **Increaser** and **Decreaser**.

**Joint**—the node of a grass stem; an articulation.

**Lemma**—the lower of the two bracts enclosing the flower in the grass flower. See also **Palea**.

**Ligule**—a membranous or hairy appendage on the adaxial surface of the grass leaf at the junction of the sheath and blade.

**Niche**—the ecological role of a species in a community.

**Node**—the joint of a stem; the region of attachment of the leaves.

**Overgrazing**—continued heavy grazing that exceeds the recovery capacity of the community and creates a deteriorated range. See also **Overuse**.

**Overstocking**—placing a number of animals on a given area that will result in overuse if continued to the end of the planned grazing period.

**Overuse**—using an excessive amount of the current year’s growth which, if continued, will result in range deterioration. See also **Overgrazing** and **Overstocking**.

**Palea**—the upper of the two bracts enclosing the grass flower in the floret. See also **Lemma**.

**Pavement**—as fines are removed by erosion, certain stony soils may develop a surface armor layer of coarse fragments, called erosion pavement, that helps protect the underlying soil from further erosion.

**Pedestaled**—a condition in which soil has eroded from around individual plants or objects such as small rocks, leaving them on small pedestals of soil. Pedestaling can...
result from actual soil movement or from freezing and thawing which lifts plants, creating a similar effect.

**Percolation**—the flow of a liquid through a porous substance.

**Plant succession**—the progressive replacement of plant communities on a site that leads to the potential natural community, i.e., attaining stability. Primary succession entails simultaneous successions of soil from parent material and vegetation. Secondary succession, which is plant succession on a more mature soil, follows disturbances on sites that previously supported vegetation. Also called *Succession*.

**Potential natural community (PNC)**—the biotic community that would become established on an ecological site if all successional sequences were completed without human interference under the present environmental conditions. Natural disturbances are inherent in its development. The PNC may include acclimatized or naturalized non-native species. Also called *Climax community*.

**Proper Functioning Condition (PFC)**—a protocol for assessing the status of riparian sites. The protocol was developed by agencies including the USDI Bureau of Land Management, the USDA Forest Service, and the Natural Resource Conservation Service. Riparian wetlands are functioning properly when adequate vegetation, landform, and large woody debris is present to dissipate stream energy during high water flows, thereby reducing erosion and improving water quality, filtering sediment, capturing bedload, aiding flood plain development, improving floodwater retention and groundwater recharge, and developing root masses that stabilize stream banks against cutting action.

**Rachilla**—the axis of a grass spikelet.

**Range condition**—(a) generically, the present status of a range unit in terms of specific values or potentials which must be stated; (b) an expression of the degree to which the kinds, proportions, and amounts of plants in a plant community resemble those of the potential natural community (PNC) for that site. See also *Ecological status*.

**Range readiness**—a condition in which all soil pores are filled with water from rain or irrigation. See also *Field capacity*.

**Repeate seasonal grazing**—a grazing strategy in which different kinds of pastures are arranged in a series and each is grazed at the same time each year, often for less than the full feasible grazing season, to provide a special use. Synonymous with *Seasonal grazing*.

**Rest**—leaving an area ungrazed, thereby foregoing grazing one forage crop. Normally implies no grazing for a full growing season or during a critical portion of plant development such as seed production.

**Rest-rotation**—a grazing management plan in which rest periods for individual pastures, paddocks, or grazing units (generally for the full growing season) are incorporated into a grazing rotation.

**Rhizome**—a somewhat elongate and usually horizontal subterranean plant stem that often is thickened by deposits of reserve food material, produces shoots above and roots below, and is distinguished from a true root in possessing buds, nodes, and usually scalelike leaves.

**Riparian area**—an area adjacent to water influenced by free water associated with streams or rivers or geologic surfaces occupying the lowest position or a watershed.

**Riparian zone**—the banks and adjacent areas of water bodies, water courses, seeps, and springs whose waters provide soil moisture sufficiently in excess of that otherwise available locally, thus providing a more moist habitat than that contiguous flood plains and uplands.

**Rotation grazing**—a grazing plan in which animals are moved from one grazing unit (paddock) to another in the same group of grazing units without regard to specific graze-rest periods or to levels of plant defoliation.

**Season of use**—in grazing, the period of year (e.g., winter, spring, season-long) when a unit is grazed.

**Seasonal rest or relief**—nongrazing for a specified period. *Rest generally is considered to be a full year of nongrazing; seasonal nonuse is considered deferment*.

**Seasonal grazing**—(See *Repeated seasonal grazing*)

**Selective grazing**—the grazing of certain plant species, individual plants, or plant parts on the range to the exclusion of others.

**Sheath**—the tubular basal portion of a leaf that encloses the stem, as in grasses and sedges.

**Soil horizon**—a layer of soil, approximately parallel to the soil surface, differing in properties and characteristics from adjacent layers above or below it.

**Spikelet**—the basic unit of the grass inflorescence, usually consisting of a short axis, the *rachilla* bearing two "empty" bracts, the *glumes*, at the basal nodes and one or more *florets* above. Each floret usually consists of two bracts, the *lemma* (lower) and the *palea* (upper), which enclose a flower. The flower usually includes two lodicules (vestigial perianth segments), three stamens, and a pistil.
Stocking rate—the number of specific kinds and classes of animals grazing or using a unit of land for a specified period. May be expressed as animal unit months (AUM) or animal unit days per acre, hectare, or section; or the reciprocal (e.g., area of land/animal unit month or day).

Stolon—a horizontal branch from the base of a plant that produces new plants from buds at its tip or nodes, as in the strawberry.

Stomata—apertures or pores in the epidermis of a leaf, bounded by two guard cells. Stomata function in the interchange of gases between the atmosphere and the intercellular spaces of the stem and leaf tissue.

Stream morphology—cross-sectional channel shape and pattern of meander along a length of stream (or river).

Sublimate—to go directly from a solid to a vapor state (e.g., from ice to water vapor) or vice versa.

Succession—(See Plant succession)

Transpiration—evaporation through stomata on leaf surfaces of water the plant has absorbed mostly via its roots and that has moved through the roots and stems to and through the leaves.

Water cycle—a cycling of water that involves precipitation and evapotranspiration with intermediate steps including runoff and storage in the air, on or in the land, and in the oceans. Also called the hydrologic cycle.

Watershed—(a) a total area of land above a given point on a waterway that contributes runoff water to the flow at that point; (b) a major subdivision of a drainage basin.
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