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Watershed Management Guide for the Interior Northwest

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Watershed Management Guide for the Interior Northwest

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Oregon State University Extension Service

Use pesticides safely!

- **Wear** protective clothing and safety devices as recommended on the label. **Bathe or shower** after each use.
- **Read** the pesticide label—even if you've used the pesticide before. **Follow closely** the instructions on the label (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.

Contents

Introduction and philosophy

Thomas E. Bedell
Extension Rangeland Resources Specialist, Oregon State University

We developed this guide to review concepts, principles, and perspectives of what watersheds are; to understand how they function; and to learn how a number of different management tools can enhance a watershed's ability to function properly.

This guide is organized differently than most publications: It contains not only original material by a number of Oregon State University Extension authors but also previously published works that bear on relevant subjects (they're identified in the contents for each chapter).

Hugh Barrett, range conservationist with the Oregon office of the Soil Conservation Service, Portland, didn't write any of our chapters; however, we credit him with much effort and thought in inspiring the development of this guide. We recognize him as an equal contributor.

Our purpose is not to give management recipes. We firmly believe readers will want to apply the knowledge they acquire here to their own situations.

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 that process clearer to you.

The experiences and background used to develop this guide come from rangeland and forestland that lies east of the Cascades. The principles we'll describe apply elsewhere also, but our familiarity, experience, observations, and research base are centered there.

We've emphasized management that restores and/or maintains fully functioning water cycles on rangeland and forestland. Land management practices must provide the opportunity for appropriate kinds and amounts of vegetation—not only to establish but also to complete their life cycles.

Frequently, such management doesn't need to be complex—but you do need to apply it thoughtfully.

We strongly recommend that you read the separate articles or publications that we've inserted into our text. These will tell you just what you will need to know to make the best use of the information that follows. We're also including some suggestions on how and where to find further information (page 3).

We want this to be a user-friendly management aid for you.

What is a watershed?

We can think of a watershed—using the simplest description—as the land on which water falls from the atmosphere, is stored within the soil, and, over a period of time, is released downslope to other locations. All land is part of a watershed.

We can also visualize each watershed as a catchment area divided from the next watershed by topographic features like ridgetops. The water that falls within a watershed or catchment, but isn't used by existing vegetation, will seek the lowest points—ultimately, it should appear in the streams and rivers draining the system.

All life depends on the soil, the water falling on that soil, and the air above and within that soil. Entire societies have disappeared because they didn't properly understand and care for their soil resource.

No other resource comes close to the soil's importance. Without healthy productive soil, plants and animals—and people—probably couldn't exist.

We don't 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 rangelands by building roads and by mining; both activities directly affect the water cycle.

With respect to watersheds, the *water cycle* refers to those processes in which water falls in either liquid or solid form and:

- is captured so it has an opportunity to move into the soil,
- stays and is retained in the soil, or
- moves through the soil by gravity into springs, streams, rivers, lakes—and ultimately the sea.

From that liquid form, it can then return to the atmosphere by evaporation—and start the cycle again.

Watershed functions

A watershed has three primary functions (the concept and the terms are Hugh Barrett's):

1. capturing water,
2. storing it in the soil, and
3. releasing it safely.

Capture

Capture means the process of water from the atmosphere getting into the soil. All moisture received from the atmosphere, whether in liquid or solid form, should have the maximum opportunity to enter the ground *where it falls.*

Managers of range and forestland can affect water capture by influencing how far the water infiltrates the soil surface and percolates.

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 factors affecting infiltration rate are fixed, such as soil type (primarily texture and depth), topography, and climate (probable type of weather events).

However, you can influence infiltration rates by managing vegetation. The form and pattern of vegetation for any site can be managed to give water the maximum opportunity to penetrate the surface where it falls. This minimizes the overland flow that causes erosion.

You can manage vegetation structure and the density of plant cover at or near the soil surface so almost all moisture that falls reaches and can enter the ground. Good infiltration rates are beneficially influenced by:

1. plant cover that reduces raindrop impact upon the soil surface and minimizes soil crusting,
2. plant litter and organic matter on and incorporated into the soil surface to absorb moisture and help maintain soil structure, and
3. plant cover that will trap snow at or very near the soil surface (this also will retard the rate of soil freezing to enhance water's chance to enter soil during the winter months).

Some moisture is captured in the foliage of trees and shrubs. In areas of low precipitation where trees and shrubs have come to dominate a site, these plants often catch snow and even some rain so that it evaporates or sublimates (goes from solid to vapor phase directly) before it has a chance to reach the soil surface and infiltrate.

Healthy vegetative cover with its accompanying root mass can keep soil more permeable so moisture readily percolates 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. Percolation also is aided by activity from burrowing animals, insects, and earthworms.

Storage of water in soil

Once water permeates into the soil, it's stored between soil particles in the soil profile. Management practices can significantly affect storage capacity on any particular site. However, keep in mind that the amount of moisture soil can hold depends on its depth, texture, and structure.

Beyond field capacity, which is the amount of water a soil holds when saturated, water will either percolate deeply or run off the surface. Soil moisture is lost in three ways:

1. through plants that grow on the site,
2. through excessive water that flows through the soil profile and into subsurface flows or seeps and then released, and
3. through direct evaporation from bare soil surfaces (capillary action).

The kinds and amount of vegetation, and the plant community structure, can greatly affect the storage on any particular site. For example, a site can have a high amount of less desirable vegetation—noxious weeds, brush, or weedy trees—that extracts water from the deeper soil profile.

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

Management or treatment practices which modify the above soil surface microclimate to reduce evaporation (slow the air movement; shade the soil and reduce temperatures) can also conserve moisture.

Safe release

In this process, water moves through the soil profile to seeps, springs, and ultimately into streams and rivers which are the conduits from the uplands. The amount and rate of water released depends on two factors:

1. the water already in the soils of the uplands, riparian areas and streambanks in excess of field capacity, and
2. precipitation that exceeds the infiltration rate and flows over the soil surface (overland flow).

We make one premise that needs to be stated here. We assume it's desirable that water should be released slowly through the stream system rather than rapidly running over the land—which results in short and severe peaks in streamflow.

The form and amount of vegetation growing in the various riparian zones strongly and directly affects both the quality and, to some extent, the quantity of timing of water moving through the soil. The most severe example of rapid release of water, whether or not safely stored or captured, would be a straight or straightened channel with little resistance to water movement.

We recognize the ideal outcomes of keeping water where it falls resulting in less runoff and more even streamflow are difficult to obtain. There are a number of circumstances or situations that interrupt the capture, storage, and safe release of water but are beyond our control.

One common example is when warm rains melt snow over frozen ground. Water can't infiltrate and has no place to go but run off. However, we do feel there are many ways we can conduct management that will beneficially affect these processes.

Managing a watershed is not complicated. We need to realize it is management of every small area and understanding the three processes that leads to success. The entire watershed must be completely cared for regardless of ownership. Each small piece of the landscape plays its part in the health of the entire watershed. 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 additional information

Because of the site-specific nature of each situation, we believe that direct conversations with qualified professionals will be the most effective way to arrive at appropriate management solutions.

One of the first sources will be the Soil Conservation Service technical guides, which you can find in local SCS offices.

Your county Extension agent will be a useful source of information.

In areas where either or both Bureau of Land Management and U.S. Forest Service offices exist, discussing situations with their resource professionals will be helpful.

Each agency has expertise to offer when they are asked the right questions.

Managing riparian areas

Thomas E. Bedell
Extension Rangeland Resources Specialist, Oregon State University

A significant part of watershed management in recent years has dealt with riparian areas. Although riparian areas are typically 1 to 2% 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.

Four inserts (listed above) follow this introduction.

"Riparian areas: Perceptions in management," by Wayne Elmore and Robert L. Beschta, appeared in the December 1987 issue of *Rangelands*. We can't improve on it, and we strongly recommend it.

We also recommend the three titles by Sherman Swanson, Extension range specialist, University of Nevada.

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Riparian Areas: Perceptions in Management

Wayne Elmore and Robert L. Beschta

A Narrow Strip of Land

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 their proximity to water, plant species and topography of riparian zones 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 (Fig. 1). 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.

Complex Riparian Issues Need Open Discussion

Interest of the public, landowners, and natural resource agencies in management of riparian areas is increasing. However, we are concerned that much discussion is misdirected, 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:

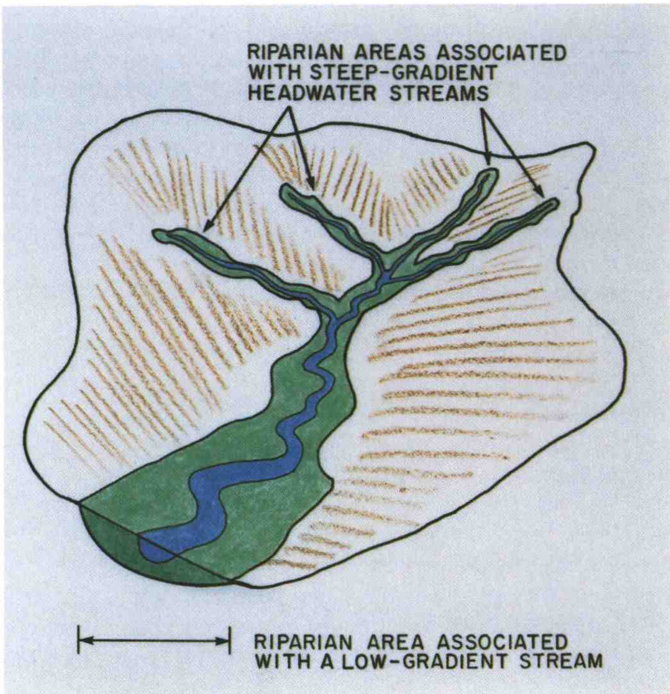

Fig. 1. *Riparian areas along a stream system.*

1. to promote awareness and discussion of riparian issues by and among livestock owners, land managers, environmentalists, biologists and the general public;
2. to identify the characteristics and benefits of productive riparian systems;
3. to encourage managers of public and private lands 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 1800's. 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 willows." Widespread beaver trapping initiated changes in the hydrological functioning of riparian areas and streams. Beaver ponds, which had effectively expanded floodplains, dissipated erosive power of floods, and acted as deposition areas for sediment and nutrient-rich organic matter, were not maintained and eventually failed. As dams 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 year-long or season-long (April-October) use.

Authors are, respectively, State riparian specialist, Bureau of Land Management, Prineville, Ore. 97754, and hydrologist, Oregon State University, Corvallis 97331.
We very much appreciate the extensive comments, suggestions, questions, and alternative viewpoints provided by the following reviewers when this manuscript was in the formative stages: Dr. George Brown, hydrologist, Oregon State University; Jim Hancock, District manager, Bureau of Land Management; P.D. (Doc) Hatfield, D.V.M., rancher, eastern Oregon; Dr. Bill Jackson, hydrologist, Bureau of Land Management; Dr. Boone Kauffman, rangeland riparian ecologist, Oregon State University; Chris Maser, ecologist, Bureau of Land Management; Lew Meyers, wildlife biologist, Bureau of Land Management; Dr. Bill Platts, research fisheries biologist, USDA Forest Service; Dr. Byron Thomas, soil scientist, Bureau of Land Management. This is Paper 2273 of the Forest Research Laboratory, Oregon State University, Corvallis.

These practices allowed livestock to concentrate their foraging in riparian areas, rather than on the adjacent hillslopes. As a result, many of the 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 are now unstable and eroding. Where channel gully erosion proceeded 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 in 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 feel 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 establish what presettlement 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 provide 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, filtering, and depositing sediment has long been underrated; they are essential to

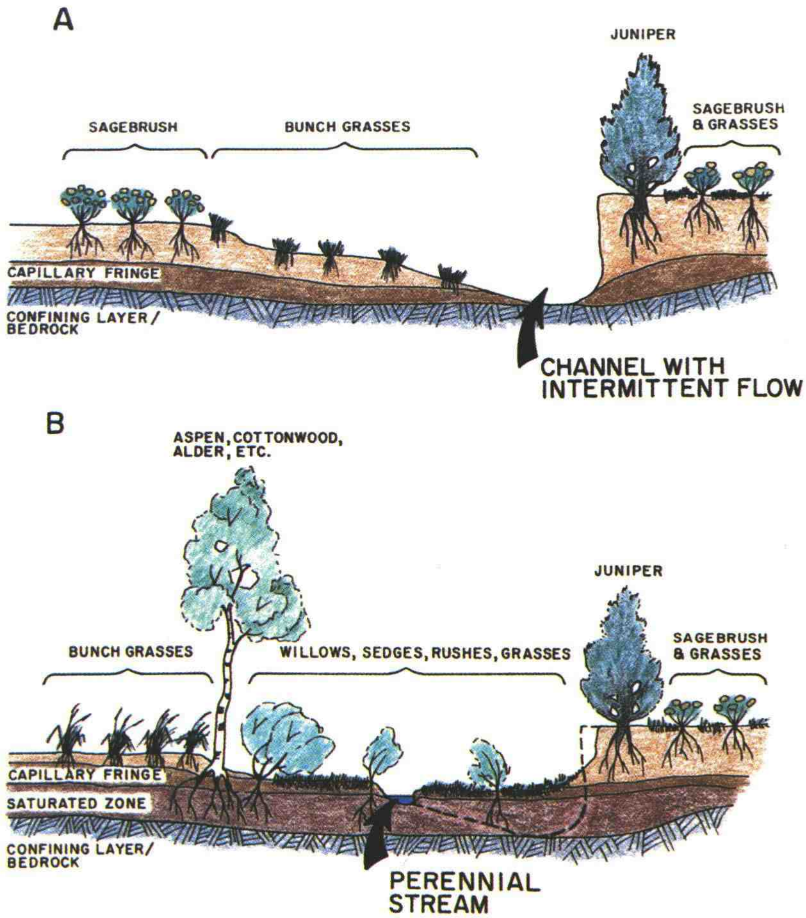

Fig. 2. *General characteristics and functions of riparian areas.*

(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 streamflow*
- *Warm water in summer and icing in winter*
- *Poor habitat for fish and other aquatic organisms in summer or winter*
- *Low forage production and 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 streamflow*
- *Cooler water in summer, reduced ice effects in winter*
- *Improved habitat for fish and other aquatic organisms*
- *High forage production and quality*
- *High diversity of wildlife habitat*

the integrity of stream channels and associated riparian areas.

Vegetation Is Important for Summer Streamflow

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 shrubs can evapotranspire 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 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). 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 building. Natural erosion rates typically provide enough sediment for successful recovery of a riparian area (Fig. 2).

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 is also 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: changing climatic and precipitation patterns, more frequent flooding, altered beaver populations, heavy streamside grazing, improper use of upland watersheds or adjacent slopes, road construction close to channels, and others. 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 is also 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% of eastern Oregon rangelands), 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 long-lasting 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. Springtime 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 are usually limited in size, allotment administration usually includes them in adjacent landforms and vegetation types. The importance of narrow riparian areas in allocation of AUMs (Animal Unit Months) 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 are typically allocated at the same intensity of forage use, often only one AUM for every 13 to 16 acres. Assuming the current public land grazing fee of $1.35 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 any 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 currently underway in 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 for using 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 channel 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. Time is required for Mother Nature to work her magic, and changes may not be obvious within the first few years. Where a channel is currently beginning a cycle of erosion, seed sources for native riparian species are absent, channel gradients are steep, or silt loads are low, 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 were streams carry substantial loads of silt during high flows. As production of vegetation increases, these areas may appear to be productive and stable systems once again. However, initial vegetation "expression" should not be confused with vegetation "succession" (Fig. 3). 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 towards a more productive and healthy ecosystem (Fig. 3). 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, reduced flood peaks, and others (Figs. 4, 5, 6, and 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 Steam System Is Unique

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 is certainly needed to improve understanding of many questions:

1. Which riparian areas have the greatest 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 stream flow?
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 habitat for wildlife and fish improve?

These major gaps in our knowledge indicate 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 long 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. 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 only spending large amounts of money to build instream structures (e.g., gabions, dikes, check dams, rip-rap, sills) or structurally modify channels will seldom "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 3 through 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.

3A

B

4A

B

5A

B

Fig. 3. *Vegetation "expression" (A) versus vegetation "succession" (B). The "expression" photo, taken in 1976, reflects species present under heavy grazing that were simply allowed to mature. The "succession" photo, taken in 1984, shows changes that can occur as grass, willow, sedge, and forb species increase. Note the narrowed channel and the well-protected, overhanging banks of the recovered stream.*

Fig. 4. *Vegetation and channel responses (A) and (B) after 3 years of rest followed by spring (May) grazing. Note the decreased width and increased sinuosity of the stream channel as recovery proceeds.*

Fig. 5. *Ten years (1976-1986) of vegetation and channel responses (A) before and (B) after 5 years of rest followed by 5 years of a late winter (Feb)/early spring (March) grazing system. Grazing use increased from 72 AUMs in 1976 to 313 AUMs in 1986. In 1976, banks were poorly defined and the stream was actively eroding the steep cutbank on the left. In 1986, the cutbank had been stabilized by vegetation. The channel had also narrowed, as vegetation stabilized stream banks being built from sediment deposits.*

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.

The View at the Crossroads

We have presented several issues and concerns that can

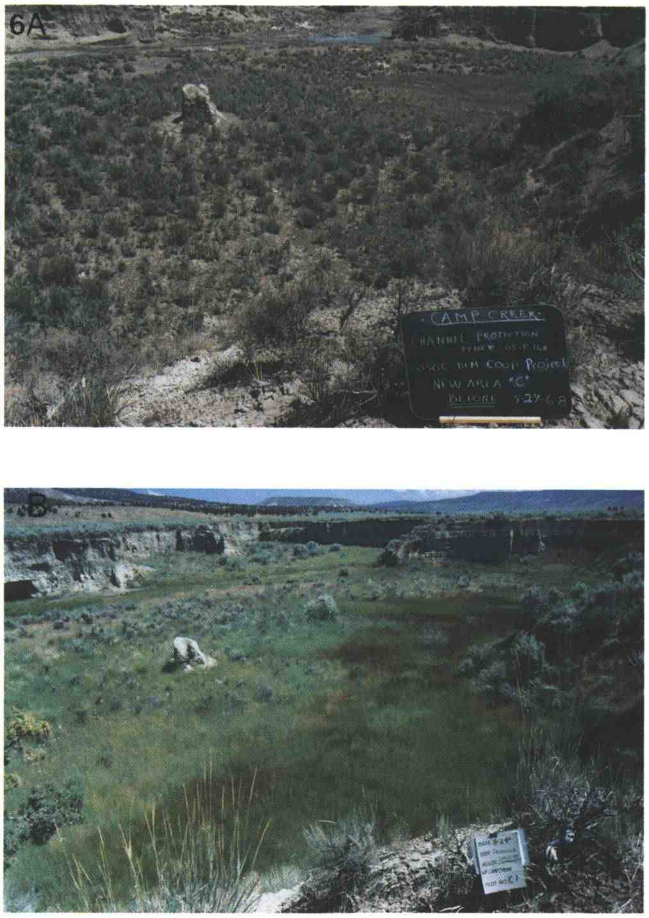

Fig. 6. *A wide, entrenched channel system that has incised 5 to 15 feet into silty-clay deposits. View (A) shows the area in 1968. View (B) shows the same area 16 years later, after exclusion from grazing. Note the expanded riparian area, as the water table influences vegetation composition across the entire bottom. Perennial streamflow does not occur during relatively dry summers either upsteam or downstream of the exclosure. Within the recovered section, however, the stream now flows continuously even during dry summers.*

Fig. 7. *Vegetation and channel responses (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 is gravel but previously was primarily fine sediments (silts and clays). These fine sediments are now being deposited at high flow—for example, on the left bank. The steep cutbank in the background, along the right side of the stream, is no longer being actively eroded by the stream.*

significantly affect the approach to managing riparian areas. Private land owners and users and managers of public lands need to reconsider 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 endeavor to focus on restoring and enhancing the unique attributes of riparian areas, we must not forget the need to manage upland areas properly. Upland areas occupy up to 99% 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.

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 importantly, they need to support changes in grazing strategies and other uses in managed riparian areas. A fresh start at establishing dialogue between 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 doesn't know the difference) to initiate management strategies that will allow our stream and riparian systems to approach their productive potential.

Notes

Fact Sheet 87-53

University of Nevada Cooperative Extension

RIPARIAN PASTURES

Sherman Swanson, Extension Range Specialist
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INTRODUCTION

Range managers have increased their attention to riparian values in recent years. Areas once considered sacrifice areas are now considered critical areas 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 forgage may no longer be grazed.

Management practices can be applied to accomplish practical livestock production and proper management of upland and riparian areas. These include: implementing grazing systems; developing hillside water; improving nonriparian vegetation; herding; 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 where 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. 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: (1) water is not well distributed; (2) the land near riparian water is steep or rocky (especially if all the water is riparian); (3) salt is placed in or near riparian areas; (4) the weather is hot and riparian shade is available; (5) nonriparian forage is less palatable than riparian forage; (6) the herd is composed of cows with calves as opposed to yearlings; (7) individual animals develop behavior patterns that favor riparian areas; (8) animal distribution is not maintained by herding; and/or, (9) 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. Cattle using riparian areas in spring, can cause physical damage to stream banks and meadows. Soil compaction can also be an important problem in moist (but not saturated) loamy or clayey soils.

Cattle use of riparian areas generally increases as the summer progresses. It reaches a peak 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 and create green up on uplands, 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 are generally 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 overused.

The cost and amount of fence required for riparian pastures may not greatly exceed that needed for riparian exclosures. Side-fence lengths can actually be shorter because the fence can be straighter. A riparian exclosure 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 they provide water for surrounding, upland, big-game habitat. Riparian areas in antelope habitat should also have a smooth bottom wire that is no less than 16 inches off the ground. Deer generally go over fences and antelope go under.

RIPARIAN OBJECTIVES

Writing good reachable objectives for riparian values is perhaps the most technical and important part of riparian management. When setting riparian objectives the manager should: (1) use stream and riparian classification methods to identify similar riparian settings and then compare areas grazed differently; or (2) identify current problems that are obviously caused by livestock and then seek to eliminate at least some of the direct impact.

On streams that have already 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. Broad 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.

MANAGEMENT OF PASTURES FOR RIPARIAN OBJECTIVES

How to manage riparian pastures depends largely on the vegetation needed for stabilizing the stream bank or providing 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 LINE STREAM

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 three year's growth on woody species.

GRASS, SEDGE AND RUSH-LINED STREAMS

The effects of improper grazing may show up quicker and be difficult to reverse along streams that depend on grasses, sedges, and rushes. On these streams, rotation grazing systems that include late-season use sometimes work well. Early-season grazing works well when overall livestock distribution favors nonriparian areas and when sediment can be trapped in last year's regrowth and stabilized by new growth.

RECOVERING GULLYS

Sediment can build stream banks and raise the bottoms of old, wide gullys. Some gullys 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: (1) stream banks are generally firm; (2) there is still sufficient soil moisture and warmth for riparian vegetation to regrow before winter; (3) sediments in spring flood waters have been trapped by last year's standing dead regrowth; (4) herbaceous species may still be green and forage preference has not yet shifted to woody species; and, (5) livestock can most benefit from green feed after upland range has matured. The reason for a short season is to minimize grazing of regrowth and to achieve, but not exceed, proper use levels. Use at this time can be heavy if the season is very short and there is moisture available for regrowth. Use can be prolonged if ultilization levels are conservative.

LOCATION AND SIZE

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

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UNIVERSITY
OF NEVADA

FACT SHEET 86-76

University of Nevada Cooperative Extension

The Value of Healthy Riparian Areas

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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 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 oasis in the desert that attracts humans, livestock, and wildlife.

Riparian vegetation stands out from the surrounding desert landscape. It provides scenic qualities that make people want to relax and spend some time. Most recreation sites feature riparian 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 for a much longer part of the year than upland vegetation. Therefore, it can be used to 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 use upland range forages that could not be harvested by man in any way other than 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 are usually 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

Wildlife use riparian areas more than any other single habitat. Big game usually go to riparian areas for water and stay to browse or graze on riparian plants. These plants may also provide necessary hiding or thermal cover. 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 vertebrates living on rangeland need riparian areas or use them for some critical period of their life.

WATER

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

For many purposes, the amount of water may not be as important as the quality or the timing of water. Floods from snow melt or thunderstorms may even cause damage from too much water too fast. Riparian vegetation plays many roles in determining the quantity, quality and timing of water flow.

VEGETATION

Vegetation improves water quality by filtering out sediments and nutrients from flood flows. When plants reduce water velocity, sediments drop out of water adding to flood plains. Plants grow in this sediment and their roots bind the sediment together to hold stream banks when future storm flows change the channel. Riparian flood plains store water during high flows and release it back to the stream during long dry periods. Well-knitted, stable stream banks and riparian vegetation provide overhanging banks that shelter fish and shade water.

Fish rely on high quality water that stays within the correct temperature range and maintains high levels of dissolved oxygen. Water with excess nutrients flowing through wetlands, like marshes with dense vegetation, becomes cleaner. The community of life removes nutrients that may cause downstream eutrophication, a condition where water becomes choked with too much organic matter and may appear green and murky. When the organic matter decays, it uses oxygen and may deplete the dissolved oxygen supply below that which fish require. Eutrophication is a special problem for cold water fish like trout that require highly oxygenated water.

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

A shallow, wide stream does not provide habitat for fish that is as good as the deep, narrow stream it replaced. Shallow streams catch more sunlight and warm up. Warm water doesn't hold as much dissolved oxygen and this may eliminate trout. Wide, shallow streams also provide less hiding cover. The fish that do survive don't live long enough to grow very big. Riparian vegetation often inmproves 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 can no longer 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 will likely 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 of their new, unprotected channels. On the old flood plain, the riparian vegetation that depended on a high water table soon dies out. This situation can also happen when a head cut works its way up through a meadow forming a gully.

GULLY EROSION

Gully erosion or down cutting of streams is a serious problem for riparian areas because water is the ultimate cause of the high values. With water, riparian areas are the most resilient of all range ecosystems. When they are stressed, their species composition changes and 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 quickly met and plant succession is usually rapid. Without water, riparian areas cease to exist. Even if water remains available, but in reduced amounts, 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, loose rock, check dams.

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. Some streams rely on cobbles and boulders for their stability. These streams remain stable no matter what happens to the riparian vegetation, although even here, riparian vegetation provides many other resource values like wildlife and livestock forage, nesting habitat, and shade. Other streams rely on occasional inputs of large organic debris such as logs or branches. Sometimes these streams remain in balance for many centuries because of their close association with, say, an aspen community. However, if some event, such as a combination of beavers and cattle, removes the supply of logs by preventing successful tree production, or a road removes part of the stand or increases flood flows, the stream may unravel. Years later, after the logs rot, it may suffer severe erosion in a few flood events that previously would have had little effect.

Stream riparian areas that have healthy vegetation and a flood plain, trap some of the water, hold it, and then slowly release it. This is important for reducing flood damage. It is also important for augmenting flow during drier times. A prolonged or more even flow benefits fish, wildlife, and livestock as well as man.

MANAGEMENT

Proper management of riparian areas involves all land users. It is every persons responsibility to protect this vital resource while enjoying its tremendous value. Those who make management decisions have a special responsibility to understand the needs of streams and riparian vegetation. With proper management, all multiple users will benefit. Without proper management we may lose a treasured resource that is irreplaceable.

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FACT SHEET 86-77

University of Nevada Cooperative Extension

Options for Riparian Grazing Management

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Riparian areas include riparian ecosystems and aquatic ecosystems such as streams, lakes, ponds, and springs. Riparian ecosystems serve as the transition between the aquatic ecosystem and the nearby upland terrestrial ecosystem. They are identified by soil characteristics or plant communities that indicate free or unbound water.

RIPARIAN VALUES

Riparian areas add tremendous diversity and value to arid and semiarid rangelands. Water and wet soils sustain lush vegetation that serves many uses: riparian vegetation may control water flow and other stream characteristics such as fish habitat; most livestock in Nevada use riparian vegetation at some time; the majority of wildlife species depend on or use riparian areas during some critical phase of their life; and people enjoying outdoor recreation use riparian areas more than any other type of rangeland. Yet, riparian areas are small. All this use is concentrated on less than 1 percent of the land.

The water in riparian areas provides many valuable functions on rangeland and downstream. Livestock and wildlife depend on riparian water supplies for using vast areas of rangeland. Streams provide valuable habitat for fish prized by recreationists. Downstream, water is commonly diverted to irrigate hundreds or thousands of acres. It may also serve as potable water for ranches, towns, or industries.

LIVESTOCK USE

Cattle naturally concentrate in riparian areas. They find green grass, water, and often shade, all within easy walking. Cattle often stay in riparian areas after forage is scarce even when they don't find a full day's ration. It has long been recognized that areas around water troughs should be considered sacrifice areas because of the intensive use made by cattle near water. We are beginning to realize that riparian areas are too valuable to sacrifice, especially where vegetation depends on abundant water and this vegetation in turn controls water flow.

Livestock use concentrated over a substantial part of the growing season damages the very resource that attracts such use. It damages vegetation that may be holding a stream bank together. A narrow, deep stream that supports a healthy fishery may turn into a shallow, wide stream where water becomes too warm for fish and where fish, without cover, fall easy prey to predators. Some streams have their meanders cut when the vegetation weakens. Cutting out through meanders increases stream gradient, velocity, and cutting power. Soon 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 not knowing how, nor having the ability, 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.

A fisheries biologist,* widely acknowledged for having discovered many of the problems common to cattle grazing in pastures with riparian zones, makes four note-

*William Platts, personal communications.

worthy points on the question "Can we graze riparian areas?" First, he says, "Yes, we can graze riparian areas." Secondly, "We ought to be able to increase the AUMs of forage harvested in riparian areas without damaging fish and wildlife habitat." Thirdly, "We don't 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 don't get our management act together, the public won't let us graze riparian areas because of the high resource value and the potential for damage from improper grazing."

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 treatment or system of treatments will work everywhere. Some riparian areas respond well to proper management of the surrounding allotment or pasture; others must be managed as separate units. Different riparian areas have different potentials. Some will produce trees that provide shade and nesting habitat for birds, including raptors (predatory birds), and others will produce lush meadow vegetation as their best crop. Most riparian areas support a diversity of vegetation types which may each encompass only a small area. Some streams can support productive fisheries and others never could.

RANCHER'S ROLE

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 cows 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 work for their country. Grazing managers have known for a long time that there are no alternatives to riding in wide open country with big pastures typical of the western range. Pushing cows into new territory and getting them situated is a continual chore that never goes away. Besides, if a rancher is not out there riding, he/she won't see the problems developing soon enough to prevent them. The problems that ranchers didn't prevent are the ones that have many concerned citizens talking about national legislation today.

FENCES

Perhaps the worst case scenario for national legislation requiring "projects" and "action plans" is that well-meaning people will interpret these words to mean "build exclosures." The job of ranchers and other range managers is to solve riparian problems before the exclosures get built and prove it with monitoring. Riparian exclosures have been a menace to many ranches. They mean forage unused, problems in animal movement and annual maintenance hassles in the floodway. On the other hand, exclosures can take the pressure off a trout stream or spring/bog so that appropriate use can be made of the rest of the pasture.

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 sidehill. It may be harder to build but it 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, 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 will cross a stream. In steep country it is sometimes useful for coaxing cows up a hill slope to put the fence in at a low angle. So, as cows go up country, they do so gradually and willingly. If cross fences are in, or in some country, even if they're not in, there's the option of grazing systems, and if one fits, it may work. Deferred rotation, rest rotation, short duration, time control and other grazing systems each work in some country. None of them work everywhere.

SEASON OF USE

Another management tool is the season of use. In some areas, turning cows out earlier helps because the cows graze hillside feed while it's still green. A recent grazing plan called for grazing earlier in the spring when cheatgrass is green. This not only solved a riparian problem but a fire hazard problem as well. Later grazing works better in some areas because the stream banks have dried out 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 problems in riparian areas. Yearling cattle may be much more willing and able to forage widely and 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 quicker if they know there is something up there worth going after. Grazing before flowering on cheatgrass will pull livestock onto the dry sites, but the trick is keeping them there when forage preference switches. Burned areas have long been known to attract grazing as has fertilized range and seedings at certain times of the year and if they don't get wolfy. If the seedings are just grass, then the time of year is early and short at most elevations; but if the seedings have some deep-rooted forbs like alfalfa or some shrubs like fourwing saltbrush, they may be favored into the mid to late summer.

Of course any forage will be of little value without water and salt nearby. A lot of bad grazing habits get started when cows come to the stream looking for a drink or a salt lick.

C R M P

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're helping to solve a problem, the more they'll 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's CRMP because if it isn't, everyone won't agree, and if everyone doesn't agree, is isn't CRMP. No participant has perfect knowledge, but everyone can share the knowledge they do have and help develop a reasonable approach.

MONITORING

Any plan should be monitored to see if it gets implemented as planned and to see if it works. Monitoring means observing what happens and keeping records of actual use, growing conditions, and events that change things such as floods, beaver dams, etc. 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, under use, or nonuse of feed. Also, monitoring includes taking pictures, especially of areas where improvement is targeted.

RECOVERY

Riparian areas are called fragile by many. Anyone who has looked has seen areas that look mistreated, but where the water table remains where it should be, riparian vegetation is the most resilient on the range. Many range and ranch managers are probably a little miffed by all the hubbub since 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 be able to talk convincingly to concerned citizens and agency biologists.

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Managing upland watersheds in grazed semiarid rangelands

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

We may need to remind ourselves of the historical pattern that brought us to our current position. Before the early 1800's, before European peoples settled the area, most of the arid rangelands of the West were in a state of dynamic equilibrium or ecological climax.

Fire, floods, and periodic overgrazing by wild herbivores occurred, but ample time passed between such disturbances to maintain stable plant communities.

After white settlers introduced domestic horses, sheep, and cattle, overgrazing brought about a period of devastation. No one knew about rangelands, carrying capacities, plant ecology, or soil genesis.

Further, the vast rangelands were "unowned," prompting a "tragedy of the commons": Each tried to graze more forage than his/her neighbors. In a matter of decades, the ecological balance unraveled.

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 1930's—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 1960's, but especially in the 1980's, 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 that we're on the right track. But we're still a long way from where we need to be. Many upland rangelands are in an ecological condition that renders them less productive than they could be.

Many riparian areas are severely eroded and 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's still much important work to do.

Management opportunities

As we look to things landowners can do with grazing management to maintain watershed productivity, our options tend to settle into several categories:

1. the number of animals (stocking rates);
2. the timing and duration of animal use; and
3. the distribution of animals.

Number of animals or stocking rates

This concept suggests that 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.

Timing and duration of animal use

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

A whole array of grazing systems has developed, all of which have some sequence or pattern of grazing and rest. There's no one best system. Each must be designed for a specific set of climatic, soil, topographic, and managerial objectives. After careful consideration, you can make a site-specific grazing prescription.

Animal distribution

There are aspects of animal behavior that also play a role in proper rangeland management. Different species, breeds, and classes respond differently to increasing steepness of terrain, distance from water, and density of tree and shrub cover.

To make any grazing prescription work, you must be able to capitalize on these animal behavior differences and responses to ensure that the rangeland doesn't become overused in one area and underused (or even unused) in another.

Herding, riding, fencing, trail construction and maintenance, salt placement, and water developments are all tools to this end. It's 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.

A key premise

Finally, you'll 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 the spot where it falls to the earth.

As infiltration improves, soil moisture is increased, plant growth and development is enhanced, subsurface water flows, groundwater recharges, springs and seeps become more active, streamflow is prolonged and erosion is minimized. As infiltration increases, overland flow is decreased, reducing the amount of soil erosion.

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

You need to remember these key points:

- Healthy roots enhance the movement of water into the soil.
- Healthy living tissue breaks up raindrops, provides shade, and covers 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'll 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."

Managing rangelands

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Rangelands are unique and distinct kinds of lands. Their vegetation is composed mostly of grasses, grasslike plants, forbs, and shrubs. Trees may or may not be present in varying amounts, depending on rainfall.

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

Range management should focus on the vegetation that's the key to watershed health. Management prescriptions should deal with the effectiveness of various practices as related to the water capture, storage, and safe release functions of the watershed.

Although it's not generally desirable to concentrate on only one plant species, it's not unusual for a species to have a "choke hold" on the site because of past management.

An example might be dense stands of western juniper. This tree occurs naturally in central and eastern Oregon; before the coming of white settlers, periodic fire apparently kept stand densities in check. However, western juniper has expanded its range dramatically in the past 70 years.

This tree requires a great deal of water, and as stand density increases, a disproportionately high percentage of available water goes to support the trees. This upsets the water cycle, and the overall area becomes drier as a result. By restoring an effective water cycle on rangeland, you'll usually improve the levels of other products besides water.

Developing management strategies for your range

We'll cover topics that range cow-calf producers will face as they develop management strategies for their overall operations. We've made two underlying assumptions. First, that spring calving is the common practice; second, that hay would be made and used for winter feeding. When producers do neither of these practices, the parts addressed to those topics don't affect them.

We'll provide a yearly calendar of management events or activities and a management planning section. The planning section is first because it sets the stage for those events in the yearly calendar.

Management planning

Every producer makes plans, whether formalized or not. Many plan over a more or less continuous time throughout the year. This is good. Designating one central time of year for planning has some merits as well. These 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; if any "slack" time exists during the year, it should be then.

Review year just completed. Analyze your notes and records carefully. Then answer these questions:

- How well did you meet all of the objectives that you had planned?
- What kind of a range forage year was it? How was it different in terms of both weather and the effect that weather had on the amount, time, and quality of forage growth?
- How well did the forage supply and demand work out? 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?
- What adjustments did you make from your plan? Were they effective in meeting your objectives?
- To what extent did weather positively or negatively affect plant and animal production as compared to your direct management? In other words, is your management having positive effects?

Review your long-range ranch plan

- Is it still viable? Are the goals realistic as you build your record base? Discard or revise the impractical or unachievable goals.

Set objectives for the coming year

- Consider tax management and lending/borrowing policies. They can greatly affect objectives.
- Break objectives into subobjectives and develop procedures to meet each. 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 months of grazing based on forage potential. Let's say you currently product 300 animal months. To get to 500 animal months may take several changes—for example, more stock water and grazing adjustments in both time and number.

So, set something less than 500 for this year, perhaps 350 or 400. Try to achieve it by a change in the pattern of grazing use, perhaps through another water development or a change in salting patterns.

Develop grazing plans and schedules

- Based on forage production and utilization data or observations, determine where grazing management changes would be beneficial.
- Determine what improvements in the coming year would be needed to put those changes into effect.
- Build in necessary flexibility to accommodate a poor forage year or a similar condition.

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. Are your cows breeding back

faster, and in larger numbers, since you began using the new seeding as a breeding unit?

- Are they giving your operation the management flexibility you intended?
- Review maintenance schedule for fences, water developments, roads, etc.

Adjustments in livestock numbers

- Is your forage and range management permitting increases in numbers? If so, you must plan *in advance* when and how to buy, what classes to buy, and how many to buy.
- Maintain proper seasonal balance of feed supply and animal demand.
- Let your lender know your money needs well in advance.
- If you plan to put part of your ranch in a nonuse category to permit range improvements, you may need to reduce livestock temporarily.

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.

Hay production

- Review overall hay management program. For example, be certain the kind and amount of fertilizer used is paying its way. Order supplies well in advance of need.

Calendar of management activities

This is intended to be a reminder of major considerations, not a list of things to do. Keep a record of your own activities and modify those in this calendar as they fit your operation. It's very important to keep a daily diary/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.

Record notes made on utilization checks. The information you record will be quite useful each winter when you review management plans for the coming year.

Winter. Range plants generally will be dormant and main management concerns will be for livestock health and well-being. For livestock that are wintering out, make certain ample forage is available for selection, since nutritive values may be at their yearly low. Cattle with access to palatable shrubs in addition to grasses will be better able to meet their needs than on grasses alone.

- Completely dormant perennial grasses and forbs should not be damaged by high levels of use. More damage can occur from physical effects than from defoliation. *Caution:* If plants aren't completely dormant, use levels should probably not exceed 60%.
- Annual plants will normally be dead so removal will not be damaging. Fall germinated annuals will be too short to provide adequate forage for more than subsistence.
- Removing more than about 75% of current twigs will be detrimental to most shrubs. Some energy for maintaining plant health is stored in twigs.

Spring. Record the date each species starts to grow. This will help you project when ranges will be safe to begin spring grazing that year. Build an initiation-of-growth record over several years. You'll 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 first spring pastures, when available. This allows deferring use of native pastures. Crested wheatgrass will be more dependable than native species in providing forage at that time. Cows will receive a flushing effect from crested wheatgrass. Stock at 3 to 4 acres per animal-unit-month (AUM) during early season and 1 to 2 acres/AUM during late spring on full stands in healthy status, as an example.
- Use rough country with yearlings rather than cows and calves if that option is available. Yearlings will cover country better and make more efficient forage use. Weigh yearlings before turning them out so you can determine their performance from range forage.
- Fertilize hay meadows. Leave a check strip so you can determine relative value of fertilizing.
- Assess effects, if any, of winter big game use on spring forage supply. Quantifying the impacts will be necessary if justifiable cases are to be made for reducing the wildlife impacts.

Summer. Coordinate federally leased forage activities with appropriate range conservationist. Make sure that communication channels are clear and no misunderstandings occur.

- Record the kind of a forage year by range unit.
- Record degree of grazing use by date. Are your grazing objectives being met? Degree of grazing use on a particular date will vary. For example, in a good forage year, amount of use will be much less unless stocking rate was increased to make up the difference. Total use and where it occurs should reflect the true situation.
- Record the actual grazing use so overall grazing capacity can be determined. Combined with trend in range condition, actual use information can be helpful in assessing whether target grazing capacities are realistic.
- Record hay production by field. Also record species composition and expected feeding quality.
- Record conditions for hay making.
- Determine value of fertilizing by comparing production in check strips against the remainder of the fertilized unit.

Fall

- Determine animal production: (a) weights of yearlings and gains on range and/or pasture, (b) weights of weaned calves.
- Determine percent pregnancy of your cattle. Was there a positive relationship between feed conditions during breeding time and percent pregnancy?
- Make an overall use map for all grazed pastures. Use the information that has been developed during the season. Use the map in planning for the next year.
- Assess degree of seedling establishment for new range seedings. Are they well rooted? When can you safely schedule grazing?
- Take soil samples from meadows and other areas you want to fertilize, to determine specific nutrient needs.

Continuous management activities

- Monitor grazing activities—make sure grazing plans work right. Use salt and water to distribute grazing. Move a fence location if it will help.
- Watch for poisonous plants and noxious weeds. Locate them on a map to make future control easier.
- Make use checks. Build up your information base so you can make better overall use in future years.
- Don't be reluctant to ask your county Extension agent or Soil 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 a common name. It's 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's necessary when you inventory.
- You can't rate your range without knowing the main species.
- Some species are grazed more than others.
- Some are more productive.
- Some are undesirable, for whatever reason.
- Some indicate particular site conditions and particular ecological conditions.

Each plant has specific parts with particular functions. Plants usually have roots, crowns, stems, leaves, and seedheads. 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, and this category is emphasized here. Figure 4-1 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 roots 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 actually creeping underground stems with joints and leaflike scales. You may have seen quackgrass or western wheatgrass rhizomes producing a new plant. Rhizomes store food andproduce new plants.

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

Aboveground, a plant may be divided into vegetative and flowering parts. Vegetative plant parts include the stems and leaves. The grass stem is made up of nodes (joints) and internodes (between the joints); it's usually hollow, but sometimes it has pith in the center, similar to corn. 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's 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 small leaflike projection known as the *ligule.* On the outside of the collar, on some grasses, are two ear-shaped tips that clasp 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. The growing point of forb stems 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, the lemma and palea remain with the seeds after they ripen and fall.

If you don't have an identification key—and you need to know the name and importance of a plant—take the plant to your county Extension agent or to some other range technician.

If they can't identify it for you, keep one specimen and send another one 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 and shipping or storing in a collection if you press each specimen.

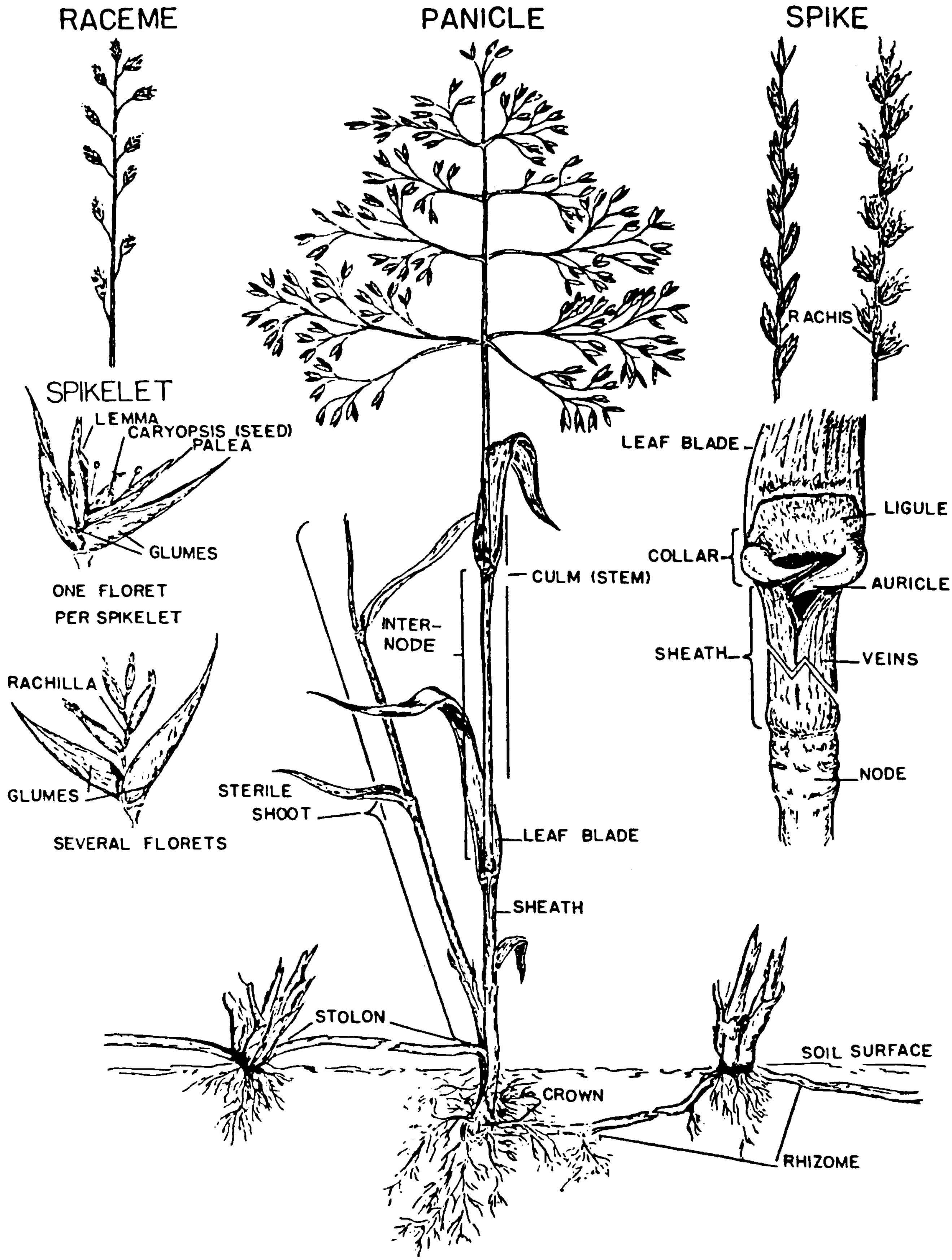

Figure 4-1.—The grass plant

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 seeds. They don't grow a second year from roots or crown. Examples are cheatgrass and Russian thistle.
- *Biennial* plants live 2 years and reproduce by seeds the second year. Yellow sweet clover is one. There are no biennial grasses.
- *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 are also grouped according to their growth form (their shape or how they look as they grow).

Because range plants are so numerous and so different in their forms and growth habits, we use five main groups for convenience in range management: grasses, grasslike plants, forbs, shrubs, and half-shrubs (figure 4-2). The next five sections describe these common range plants.

Grasses

Grasses and plants with jointed stems; stems are generally hollow, leaves are in two rows on the stem; veins on the leaves are parallel. These are "true grasses" and are among the most important kinds of range plants. Examples are:

- bluebunch wheatgrass (perennial bunchgrass)
- quackgrass and western wheatgrass (perennial 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. Veins are parallel in the leaves. These are sedges and rushes. Examples are:

- elksedge (triangular in cross section)
- Baltic rush (round in cross section)

Forbs

A forb is a nongrass plant with annual stems (tops). There are usually netlike veins in the leaves. Examples are weeds and range flowers. We use the term *forb* instead of *weed* because weeds are best 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 (perennial creeping rhizomes)
- tapertip hawksbeard (perennial roots)
- bull thistle (biennial roots)
- tumbling mustard (an annual forb)

Shrubs

A shrub is a woody plant; its stems and buds live over the winter above the ground and 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 of shrubs are:

- big sagebrush
- rabbitbrush
- bitterbrush

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:

- matchweed
- winterfat

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

Green plants are the foundation of all life. Understanding how they grow and how grazing management affects growth is basic to range management. Grazing can hurt or help plants, depending upon when it occurs and to what extent. Knowing how various species function permits more than just improved grazing management.

For example, you can control weedy species by planning certain activities at their most susceptible periods of growth. Short periods of early growing season grazing have proven beneficial to help thicken up new grass stands.

This is especially effective when species growth periods are different enough, such as early-growing annuals and later-growing perennials.

Photosynthesis is the process by which the plant produces its own energy or food from the sun's energy by combining water, carbon dioxide, and plant nutrients in the presence of chlorophyll contained in the green leaf.

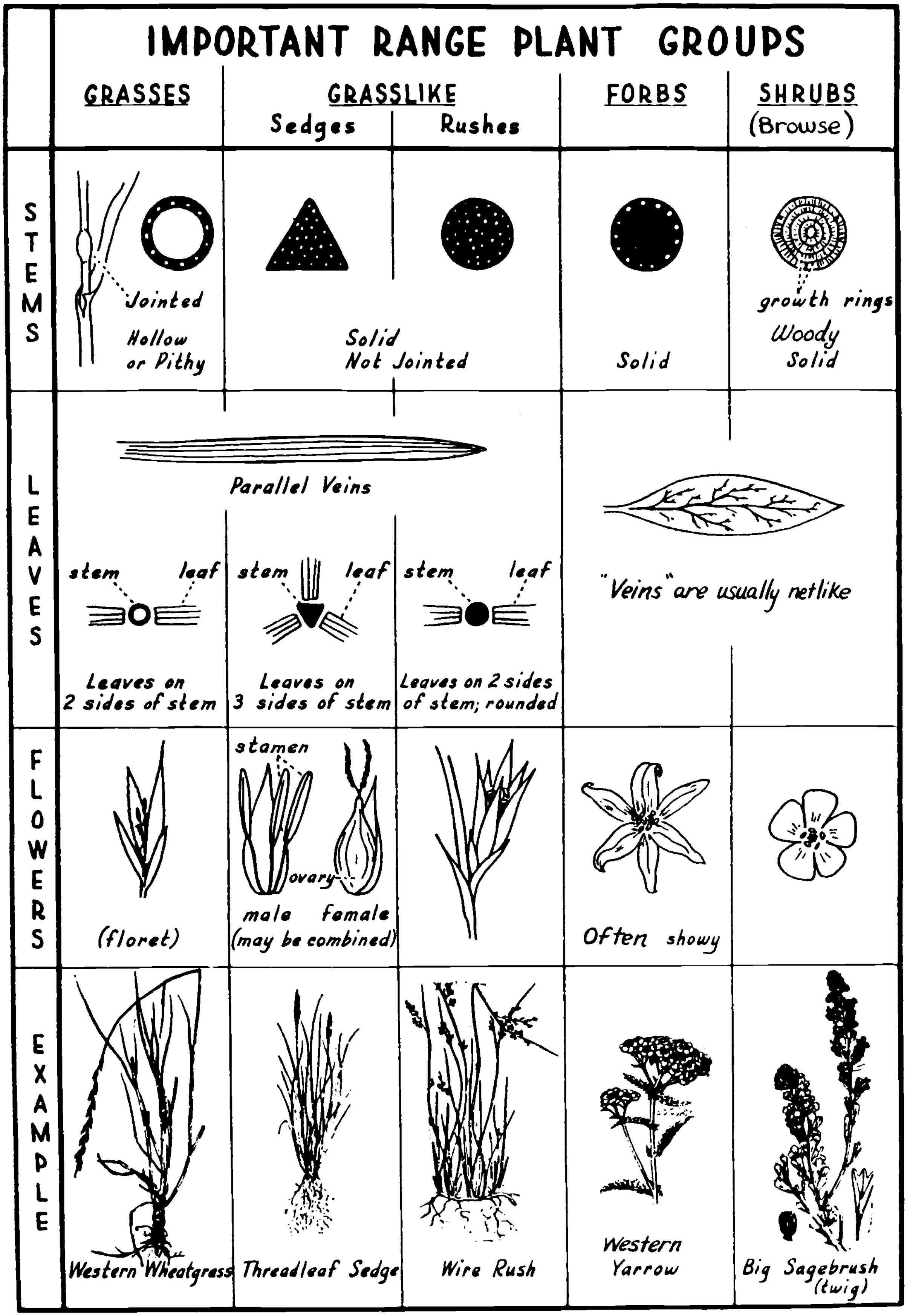

Figure 4-2.—Important range plant groups

A large number of factors affect the rate at which this process occurs; on range or pasture the most effective factor that land managers can control is the time and level of leaf removal. The amount of energy produced relates to the amount of effective leaf area (number, size, and activity of green leaves).

Energy or plant food is also consumed by the process of respiration. This process continues as long as the plant lives. Perennials undergo dormancy periods of varying length each year. Throughout these dormant periods, plants remain alive through respiring some of their stored energy.

Except for evergreens, perennial plants must send up new leaves and start their growth cycle anew each year. In doing so, they depend on stored energy. Perennial grasses and forbs store energy in roots, crowns, and stem bases. Shrubs store it in roots, crowns, and twigs (buds).

Old leaves of grasses and forbs are no longer living after growth ceases each year. Their removal then won't affect the level of stored energy—that energy was transferred from leaves to the storage sites earlier in the season.

As a survival mechanism, plants have the ability to store excess energy, but this ability 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.

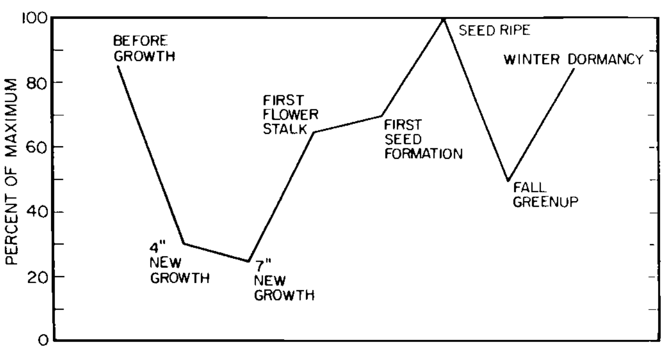

Figure 4-3.—Available energy in roots of bluebunch wheatgrass at varying stages of maturity

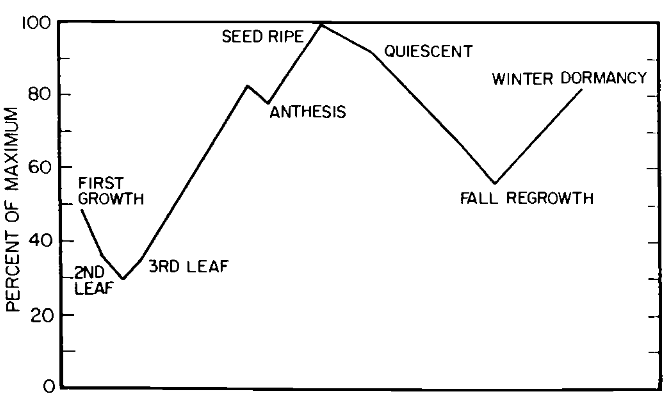

Figure 4-4.—Available energy in roots of squirreltail at varying stages of maturity

So understanding the survival abilities of plants on your ranges has much to do with perpetuating their productivity.

The amount and vigor of new spring growth of perennials depends upon the level of energy stored the previous growing season. Roots begin growth before leaves, in some cases several weeks before. The general pattern of energy or carbohydrate decline or depletion is fairly similar among species, but the pattern of storage is not.

Growth after dormancy periods requires using stored energy. This depletes the total amount of available energy within that plant, so the reserves must be restored for the plant to maintain health and vigor. The plant must grow on past these early stages and start to restore energy that it used. Most perennial grasses are still storing energy up to the time of seed maturity.

Some species, like bluebunch wheatgrass, must make at least half the season's growth before reaching the energy level at the beginning of the season. Other species, like squirreltail, reach that level by about the fourth leaf stage (figures 4-3 and 4-4).

The period between the time energy stores are reduced and recovered is really the most critical time during the annual growing cycle. The plant must have enough leaf area remaining after grazing to make more growth. This growth comes from photosynthesis occurring within remaining leaves, not from stored energy.

The more active leaves that remain after grazing, the greater the chance for more growth. For this to occur, there obviously must be enough soil moisture remaining.

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

Energy is needed at all times, but there are three especially critical periods in the life cycle:

- First is early spring when new growth is initiated. Energy is drawn out of storage.
- Next is the active reproduction from flower stalk to seed, when energy comes from upper leaves currently producing it.
- Last is fall regrowth. Energy comes from storage here, too. In addition, plants need energy to replace grazed leaves and to withstand drought conditions.

One of the reasons for range deterioration in the turn-of-the-century era is that livestock owners and operators didn't 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, don't expect seed to be produced in the dry years.

Managed spring grazing and grazing after maturity don't greatly affect energy storage and don't seem to injure plants.

Studies show that root growth slows and may stop if enough tops are removed. But when less than 50% is removed from most species at this time, little to no effect takes place.

If spring grazing is only for a short time period and is stopped while enough soil moisture remains to allow ample regrowth, the plant should restore the energy it needs.

Grazing shouldn't occur again until the leaves have made good regrowth. When growing season moisture is very limited and plants are grazed severely, there won't be enough leaf area left for the plant to both extract remaining available moisture and 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.

Low energy reserves, whether caused by past grazing practices or not, also weaken the plants' ability to tolerate cold winter temperature. The concentration of the cell sap is raised, which lowers the freezing point. Low food reserves result in reduced root growth and decreased drought resistance.

It boils down to this: A continuously, closely grazed plant can't supply its own needs, and it's 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 a great deal from plant group to group and, of course, from species to species. Buds of forbs and shrubs occur 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 so bud removal can occur, followed by relief from grazing, new growth from lateral buds may keep up production. Depending on the species, the ratio of reproductive to vegetative or leafy twigs or stems will be different. This can affect the forage quality.

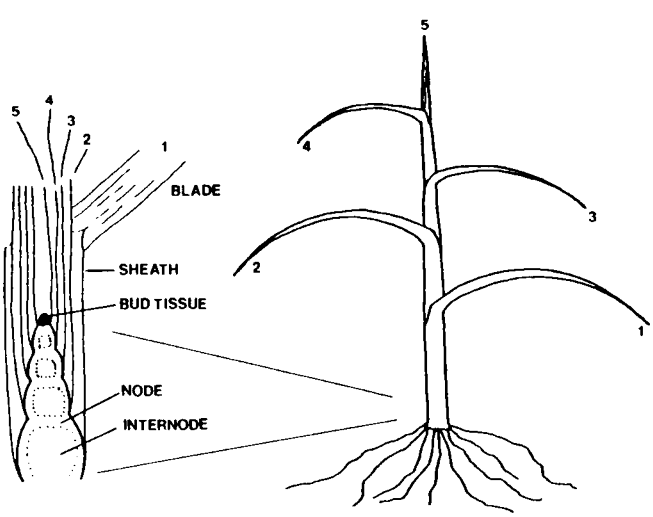

Figure 4-5.—Anatomy of a grass stem

Grasses are uniquely suited to be grazed because their growing point is protected inside the plant for most of the growing season (figure 4-5). 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 unrolled or unfolded, its growth is complete.

Grasses have two common growth forms—stemmed and stemless. Stemmed grasses tend to have a high percentage of reproductive to vegetative stems (figure 4-6). Some stemless species also have a high reproductive-vegetative ratio, but several, such as the bluegrasses and

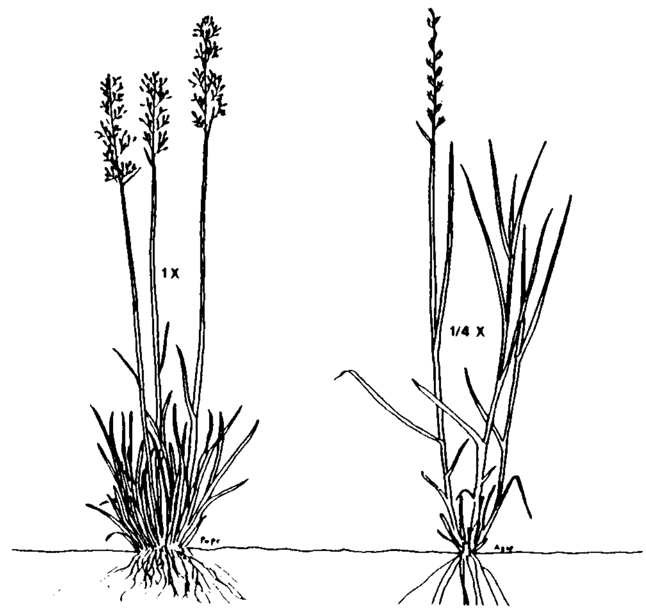

Figure 4-6.—Examples of a stemless grass, Kentucky bluegrass (left), and a stemmed grass, bluebunch wheatgrass (right)

grama grasses, have a high ratio of vegetative-to-reproductive stems.

Stemmed grasses tend to be more robust and productive. They're also more numerous in the cool season growing conditions. Some species have the ability to grow more or less prostrate and can escape grazing that way. Managing to incorporate this knowledge will allow you to capitalize on each plant species' desirable and less desirable points.

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 are pushed up through the tube from below ground. The nodes are close together; only in the later part of 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 early leaves (up through four or five) are pushed up as with stemless. 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, there'll be no more growth on that stem. That can't happen for the stemless ones 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. If enough soil moisture exists, such buds may develop, but in most years there's not enough soil moisture left for very much regrowth.

If grazing can be managed intensively enough, you can 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'll be able to 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 period of time from weathered rock. They're affected by topography or position, by organisms, and by the climate that prevails in a local situation. These factors affect the soil's ability to support life.

Soil depth, texture, structure, and color—they're all characteristics the landowner learns 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're often quite rocky. The total environment is harsh, and range soils have often been discounted as a resource because they're not cultivated and can't 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 of moisture availability to plants strongly influence which plants will grow and how they'll 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 location or position it has (topography),
- the time over which it has been there,
- the other organisms in its environment (including people), and
- the climate in the immediate area as well as overall climatic influences.

Essentially, soil and the plants that grow on it develop together and not independently of one another. When any of these factors is changed, the plant species may change, or the growth characteristics of the same species may be altered.

Plant species are adapted to different conditions. On any one area, changes in plant species composition will occur with the passage of time. Some species are replaced by others that can grow, compete, and reproduce there. The progressive change through time is termed *plant succession.*

A theoretical endpoint is called *climax*, as used in the term "climax plant community." This concept holds that a pinnacle of soil and plant development will occur, when it's in dynamic equilibrium. All usable spaces, called *niches*, are filled. The only disturbance recognized in the concept is natural and outside human influence.

This concept has primary relevance for one major reason: Climax plant communities are important tools in characterizing what is termed a *range* or *ecological site.*

When the climax community is composed of different species—or sometimes of similar species but of different proportions—the sites on which such species grow are different.

Thus, the designation, "Ecological Site A, Site Y." The sites are given names according to the physical descriptions or to the major plant species that form the climax or potential plant community.

To repeat: Ecological sites are characterized by the total environment—soil, slope, climate, and species composition of the potential community.

Ecological status/range condition

Ecological status, sometimes known as *range condition,* embodies management and includes the influences that human or other changes can have on the plant composition.

Ecological status refers to the present state of vegetation and soil protection of an ecological site in relation to the potential natural community (PNC) for that site.

Range condition is a term with more than one meaning. As we use it here, some technical agencies define it very much the same as ecological status. It's the present state of vegetation of a range site in relation to the climax plant community (natural potential) for that site.

We can use both concepts and terms when we discuss current vegetation and the influences that management has on plant species composition. To illustrate, plant species have varying tolerances to particular influences—grazing, fire, flooding, etc. Livestock eat plant species, and so do wild animals and insects.

The reaction of plant species to grazing has been described in the context of *decreasers* and *increasers* or of *invaders* (those that weren't present in the climax community).

This concept says if a climax plant community is grazed repeatedly, in whatever manner, some species will decrease, some will increase, and (if the activity went on long enough) some species (very often annuals) will invade.

We can apply the same concept to other influences—fire as an example. Some shrubs tolerate fire and sprout back; others are killed and reproduce by seed.

If both big sagebrush and gray rabbitbrush occurred with resident bunchgrasses and if a fire occurred during a season when bunchgrasses weren't damaged, the rabbitbrush would act as an increaser to the influence of fire whereas the sagebrush would act as a decreaser.

In time, seedlings would come in. If the same plant community is strongly influenced by grazing, the responses can be different. Some grasses will decrease and some will increase, but both shrubs will increase.

This sounds confusing, but it's what happens. This complex relationship demonstrates the importance of all the interwoven issues of site, weather, species, and management.

The departure from climax or potential natural community, for whatever reason, is described in strictly utilitarian terms, but it's expressed as a percent of the potential community in terms of its species composition.

This is a way of describing the range on its successional or ecological gradient. In other words, for each site that's been studied, a particular species composition will fit one of the condition classes or status ratings.

For general discussion purposes for a range site, there are four subdivisions. Table 4-1 shows them in terms of ecological status, potential plant community, and range condition.

Management can deal with this concept because we can recognize an ecological site on the ground, map it, and describe the ecological status or range site. Forage productivity isn't always highest in a climax grassland or shrub-grass plant community, but for general consideration on most sites, it will be.

Table 4-1.—Range sites subdivided by ecological status, potential plant community, and range condition

Ecological status	% Plant community	Range condition
Early seral	0 to 25	Poor
Mid-seral	26 to 50	Fair
High-seral	51 to 75	Good
Potential plant community	76 to 100	Excellent

Managing for excellent condition may be impractical—in fact, it often is. Climax herbaceous plant species aren't necessarily the most preferred species. You should know this important point: The species that occur are a way to "read the range"; through various practices, you can adjust species composition, forage production, and ecological status.

We must view forested plant communities in a different ecological context. Since succession proceeds toward trees from the point after logging, the more the canopy closes in, the closer to excellent conditions (PNC), and the lower the production of the herbaceous understory.

From a grazing standpoint, excellent condition is poor and poor condition (when herbaceous plants should abound) is desirable. Early to mid-seral status in a forest situation is probably desirable game habitat, too.

Using the ecological status concept

If ecological status or range condition is a way to describe vegetation, it follows that with enough knowledge about the productivity (status/condition) of a site, you can phrase objectives in terms of condition or status.

Let's repeat an important point: Except for forested communities, an improvement in ecological status/range condition often means an increase in forage production.

Managing for high or good condition on all ecological sites becomes a management goal that you can measure. Species composition at present determines where we are. If we know the successional patterns, we can recognize when we're reaching goals.

Without knowing the successional changes, managers can either:

1. expect to make more progress than is possible for the site and be dissatisfied with results, or
2. not take advantage of the site potential.

In either case, you need to know what plant species shifts will occur for each site as ecological status changes.

Trend in condition or ecological status

Upward, downward, stable—these represent trend in condition of the range. Trend in condition for a site is determined by measurements taken at two different dates, preferably with 5 years between them. Be cautious when you interpret what you find.

Very good and very poor precipitation years can affect production and relative species composition. You'd expect faster recovery when good years occur and the opposite in poor years. Accurate production records to supplement trend information will help your interpretation.

Management affects range condition/ecological status

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.

Removing grazing pressure to allow plants to grow back is important. 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 condition changes under some circumstances. Using appropriate herbicides has considerable merit. You can spray invading species like fringed sagewort from plains grassland and speed up succession.

You can spray some grasslands that are heavy to forbs, or even fertilize them, which allows grasses to increase and hastens succession. Big sagebrush spraying will reduce the increased 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 don't tolerate fire—western juniper and certain other nonsprouting junipers, for example. They're confined to rocky sites where there's not enough fuel to carry fire. But in the absence of fire, they've spread onto better soils—and over time, they've become dominant.

Rating your range

Perhaps there's really only one good reason for rating (evaluating) your range: You need to know its status in some detail to know if improvement is occurring—or if you just think it's occurring. Don't trust your memory. Use a simple, straightforward scheme on a rather regular basis. You'll find a record helpful in planning better future management.

You should know the status of soils and vegetation on your range and pasture areas:

- 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 it something you can control?

Rate your own private range and your leased range, especially if it's 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 here. It will help you determine what is the true situation.

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 we have little control over where soil will be deposited after it starts to move.

Consequently, retaining it in place makes good sense. Evaluating your range will tell you the current situation in some detail. It doesn't tell the cause. Soil can move because of lack or 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. When you do the rating, you need to determine what the best situation looks like to determine the amount of deviation.

Recognize the effects of soil texture. Light-textured (sandy) soils can be moved by wind from plant interspaces to the plant crowns. Heavier-textured (clay) soils heave because of repeated freezing and thawing.

Pedestalling of plants, where the soil appears to be (or actually is) removed from around the plant, can result from soil movement or from freezing and thawing—which lifts plants, creating a similar effect.

Make note of this. You need to *know* whether the soil was being 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 events.

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

Assess the effects of storms on similar areas that are grazed versus those that aren't. Record the intensity of storms. If real differences occur, and if the differences appear to be caused by grazing, this will tell you where your management actions need to be concentrated.

Look at plants as intensively as you look at the soil. To rate a range, you must identify your plants. Assess the state of plant health on at least a species-group basis. The rating should tell you how capable the range or pasture is of maintaining the most desirable plant productivity.

Therefore, look at all of the plants—how vigorous they are or how weak, whether they're reproducing, whether there are many or few undesirables present and, if present, the locations where they may be concentrated.

Look at the levels of grazing use and decide if a different species might be preferred. Determine whether there's an effect of differential grazing on vigor.

Whether you use a scorecard or just make notes, record your observations so you can rate the same locations in future years. It may be impractical to rate every site, so establish benchmark areas. You can make the ratings at any time of year, but it may be better to do it after the grazing season than at other times.

Agency rating forms or scorecards use numbers, so you can make a numerical rating each time you rate the area. Figure 4-7 is a rating form used by the Bureau of Land Management. Figure 4-8 uses a simple, subjective approach; figure 4-9 shows how to fill it out.

Regardless of the form you use, remember: It's important to rate your range, record your observations, and *use* them to make your management better.

Range site symbol ______________________ Date ______________________

Condition class symbol ______________________ Examiner ______________________

Legal description ______________________

OBSERVED APPARENT TREND

(Check appropriate box in each category which best fits area being observed)

VIGOR

(10 points) ☐ Desirable grasses, forbs, and shrubs are vigorous showing good health. These plants should have good size and color and produce abundant herbage.

(6 points) ☐ Desirable grasses, forbs, and shrubs have moderate vigor. They're medium-sized with fair color and produce moderate amounts of herbage; some seed stalks and seedheads are present.

(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 seedheads almost nonexistent except in protected areas.

SEEDLINGS

(10 points) ☐ There's seedling establishment of desirable grasses, forbs, and shrubs. Seedlings are present in open spaces between plants and along edges of soil pedestals. Few seedlings of invader or undesirable plants are present.

(6 points) ☐ Some seedlings of desirable grasses, forbs, and shrubs may be present in open spaces between plants. Some seedlings of invader or undesirable plant species may be present.

(2 points) ☐ Few if any seedlings of desirable grasses, forbs, and shrubs are being established. Seedlings of invader or undesirable plants should be present in open spaces between plants.

SURFACE LITTER

(5 points) ☐ Surface litter is accumulating in place.

(3 points) ☐ Moderate movement of surface litter is apparent and deposited against obstacles.

(1 point) ☐ Very little surface litter is remaining.

PEDESTALS

(5 points) ☐ There's little visual evidence of pedestalling. Those pedestals present are sloping or rounding and accumulating litter. Desirable forage grasses may be found along edges of pedestals.

(3 points) ☐ Moderate plant pedestalling. No visual evidence of healing or deteriorating. Small rock and plant pedestals may be occurring in flow patterns.

(1 point) ☐ Most rocks and plants are pedestalled. Pedestals are sharp-sided and eroding, often exposing grass roots.

GULLIES

(5 points) ☐ Gullies may be present in stable conditions with moderate sloping or rounded sides. Perennials should be establishing themselves on bottom and sides of channel.

(3 points) ☐ Gullies are well developed with small amounts of active erosion. Some vegetation may be present.

(1 point) ☐ Sharply incised V-shaped gullies cover most of the area with most of the gullies actively eroding. Gullies are mostly devoid of perennial plants with fresh cutting of the bottom.

Total points _____ Rating: 26-35 = Upward; 17-25 = Static; 7-16 = Downward

Comments:

Figure 4-7.—BLM range rating form (taken from BLM, EIS, Drewsey Resource Area, Oregon)

Pasture or range ______________________ Date ______________

Location within pasture ______________________ Observer ______________

Kind of site ____

Terrain ______________________ Kind of growing season ______________

Plants				
Species composition	Good	Fair	Poor	
Ground cover				
Desirable species	High	Medium	Low	
Undesirable species	High	Medium	Low	
Vigor				
Desirable grasses and forbs	High	Medium	Low	
Desirable shrubs	High	Medium	Low	
Undesirable grasses and forbs	High	Medium	Low	
Undesirable shrubs	High	Medium	Low	
Grazing use	None	Light	Moderate	Heavy
Poisonous-noxious species	None	Scattered	Common	Abundant
Soil				
Litter	High	Medium	Low	
Surface protected by	(rocks, twigs, litter, other)		Adequate	Inadequate
Pedestalling of perennial grasses	None	Slight	Moderate	
Surface movement by water	None	Slight	Moderate	
Surface movement by wind	None	Slight	Moderate	
Gullies	None	Few	Several	
Condition (if applicable)	Sloughing & getting worse		Revegetating & healing	

Notes

Figure 4-8.—A form for recording range rating

Pasture or range Coyote Butte

Date July 10, 1990

Location within pasture North End

Observer Joe Smith

Kind of site Loamy Upland

Terrain Rolling

Kind of growing season warm, dry, early

Plants				
Species composition	Good	Fair	Poor	
Ground cover				
Desirable species	High	Medium	Low	
Undesirable species	High	Medium	Low	
Vigor				
Desirable grasses and forbs	High	Medium	Low	
Desirable shrubs	High	Medium	Low	
Undesirable grasses and forbs	High	Medium	Low	
Undesirable shrubs	High	Medium	Low	
Grazing use	None	Light	Moderate	Heavy
Poisonous-noxious species	None	Scattered	Common	Abundant
Soil				
Litter	High	Medium	Low	
Surface protected by	(rocks, twigs, litter, other)		Adequate	Inadequate
Pedestalling of perennial grasses	None	Slight	Moderate	
Surface movement by water	None	Slight	Moderate	
Surface movement by wind	None	Slight	Moderate	
Gullies	None	Few	Several	
Condition (if applicable)	Sloughing & getting worse		Revegetating & healing	

Notes

Trend appears static, but range needs improved management.

Figure 4-9.—Sample of filled-out form for recording range rating

Grazing to maintain a healthy range

To a cow, grazing is the natural means of getting her daily sustenance. To the manager, grazing should be more than that because when and where she grazes has a great deal to do with maintaining and improving overall productivity of both plants and animals.

Plants have differing nutritional qualities throughout the year and cattle, no matter where they are, constantly eat what they prefer and as much of it as they possible 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'll need to consider a number of factors to develop and carry out successful grazing plans. You'll need to visualize what animals are doing to each plant species each day they're on range and pastures.

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

Try to visualize what grazing a plant is doing to its ability to grow and compete. At the same time, assess what the lack of grazing on associated plants is doing. For example, cattle almost never graze big sagebrush except perhaps during a rough winter. Big sagebrush, therefore, is completely free to compete with the more desired species. The same can be said of other nongrazed species.

So think of grazing in terms of:

- how many animals there are for a given area (intensity of use),
- how often grazing is done (frequency of use),
- when grazing occurs in a plant's life history (season of use), and
- what plants are being eaten (selectivity of use).

Four periods for plants

On ranges in the West, there are four periods in the year to consider for plants.

Period 1. Initial growth, usually 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 can't usually get enough new growth to satisfy their intake needs.

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

If some of the previous year's residue remains, more of the animal's intake needs will be met, and there also could be a lessening of the grazing effect on the plant. But if more than 1 year's old growth is present, animals will avoid such plants and concentrate on the new plants, putting more pressure on them.

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

Period 3. This is the flush period where animal demand is usually less, sometimes greatly so, than the forage supply. Nutrition is high, animals gain well during the entire period but less well as the end arrives. 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 be during the wet season, also. There may or may not be a late summer-fall green-up, which is a short repeat of Period 1 but not of Period 2 and 3. Period 4 will be the longest period 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 species.

Ingenuity in grazing management is especially needed in Period 4. But if good management has prevailed 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 to provide an animal unit with its needs for 1 month. One AU is commonly accepted as one cow with calf less than 6 months old. There's no agreed-on standard weight of forage. Figures of 750 to 1,000 pounds are often used.

AU equivalents. Various conversion factors used with no universal agreement. These are the suggested factors:

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. Unit area needed to support 1 AU for 1 month. Expressed as acres per 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. Refers to the specific commodity for a specific time 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 time, but generally the end of season.

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

Continuous grazing. Unrestricted use access during the grazing season. Doesn't refer to level of use.

Season or seasonlong. Grazed for the duration of a particular season of the year.

Repeated seasonal. Grazed at the same season each year.

Deferred. Not grazed until the main forage plants have reached a set level of maturity, often setting of seed.

Rotational. Animals moved from pasture to pasture on a particular schedule. The schedule may be based on the calendar, on level of use, or stage of growth.

Rested. No grazing during at least a 1-year period.

Rest-rotation. Scheme 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 to get professional assistance in developing a grazing plan, make sure the plan is more than just a series of animal moving dates 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. Recognize the general times that the four periods 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'll never 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 made up of 60% less desirable plants and 40% desirable plants. You want to increase desirables to 60 to 70%.

You know that to do this, you'll take 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, as one objective may be to graze all pastures each year.

General observations

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's an important question: How much is too much? It's up to you to decide.

Pastures generally don't have to have all-season rest to maintain range forage yields. Grazing may loosen soil, plant seed, tramp litter into the surface, and cycle nutrients. Perhaps most important of all, it removes the old growth—if you don't remove it, old growth will contribute to less uniform use the following year.

Additional pastures mean more flexibility to the point of obtaining maximum safe forage use.

Use stock water as a way to move grazing use. Fencing water from cattle or turning off water valves in areas that need relief can be effective in continuously or season-long grazed pastures.

Don't discount continuous grazing as long as you can meet your objectives. Excessive stocking pressures have given continuous use a bad name.

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

If a plan calls for spending more dollars, scrutinize the level of expected benefits. In other words, what's the point beyond which you can't get back your investment? You don't 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 can restrict their use as management tools to times of adequate forage value.

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

Don't 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: growth Period 1; the period from the time when growth buds of perennial grasses are elevating to seed maturity; and the period when late energy storage is occurring.

It's 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's the best forage use? You'll need to define it for yourself. A qualitative definition might be: grazing in a manner that maintains or improves range plant health, while it produces the largest amount of useful animal product over a sustained time period.

A shortened version might be "getting the most from the resource while maintaining its productive potential."

Research in a number of States reaffirms that the best use of range forage results from a mixture of the right numbers of animals (grazing pressure), the correct time period or 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 show further that the amount and form of herbage left after completion of grazing is more important than stopping grazing when you've achieved a certain percent use by species.

It's important for one primary reason—the greatest economic returns over a period of years will be at a particular point in terms of residue or herbage left.

There's an optimum amount of plant material to maintain the plant community and provide soil-plant stability, also. Figure 4-10 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 don't 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.

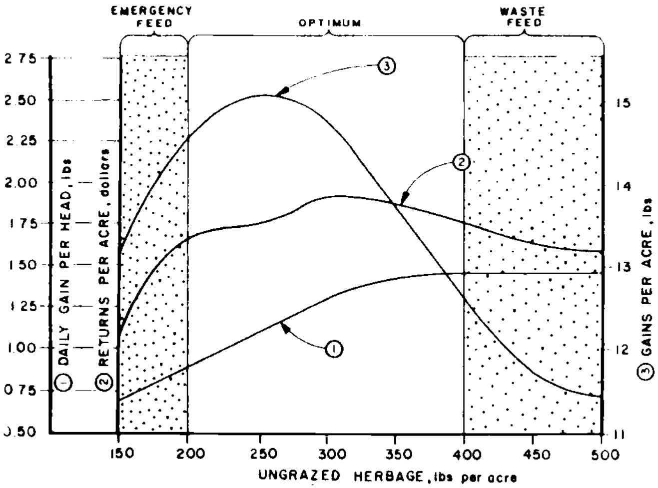

Figure 4-10.—The best animal production doesn't mean either maximum gains per unit area or maximum gains per head. Moderate stocking provides most returns in the short run and assures continued high yields of forage. Reproduced with permission from Stoddart, Smith, and Box, *Range Management* (New York: McGraw Hill, 1975), p. 273.

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 intakes of 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:

1. early growth, damp soils, high succulence, low daily productivity, when it's easy to have demand exceed supply;
2. beginning of rapid growth, when demand and supply are about equal;
3. flush of growth, when supply exceeds demand; and
4. dormancy, when there's no new growth and feed value is lowered.

Highest animal production occurs in Period 3. Calculate when these periods or phases occur for each range and pasture unit. By doing so, you're in a position to match the demand and supply.

Simply put, range readiness is that time after which forage plants can safely sustain proper grazing without negative effects. It's a concept that long has been used, but it may no longer be important if intensive enough grazing management can occur.

A serious problem with applying the concept is the variation from year to year in range readiness. Reports indicate readiness varies more than 6 weeks in different years on native ranges. Management must develop means to cope with this high variation.

Forage use depends on...

Terrain or topography. As a rule, cattle are lazy and don't climb hills unless they must, and they don't climb well until they become acclimated to them. Thus, steeper areas will be undergrazed when the bottoms are correctly grazed. Using fencing to separate similar terrain areas is sometimes effective. Yearling cattle will graze steep areas better than cows and calves.

Vegetation type. Cattle won't graze shrub types of range as evenly as grass types during the growing season. Fall and winter grazing on shrubs should increase the proportions of grass, since grasses should be less preferred or not as available at that season.

Availability of stock water. On level ranges, cattle will go as far as 4 miles for water, but distances as much as 2 miles will severely limit use. When combined with either steep or long slopes, forage occurring more than ½ to ¾ mile from water will receive very little use unless the range is overused at closer distances.

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

Type of previous grazing management. Well-planned grazing can effectively extend the period of use and/or the 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 will permit regrowth for use later that year or perhaps early in 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

There are two major purposes for determining use:

1. Only by knowing where areas of differential use occur can you design plans to make better and more efficient use of your range resources.
2. Overuse or misuse is the greatest contributor to either range deterioration or the lack of improvement in range condition.

Knowledge and a record of forage use by area, coupled with periodic assessments of range condition, are indispensable keys to long-range planning.

If good past records are available, and if the grazing plan developed for the area works well, you'll 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 the pastures are large, the use maps help you decide whether you need further range developments.

Watering locations in areas of underuse or no use are like buying more forage. Subdivision by fencing may also be necessary to accomplish that purpose.

Range developments: A key to better grazing use

The purpose of range developments is to 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. Each one should add some overall benefit, not only from an economic standpoint but also from an efficiency of management standpoint.

Good management is more than having the correct or adequate 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 time 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, as with range improvements, require capital cost investment; thus, they must bring economic benefit. Ask yourself:

- How many AUM's (animal unit month) 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?

By knowing the relative amount of unused or underused forage, calculate its value based on realistic prices. This will give an estimate of the yearly increased increment of forage value. With this information and costs of particular developments, for example, 2 miles of fence and two water developments, you can analyze whether you can afford to make the investment.

Water and its sources

In addition to providing cattle with water of good quality, water developments can be an effective means of distributing livestock on the range. Regulating cattle access to water will permit better utilization of 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 won't travel more than ½ mile in mountainous terrain and no more than 1 to 1½ miles on level range and make even forage use. One watering facility for each 50 to 60 animal units is desirable if you expect to use the unit all season.

When it's 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 a greater distance than they will 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 6½ gallons per day if they're watered on alternate days. Water intake will be less on green forage in spring and when weather is cool.

Numerous kinds of water developments exist, and they need only brief discussion. For any new development, be sure to determine whether you need to file a permit for its use.

In a number of Western States, the development and use of both surface and groundwater is controlled by State regulations. Before you invest in water developments, consult the appropriate regulatory agencies to ensure compliance.

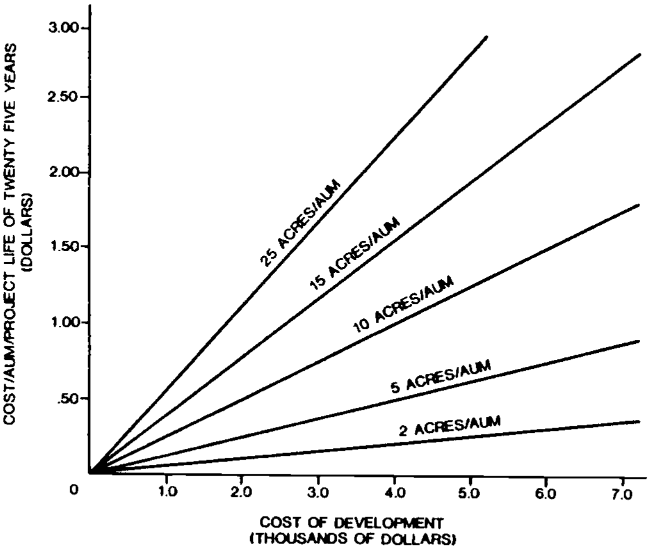

Figure 4-11.—Cost of water development in relation to stocking rate (From Duncan, 1973. Spring Developments, BLM mimeo, Oregon-Washington State Office)

Consult figure 4-11 to help determine the cost per AUM for water if you know the stocking rates for the areas to be served and the costs of the developments.

Streams aren't considered as developments. If streams are only intermittent, consider providing a reservoir. Permits are required for reservoirs. On perennial streams, public concern exists for bank protection and maintenance of high water quality.

Consequently, use care in grazing intensities on such sites to prevent or minimize such breakdown. If you fence the stream separately, provide for water gaps. Care in construction will pay off in lower maintenance costs. It's been estimated that the dollar value for each day of maintenance can be as high as 15% to less than 5% of the initial investment.

Springs. Careful 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 ½ 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 in such a way that stock have no opportunity to trample the source. Several development techniques exist.

Frequently, location of potential spring developments is aided by consulting current aerial photos or by flying the area. Use of color, infrared film will allow water-loving plants to show up differently in the picture.

Sometimes, spring flow can be increased dramatically by removing trees and brush in the vicinity. In several Western areas, springs have started to flow after controlling brush.

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 isn't as great as a spring, streams, or well.

Care in construction is critical. Spillways are necessary. You can obtain specifications from technical agencies. Reservoirs should be built with as small surface area as possible in relation to depth. High sides reduce wind movement and decrease evaporation. It's 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 like 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 Soil Conservation Service technicians or other technical advisors.

Wells. Vertical wells provide 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 a major water source.

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, seepy flows of water. Water flows of its own accord, by gravity, as with a spring. It's piped and can be controlled with valves. It's a high-quality source.

Hydraulic rams. These age-old devices deserve more use in the mountain West. Water from a spring or other sources such as a ditch or small stream is diverted into a drive pipe to the ram, which lifts it through a delivery pipe.

The basic minimum is a flow of 1½ gallons per minute with a fall of 20 inches or more. A theoretical lift to fall ratio of 25:1 exists. If you need water at a higher elevation than a spring source, the ram has real possibilities.

Water catchments. Numerous possibilities exist. 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.

Research has been done on other kinds of catchments. The reliability of precipitation is an important factor. Catchments often are used where there isn't enough precipitation for a stock pond and other sources of water don't exist.

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), mechanical covers (concrete, gravel-covered membranes, asphalt-soaked material, rubber and artificial rubber, sheet metal).

Table 4-2 gives some guidelines for effectiveness and costs. If you want to use catchments, you're advised to get further technical help.

Pipelines. A great deal of range forage has been opened up since the advent of PCV (polyvinyl chloride) and plastic pipe. Piping is generally by gravity. Pipe should be buried—it will work well aboveground, but it won't last as long. You can turn water on and off as you want, a definite advantage in influencing grazing distribution.

Hauling. This is generally 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.

Hauling can result in distributing grazing to areas that otherwise wouldn't be grazed. Stock may get to drink more often and generally don't need to travel so far when you practice water hauling.

Because of 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. Move water tanks often to improve evenness of use.

Fences

Although water by itself is an excellent way to improve or manipulate grazing distribution, it's 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.

Table 4-2.—Water costs for various water-harvesting treatments (source: *Journal of Range Management*, 28:430)

Treatment	Runoff (percent)	Estimated life of treatment (years)	Initial treatment cost per yard[2]	Annual amortized cost[1] per yard[2]	Water cost per 1,000 gallons in a 20-inch rainfall zone
Rock outcropping	20-40	20-30	$ <0.01	$ <0.02	$0.22-0.45
Land clearing	20-30	5-10	0.01-0.02	<0.01	0.30-0.45
Soil smoothing	25-35	5-10	0.05-0.07	0.01-0.02	0.25-0.71
Sodium dispersant[2]	40-70	3-5	0.07-0.12	0.01-0.02	0.13-0.45
Silicone water repellents[3]	50-80	3-5	0.12-0.18	0.02-0.04	0.22-0.71
Paraffin wax[4]	60-90	5-8	0.30-0.40	0.05-0.10	0.50-1.49
Concrete	60-80	20	2.00-5.00	0.17-0.44	1.89-6.53
Gravel covered membranes	70-80	10-20	0.50-0.70	0.04-0.10	0.45-1.27
Asphalt fiberglass[5]	85-95	5-10	1.00-2.00	0.14-0.48	1.31-5.00
Artificial rubber[6]	90-100	10-15	2.00-3.00	0.21-0.41	1.87-4.00
Sheet metal[7]	90-100	20	2.00-3.00	0.17-0.26	1.51-2.57

[1] Based on the life of the treatment at 6% interest.
[2] Cluff, 1975.
[3] Myers and Frasier, 1969.
[4] Fink et al., 1973.
[5] Myers and Frasier, 1974.
[6] Lauritzen and Thayer, 1966.
[7] Lauritzen, 1967.

Consider the natural boundaries or barriers to livestock movement. Fences need to built only for the specific purpose you have in mind.

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 the cattle won't crowd it as badly.
- Don't fence down a drainage bottom—rather, split it at an angle.
- Fence by site whenever possible.
- Don't fence up and down slope, but at an angle.
- Always remember the objective for the fence. You want to visualize how it will work *before* you build it.

You should consider suspension fences when terrain will permit. You can reduce substantially the cost of both construction and materials. When they're properly made, suspension fences actually turn cattle better than conventional barbed wire ones. The principle of spooking the animal through both the movement of the wire when touched and the sound from wind works well.

For use 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 the fall and put up in the spring. Yearly maintenance costs less compared to conventional fences, where wires often are broken and posts pulled 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's no secret that cattle use roads and trails just as humans do. Putting them into steep, or 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, analyze first what you want, then determine if developing more roads and trails will achieve it.

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 performance by pasture can be determined.

Stock driveways may be on their way back, as the cost and availability of fuel changes. Whether such a passageway is required will depend on the number of times you need to move cattle and by how many cattle you move.

Historically, driveways were used for movements between seasonal feed sources. Less labor is necessary for moving along a driveway than in the open. This is a relatively more important consideration in the 1990's than in the days where labor was abundant.

Range improvements: Ways to increase forage production

Range improvements are changes that managers make to purposefully change the vegetation; their goal is to improve and increase forage quantity and quality.

Through the range planning process, you'll have identified problems and the opportunities for correcting them. You'll probably consider some form of range improvement.

You should make a thorough economic analysis of each problem situation 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, step by step, how to compare various improvement practices. Then you need to develop projected total income and the 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 using specific practices.

Because there's great variability in conditions, you're advised to obtain technical assistance for making a study of the alternatives. Some Extension agents and specialists and Soil Conservation Service technicians are trained in this field. They may know of alternatives you hadn't thought about.

Overall consideration

Improving ranch productivity through range improvements has four main components:

1. selecting the most appropriate practice or practices for each site and situation;
2. managing the resource after you've improved it;
3. maintaining productivity by retreatment if necessary; and
4. integrating and managing improved areas with the other resources of the ranch.

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

At the same time, depending on the practices that you might use, consider improving the higher ecological condition areas before tackling the poor and fair condition ones.

Good range responds to treatment more rapidly than poor, and there should be a greater level of biological stability. You also need to recognize, however, that the total amount of response may not be as great as from the lower condition sites.

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

Maintaining use on all areas is essential. In years of too much grass, lack of use may encourage no use in the following years.

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

After range improvement has occurred, regardless of practice, be certain to apply a grazing strategy that will maintain the productivity engendered by the improvement. You must recognize that grazing animals can have good impacts or detrimental impacts on plants.

Finally, most improvements need followup. Understanding the kind of sites one works with will give large clues as to the kinds and amount of followup that will be needed. Often you can repeat the same practices for followup—for example, fire on big sagebrush, where many seedlings emerge. Repeat when necessary.

Prescribing the correct practice or set of practices for the various ecological sites requires good technical knowledge. If you feel you don't have that know-how yet, don't be embarrassed to ask for some assistance.

Controlling undesirable plants

You can use a number of practices to 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.

Don't expect some desirable native plants to come back in rapidly just because you remove the bad ones, unless there's a sufficient population of the desirable ones already present. If there isn't, then consider seeding the desired species along with controlling the undesirable.

Some of the most successful seedings incorporate a practice like 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 be accelerated under the right conditions.
- Often water yield and availability improves.
- Stock have more accessibility to forage, and they're easier to handle when you control trees and brush.
- Poisonous plants may be controlled.
- Weed seeds may be reduced.
- Fire hazards should be reduced, and often plant control improves habitat for game animals as well.

Although not necessarily a disadvantage, plant control alone might not be appropriate when site potential is too low, when costs are too high and can't be spread out over a long enough time period, when serious erosion hazards exist, and when drift from sprays would cause problems where chemicals are the only solution.

For each general category of plant control, both advantages and disadvantages occur. 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, are often used because no other practice is either effective or economical.

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

Advantages

- Timing not critical. Can do when ranch labor available.
- Generally considered most convenient of methods.
- However, some plants are more and/or less sensitive at particular times of year—for example, roto-beating sagebrush in the fall is generally less successful.

Disadvantages

- You may not have the desired equipment.
- Costs may be rather high.
- Frequently, there's enough soil disturbance to require seeding (an advantage if you *want* to seed).
- Terrain may be too steep.

Chemical. This general category of methods has been phenomenally successful in achieving range improvement. Use only chemicals that are registered by the Environmental Protection Administration (EPA) for that specific application.

Because of this regulation, it's more and more likely that most chemical application will be made under contract by licensed applicators. This, in itself, doesn't relieve a producer of liability—you still must follow label instructions for the chemicals.

If contracted, less ranch labor will be used than in the past—at least for spraying. Chemicals come in a wide variety of forms, and they can be applied in liquid (sprays or injected as into trees) and solid (granules primarily).

Advantages

- Very site-specific.
- Rapid in terms of ease of application.
- 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 as long as 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 adhered to, predictable results occur. The techniques, overall, are being developed to make burning a skillful management technique. Fire is environmentally accepted.

It can be used as an overall part of a management program, as well as just for range improvement—for example, to burn off old forage residue as an encouragement for better livestock distribution. This can be practiced on a periodic but planned basis.

Studies are now revealing more information on times of fire tolerance as well as susceptibility of various forage species. Fire can be used effectively in maintaining productivity of an improved range.

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, and it removes that.
- Improves game habitat.
- Opens up areas for access.

Disadvantages

- Liability when escapes occur.
- Need good preparation—that is, often more than just fire lines.
- Often damaging to nontarget species as well as target 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.

Biological. Grazing for particular purposes is a form of biological control. Such biological forms as insects and diseases, however, are more often 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 few examples of good success occur.

To be considered for biological control, the organism must be specific for the host plant and should 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's 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's 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.

Seedings for early spring use offer a source of feed for cows in early lactation, which need abundant good nutrition to recover well from calving and start to cycle on time. Additionally, seedings for early spring use permit deferment of use on native ranges, which may allow more rapid range improvement than would come about otherwise.

Seeded species are often not only more productive than the natives they replace; but they're also usually more tolerant to grazing. This will be especially true if the planted species is introduced and not native.

Crested wheatgrass, used since the mid-1930's, is the model for this purpose. Early, palatable, and nutritious, it consistently allowed the producer to get cows and newborn spring calves off meadows before native species are ready for use.

Seeding is indicated under a large number of situations, but most seeding is done for one or both of these reasons:

1. There's a need for forage that the present species composition and site characteristics can't fulfill.
2. The current ecological condition is poor, and 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.

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

You can plant species for more or less specific cases. This should give you much more flexibility than having to operate on native range alone.

Seeding success will be limited when annual precipitation averages less than 9 inches. This is particularly so if soils are saline or alkaline as well. Opportunities for range improvement on such sites are limited mostly to improved grazing management, unless you can augment the soil moisture supply.

In species selection, the primary consideration is: Will it establish, grow, and reproduce under my conditions? Such characteristics as drought tolerance, winterhardiness, and season of growth take on great significance.

Once you find a list of adapted species, the remaining characteristics center around its use under your conditions. Will it be productive when I 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 my cattle eat and like it? Is its forage value enough to promote desired levels of animal performance?

You must plant seed somehow, in some way. Broadcast seeding, except immediately following a forest-type fire, usually isn't successful. Seed must have soil or some water-holding or retaining material around it to germinate and establish.

You'll need to remove the competing vegetation, prepare a shallow but firm seedbed, and do your seeding 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 rangeland to permit grazing management. Don't graze until the plants are well established. This is usually reflected by development of a seed crop.

There's one exception: If the initial stand has many weeds, like cheatgrass, grazing for a very short time (few days) with a large enough herd will significantly aid weed control and stand establishment.

Graze when soil moisture is available and remove stock long before moisture is gone. Such short-duration grazing shouldn't exceed about 10 days. Close management will result in a strong stand.

Recovering investment costs is a function of both the cost itself and the management of the seeding. A great deal of flexibility in use exists as compared to native species. There's a number of grazing plans you could use.

If correct grazing occurs at least once per year, old growth won't build up, and poor use shouldn't occur. Frequently, the entire pasture isn't seeded. After 2 years of nonuse, grasses present in the pasture won't be nearly as palatable as newly seeded grasses.

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

Mechanical range improvement

In areas where high intensity storms occur during the growing season, a good deal of the water is likely to run off, even when good vegetation cover is present.

A number of different practices have evolved to solve the problem on rangeland. All were 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-textured soils, but they don't 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 periodic intervals. Water is held at its source, increasing soil moisture storage at relatively low cost. It's most applicable to medium to medium-fine textured 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% after pitting, with a change to midgrass, mostly western wheatgrass. Life of pits is limited, however—sediment builds up over a period of time, which reduces the effectiveness.

Water spreading. This is a form of irrigation whereby water is diverted from areas of concentration to nearby relatively flat, smooth areas to augment the natural moisture. You'll need a good knowledge of runoff characteristics to decide whether water spreading is feasible, as you'd 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 borne by increased productivity, and the number of floods per year strongly influences its profitability.

Range fertilization

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

In areas of less than about 15 inches of annual precipitation, the plant's limiting growth factors are mostly weather-related. Nitrogen has been shown to increase a plant's ability to use water, but cost may not justify this increase.

Additionally, native species in these arid to semiarid environments evolved under those conditions, and often they're just not economically responsive to additional levels of plant nutrients.

Fertilizers aren't 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. In areas where both cool- and warm-season grasses exist, a shift toward more cool-season grasses probably will occur 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're 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 only stimulate more forage in the above-average moisture years when more forage is generally available than can be used anyway.

Consequently, fertilization on dryland ranges, whether native or seeded, is often a questionable practice. 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 and sulfur than do grasses and grasslike plants. Thus, to keep legume production, you must satisfy the need for phosphorus. With the cost of all fertilizer certain to increase, the practice of fertilization requires close economic scrutiny. Usually, you can profit by fertilizing irrigated hay meadows and pastures.

For further reading

Economics of Range Improvements—A Rancher's Handbook to Economic Decision Making, Utah Agricultural Experiment Station Research Bulletin 466, 1967. Single copy 50¢ postpaid; order from Bulletin Room, Utah State University, Logan, UT 84322-5015.

Range management: Dealing with drought

Regardless of how we define drought, dealing with it is an extremely serious proposition. 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.

If you don't 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'll 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 is decreased dramatically. Plants with shallow roots are affected much more than deeper-rooted ones. Annual plant production may be practically nonexistent. High ecological status ranges will be less serious affected.

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

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

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

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

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

Ability of perennials to recover following drought seems to be closely related to the degree of grazing pressure existing before and during drought.

Use that exceeds 60% of current growth can decrease some plant species' ability to recover, according to a study in Oregon. However, light use (not above 25%) seemed to have a beneficial effect. Moderate use (25 to 60%) seemed not to affect production of several major species.

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

Nutritive values of individual plants during and shortly after a shortened and dry growing season may actually be higher than normal, since there's no dilution effect of nutrients by much top growth.

But the following dry season often is longer than normal, and deterioration of forage value will probably occur at the same rate as 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.

Upsetting the cows' ability to breed on time seriously affects future production. When cows don't get adequate nutrition during lactation, they respond by missing heat periods, or—at best—they'll breed but they won't conceive.

Drought in the period after calving and remaining through several months can delay a cow's breeding for 3 months or longer. You can make special provisions to provide cows with good feed to keep them on schedule.

If you don't, you're facing several years of reduced production from cows who breed late, and so calve late the following year. Late calves are always lighter. A cow that calves 3 months late, even if she could be managed to breed back one cycle early per year (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 condition. Although unused forage may be present in the farthest reaches of pastures, the probability of harvesting it is questionable.

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 alternative feed supplies, their availability, and cost.
- Evaluate your livestock inventory.

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

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

Determine if you have any viable possibilities of developing more water, or if additional fencing 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's a real abundance of unused, available forage.

Light-moderate history. Reduce grazing load to match forage supply. Continue light to moderate use; this will allow plants to maintain their present level of vigor.

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

You can't defer use if you don't have alternate feed. If you don't have any feed alternatives, your options are fewer:

1. Reduce numbers as much as you possibly can, at least for early season grazing.
2. Spread grazing load uniformly. Graze a plant only *once*. There'll be little opportunity for regrowth if you graze it repeatedly.
3. Stock water will be a real problem:
   - Graze the areas first where the water source may fail in later season.
   - Haul water, if necessary, but prepare for high costs.
   - Drinking on alternate days won't lower production of dry cows and yearlings, but a lactating cow needs water daily or calf gains will be reduced by 50% or more.
   - Lactating cows drink 15 gallons per day in summer.
   - Cows drink more water when forage is dry—as it will be during drought.
4. Supplement low-quality feed. Don't substitute feed.
   - If you supplement, cattle should rustle for themselves better—if you substitute, they won't.
   - Don't let the cattle condition serve as an index of range use. Animal performance can remain stable (even improve) while the range is being hurt.
5. Wean early and feed at home, at another feedlot, or sell.
   - Calf performance will stay up.
   - Cows won't get as poor, or if they're poor, they won't 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 lowered 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 further 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're certain your forage supply will 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.

Plants that were heavily grazed will take longer to recover, and some species won't recover if heavy grazing continues. Plants have to be given the opportunity to get enough energy to improve their vigor.

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.

Riparian response to certain grazing management practices

The concerns of forage production for livestock consumption, wildlife habitat, streambank 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'll attempt to evaluate several scientific investigations and to give numerical values to the response of the riparian system to certain livestock grazing management practices.

Importance of riparian zones

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

Satterlund (1972) emphasized land uses and their impact on quantity, quality, and timing of streamflows, all of which relate directly to riparian zones.

Thomas (1979) pointed out the importance of riparian zones to wildlife by stating that "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 (1980) found that cattle use in a forested grazing allotment in eastern Oregon was disproportionately heavy in the riparian zone: 1.9% of the land area was classified as riparian, but it accounted for 81% of the herbaceous vegetation removed by livestock.

Wild land recreation also closely correlates to water; riparian zones often contain favorite campsites, fishing, frolicking, and scenic values.

Perhaps this is the most obvious conclusion we can draw from the literature: There's very little scientific information about this issue. This doesn't mean we know nothing about it, but we must recognize that much of what we've been able to glean comes from observing isolated, and frequently nonrepeated, demonstrations.

The obvious importance of these zones has sparked considerable interest and volumes of reports, studies, and opinions. We'll focus on several livestock grazing implications in riparian zones.

Degradation caused by abusive practices

Meehan and Platts (1978) 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 riparian system and abusive grazing. It's clear that overgrazing has caused significant negative changes.

However, the answers to these questions are less clear:

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

Until we can translate these questions to measurable quantities (as far as we're able) and answer them, land managers won't be able to fully understand and allocate the resources entrusted to them.

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 (1977) noted that when Camp Creek was fenced in 1964, the streamside had no shrub canopy; exposed streambanks were common. By 1974, though the condition of the stream outside the fenced section remained unchanged, the alder and willow shrub canopy on the inside provided up to 75% shade to the stream.

They further 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° outside compared to 13° inside the fenced area.

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

In the 10 years since grazing has been reintroduced, the authors couldn't identify any measurable change in fish population that had resulted from this type of livestock use.

These observations—though they weren't reported elsewhere and weren't as complete as we'd like, serve to make me believe that riparian zones have a remarkable ability for rapid recovery. Once in good condition, they're capable of supporting managed livestock grazing. In this case, late-season use was the prescription.

Grazing systems

Hayes (1978) 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 didn't significantly alter channel movement.

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

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 grazed meadows.

Johnson (1965) reported that season-long grazing in mountainous areas increased the use of the meadows (especially the riparian zones) into the latter part of the season.

Hayes (1979) speculated that because the probability of bank degradation increases as livestock concentrations intensify along streambanks (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 (1981) investigated a number of livestock grazing practices on Meadow Creek in the Blue Mountains of Oregon, and they discovered that the relative stability of that system hadn't statistically changed after 2 years of systems grazing at a level of 3.2 ha/AUM.

Bohn and Buckhouse (1986) followed up the Buckhouse, Skovlin, and Knight study, using the same plots after the grazing schemes 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 livestock grazing proved to be the most destructive.

In a separate analysis, Bohn and Buckhouse (1985) studied infiltration rates, sediment production, penetrability (using a penetrometer), and bulk density on the same Meadow Creek sites. They found (1) rest rotation favored the hydrologic parameters they measured and (2) deferred rotation and season-long grazing did little to enhance—and sometimes hindered—hydrologic response.

Streamside vegetation

Roath (1980) noted that the riparian zone accounted for a disproportionate amount of forage production and consumption, yet he reported the streambanks to be stable in his study location near John Day, Oregon.

He noted that Kentucky bluegrass (*Poa pratensis)* was the dominate 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 to defoliation, grazing at an intensity that would reduce and maintain the grass at a stubble height of about an 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 on the meadows.

He suggested, therefore, that herbaceous components in the riparian zones could be manipulated by changing seasons of use, matching relative succulence and palatabilities of the hillside, and riparian vegetation.

Animal behavior

In a separate analysis, Roath (1980) 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's interesting to consider the ramifications.

For example, would it be possible—through breeding, training, and/or herd culling practices—to establish a group of animals that actually preferred and selected upland rather than riparian sites while foraging?

Conclusions

I believe we can draw several observations from these studies:

1. I think it's clear that riparian zones are important focal points for most of the products and uses associated with many natural ecosystems.

2. It's 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 for recovery of degraded riparian zones is remarkable.
   - The reason may be vegetation such as the Kentucky bluegrass, which is exceptionally tolerant of heavy use and provides considerable stability for the system.
   - Or it may be a function of the rich nutrient and soil resource or the relatively higher moisture that's available in this zone.
4. It appears that by exercising the appropriate tools available to range managers—such as control of grazing intensity and season of use—livestock grazing can be compatible with the other uses and values appropriate to these unique and important areas.

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WATERSHED MANAGEMENT GUIDE FOR THE INTERIOR NORTHWEST

Forests and watershed management in eastern Oregon

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Forest lands of central and eastern Oregon occupy the mid and upper elevations of most watersheds, and they're 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. This occurs 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 irrigation of 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

Forest types exist according to soil type and climatic zones. The climate of central and eastern Oregon is continental, with warm and dry summers and cool, moist winters. Eighty percent of the rainfall occurs from late fall through early spring. Air masses originating over the Pacific Ocean move eastward over Oregon, bringing with it abundant moisture.

Rainfall patterns in eastern Oregon are greatly affected by the Cascade Mountains. Moisture levels at the crest of the Cascades are 60 to 100 inches, much of which is stored in deep snowpack. East of the Cascade Range lies a rain shadow, where moisture levels fall to 7-8 inches within 20 miles of the crest. Further eastward, 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 mid and upper elevations where temperature and moisture are more favorable for their growth, while various dryland range species (grasses, sagebrush, 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 Cascade Mountains. 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 have occurred from these volcanic mountains and from numerous cinder cones that dot the landscape.

Thus, soils in this region are often 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 are also influenced by volcanic deposits. Much of the soil in this region contains volcanic ash and fine pumice, particular in flatter terrain. This ash cap has very high moisture-holding capacity, and it supports some of the more productive forest land in eastern Oregon. On steep slopes, little ash is found because most has eroded down to the lower slopes and draws.

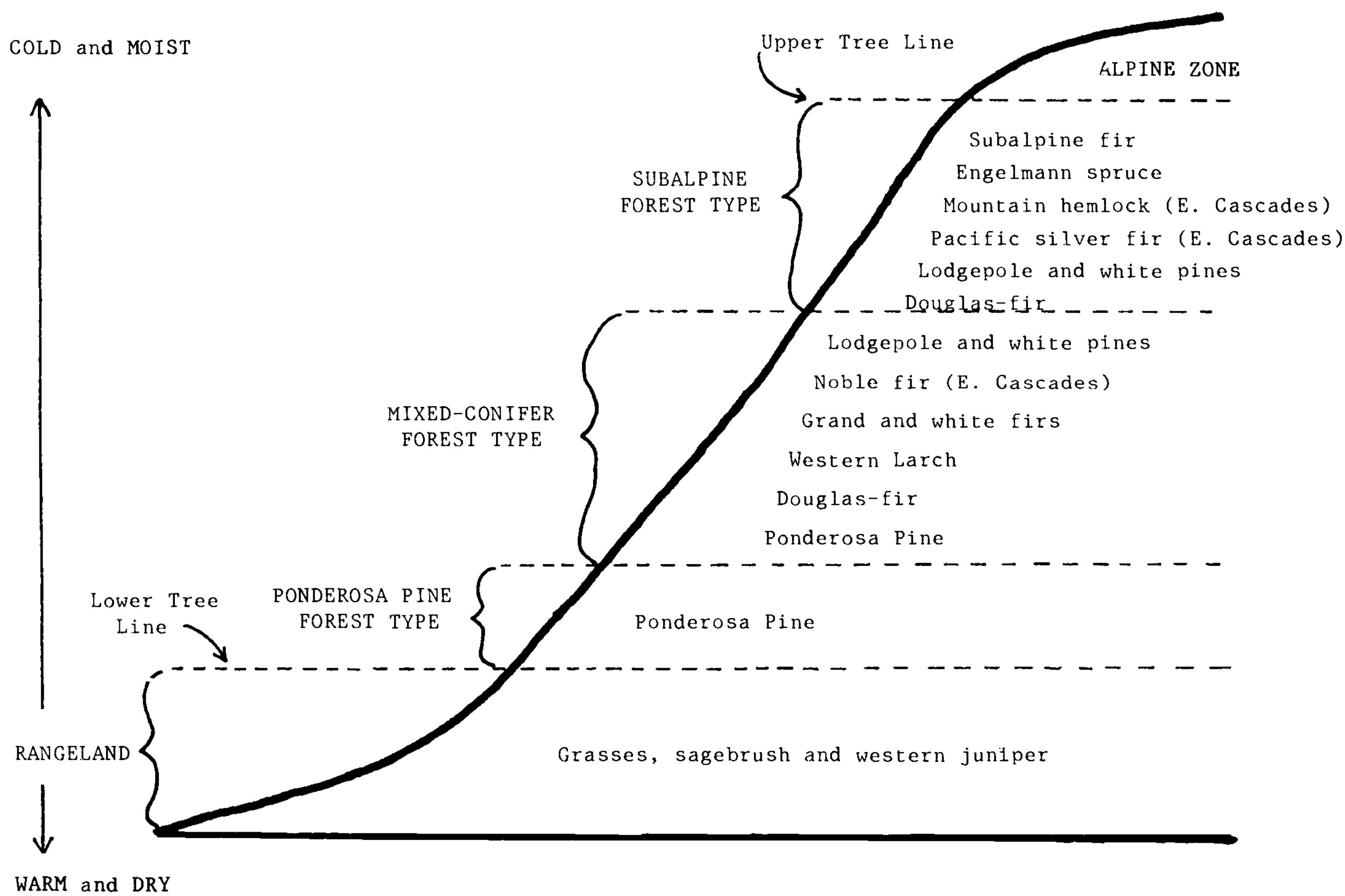

Figure 5-1.—Distribution of major coniferous species within forest types by elevation, moisture, and temperature

Forest types

Three general forest types exist in eastern Oregon. These include the ponderosa pine, mixed-conifer, and subalpine forest types (figure 5-1).

Low elevations in eastern Oregon are comprised mostly of grass and rangeland areas. Western juniper is often present in this zone. Moisture accumulation (rain and snow) varies from 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 of the large quantities of water they consume—which, in turn, lowers grass production, range carrying capacity, and watershed condition.

Ponderosa pine forest

As the moisture rate increases, sagebrush and juniper give way to the ponderosa pine forest type. Here, total precipitation (from rain and snow) is 12 to 18 inches. The ponderosa pine type represents the lower 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 invasion to occur beneath the fire-resistant pine.

Mixed-conifer forest

Above the ponderosa pine type lies the mixed-conifer forest. Precipitation ranges from 20 to 35 inches. Here ponderosa pine, Douglas-fir, white and grand firs, and western larch are common tree associates. White pine and western redcedar can also 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 pines are most common. On the east slopes of the Cascades, mountain hemlock and Pacific silver fir are also found.

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

The hydrologic cycle in forests

Interception

Water moves from the atmosphere to the ground and is absorbed into soil (figure 5-2). Vegetation—trees, grasses, or shrubs—intercepts some of this moisture (rain or snow) on foliage surfaces. Some 10 to 15% of the total rainfall is intercepted by foliage and returned 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.

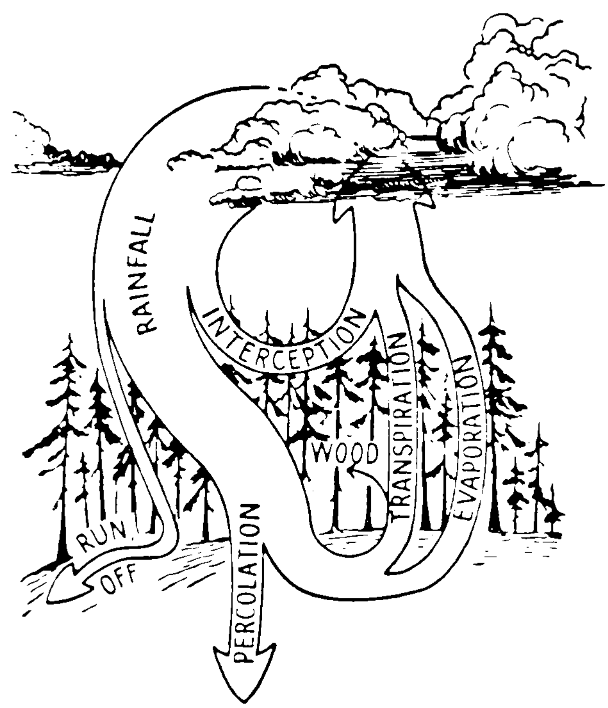

Figure 5-2.—The water cycle in the forest. Reprinted, with permission, from Daniels, T., J. Helms, and F. Baker, *Principles of Silviculture,* 2nd ed., © 1979 McGraw-Hill, Inc. More recent terminology uses *infiltration* to denote water moving across the air/soil interface; *percolation* is movement through the soil profile.

Moisture that penetrates the forest canopy is also 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 is also an important source of nutrients, and it acts as a protective cover to protect the soil from erosion during high-intensity rainfall.

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 depends on the soil type (texture and structure) and the amount of disturbance to the top soil layer. In undisturbed soils, infiltration 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. This results in water moving overland. Overland flow can lead to erosion and sedimentation into streams.

Soil moisture storage

Once water has entered the soil profile, it's either temporarily detained or stored between soil particles. Moisture retained within the soil profile is then used by vegetation during the growing season, when rainfall is scant.

When rainfall enters the soil profile in the fall, after the summer drought, almost all water is retained in the soil profile. As the moisture recharge period continues through late fall and into the spring, the soil may become very wet—it can't hold any more moisture against the force of gravity. This is known as *field capacity.*

Depth and type of soil. The amount of water held in the soil 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 represent a large soil volume with considerable pore space, capable of retaining more total moisture than shallow soils of the same soil type.

Soil type. Within the soil profile, the type of soil (texture and structure) affects the porosity (size of pores between soil particles) and, therefore, 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 (like loams) retain more than sandy soils (coarse texture).

At the other extreme, fine soils, such as those dominated by clays, have such small pore size that water is so tightly held between soil particles that plants are unable to extract it (figure 5-3).

Transpiration

Water stored in the soil profile acts as a large reservoir. Because little rainfall occurs during the summer months, 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're used in photosynthesis and plant maintenance.

Excess water passes through pores (stomates) in the leaves and needles, and it's evaporated from the leaf surface into the atmosphere.

This process of water movement through plants is known as *transpiration.* A substantial amount of water is moved from the soil to the atmosphere in this fashion. 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 available soil moisture, it becomes increasingly more difficult for the plant to extract the remaining moisture because it's tightly bound between soil particles. If plants can't meet their demands for moisture, they may respond by closing stomates, which stops 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 stress in early to mid-July, depending on the aspect (north vs. south slopes), 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 evaporated from leaf surfaces, or taken up and transpired by forest vegetation, eventually percolates downward to the stream channel and/or underground aquifer.

It seems logical, then, that managing vegetation to reduce interception and transpiration losses is one approach to increasing streamflow by preventing its loss to the atmosphere.

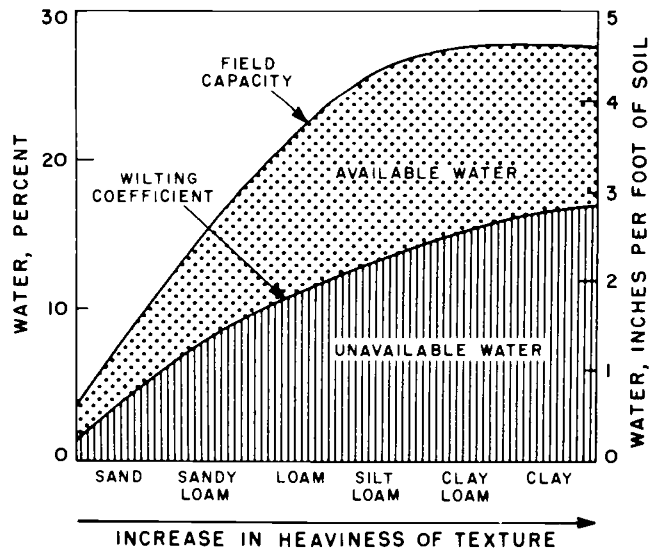

Figure 5-3.—Representative curves of general relationships between soil moisture characteristics and soil texture for agricultural soils. Specific soil types may vary from the indicated value. Reprinted, with permission, from Buckman, H.O., and N.C. Brady, *The Nature and Properties of Soils,* 6th ed. revised by N.C. Brady, © 1960 The Macmilllan Co.

Effects of forest practices on watersheds

Harvesting activities can greatly effect water quality and quantity. Although most people view harvesting as just severing trees from the stump, other associated activities have the greatest effect on water, particularly water quality.

Road and skidtrail construction (to extract logs from 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's being closely studied in many areas of the arid West. This is described more fully in "Opportunities to increase water yield from forested areas" (righthand column).

A number of publications on proper road-building and timber harvesting, and their potential impacts, are listed in "For further reading" (page 46).

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. These tend to be the greatest sources of sedimentation.

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's important to use buffer areas between road and stream to reduce sedimentation directly into streams. Where stream crossings are necessary, design them carefully to handle storm runoff. Careful layout and preplanning of roads 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 reduces infiltration rates. This promotes overland flow and increases erosion and sedimentation.

If you keep skidtrail areas to 10-15% or less of the total area, you can significantly reduce impacts to water and safeguard the productivity of the site. It's also important to minimize soil compaction when you conduct slash piling with heavy equipment.

Fire

Burning is a silvicultural tool that's widely used in eastern Oregon forests. Burning is used in clearcuts and other harvested areas to reduce the amount of slash and to prepare 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 they 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.

Opportunities to increase water yield from forested areas

Research throughout the West shows that timber harvesting can increase streamflow. 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, more water is available to contribute to streamflow (figure 5-4).

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% of the watershed is harvested in small clear-cut patches (2 to 5 acres) evenly dispersed over the watershed.

This pattern of cutting not only reduces transpiration and interception losses within clear-cut areas, but also affects snowpack accumulation, retention, and melting.

Mid to high elevations in eastern Oregon could also yield water increases if they're harvested in this manner. However, the magnitude 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% or less may result in no significant increase—any additional water is used by neighboring trees.

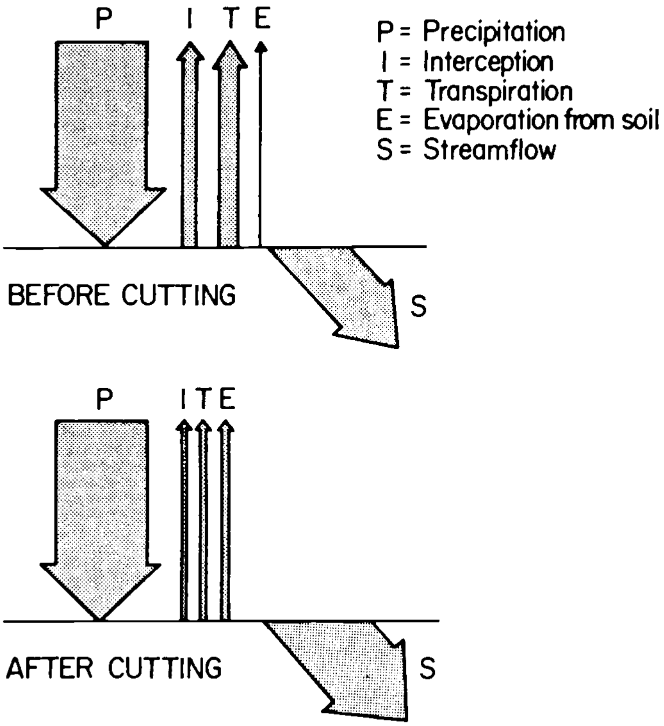

Figure 5-4.—Relative sizes of components of the forest hydrologic cycles, before and after timber cutting. Reprinted, with permission, from Fredriksen, R.L., and R.D. Harr, "Soil, Vegetation, and Watershed Management," in Heilman, P.E., H.W. Anderson, and D.M. Baumgartner, eds., *Forest Soils of the Douglas-Fir Region,* Washington State University Cooperative Extension Service (Pullman, 1979).

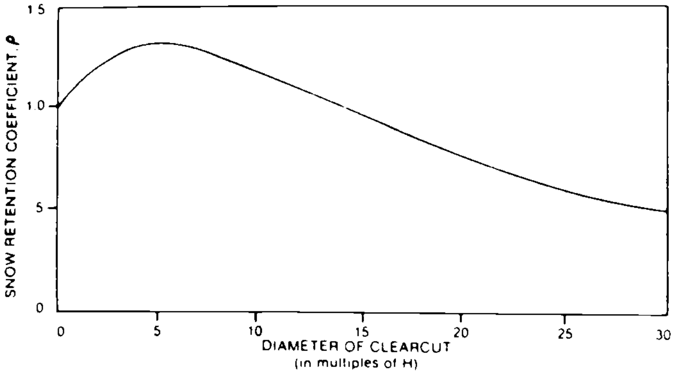

Figure 5-5.—Snow retention as a function of size of clear-cut. *H* is the height of surrounding trees. Reprinted, with permission, from Troendle, C.A., and C.F. Leaf, "Hydrology," in *An Approach to Water Resources Evaluation of Non-Point Silvicultural Sources,* Environmental Research Laboratory, Athens, Ga., EPA 60018-80-012 (1980).

Timber harvesting effects on snowpack accumulation and retention

Timber harvesting affects snow capture, retention, and melt. Studies conducted in watersheds of the central Rocky Mountains show that snow deposition can increase 15 to 35% in various-sized openings. 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—so net snow accumulation within the watershed usually remains 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 3 to 5 tree heights (H) in diameter are most efficient for snow deposition (figure 5-5). Clear-cut patches larger than the 3 to 5H-size begin experiencing snow scour from increased wind into the larger openings (figure 5-6).

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

Aspect, slope, and tree cover. These three factors 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.

In addition, because the earlier snowmelt comes at a time when transpirational demands are low, more water is available for streamflow (figure 5-7).

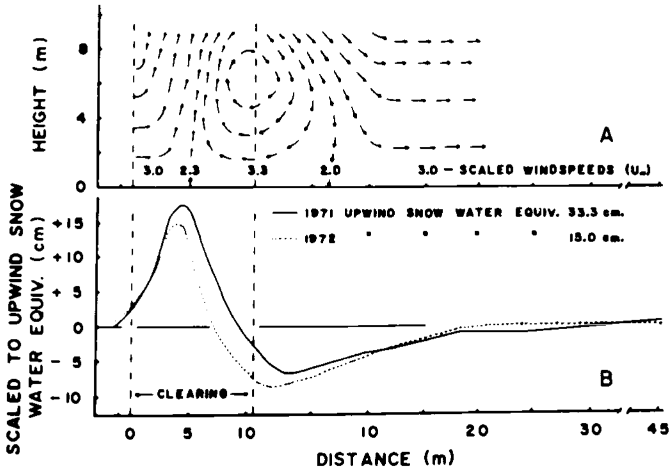

Figure 5-6.—Peak water equivalent in the open and the downwind forest, expressed as a deviation from the norm or upwind forest. Also shown is the relative wind speed observed at the site. Reprinted, with permission, from Gary, H.L., "Snow Accumulation and Melt as Influenced by a Small Clearing in Lodgepole Pine," *Water Resources Research* 10:345-353, 1974.

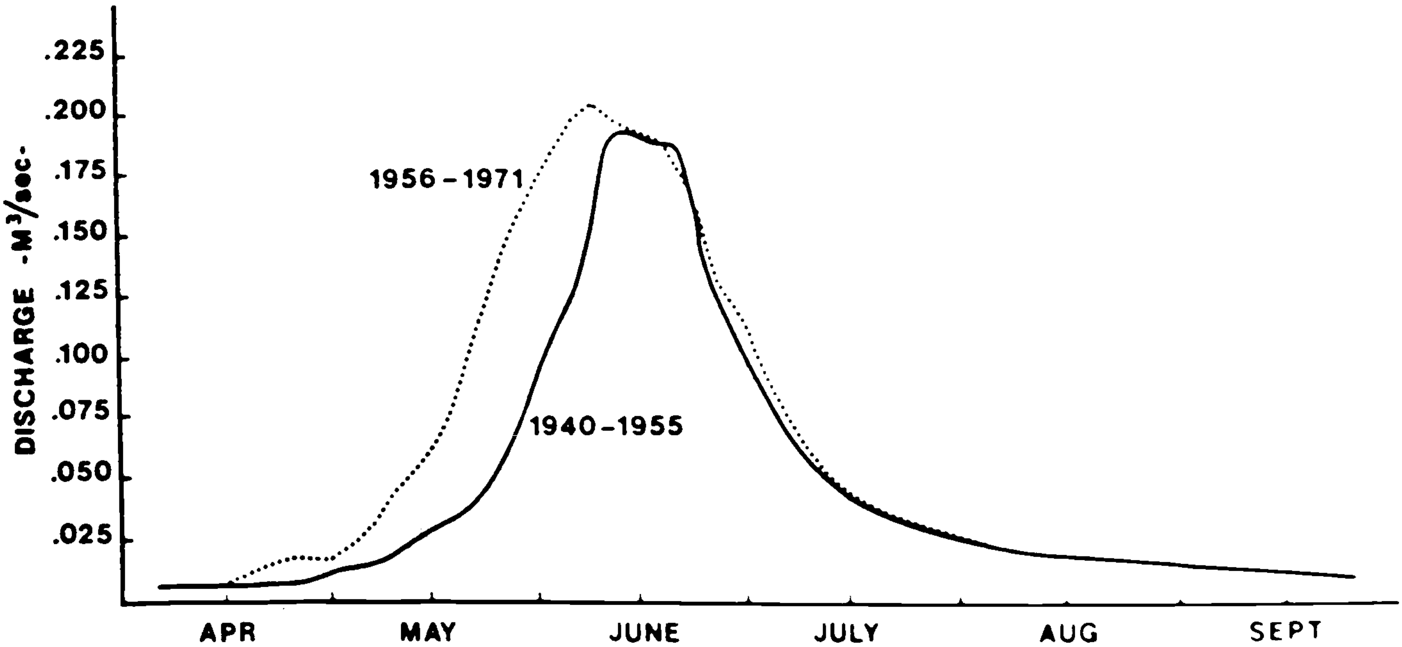

Figure 5-7.—Average hydrographs for Fool Creek Watershed, Colorado. Solid line is the average for 1940-1955, before timber harvest. Dotted line is the average for 1956-1971, after timber harvest. Reprinted, with permission, from Troendle, C.A., and C.F. Leaf, "Effects of Timber Harvest in the Snow Zone on Volume and Timing of Water Yield," in *Interior West Watershed Management* (Symposium Proceedings, Spokane, Wash., April 8-10, 1980), Washington State University Cooperative Extension (Pullman, 1981).

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.

The increase will generally be greatest the first few years after harvest, and it 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

Potential exists to increase water yield in the interior Northwest. What areas hold the greatest potential for water increases? The greatest potential to increase water yield seems to exist 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's warmer and receives less moisture—available moisture is slightly greater than evapotranspirational losses.

Although it's been demonstrated that water yield can be increased, the more important question is, can this objective realistically be achieved given ownership patterns and current land management objectives?

Since 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—it's 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 opinion. 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

OSU Extension publications

These publications are available from Publications Orders, Agricultural Communications, Administrative Services Bldg. 422, Oregon State University, Corvallis, OR 97331-2119.

Shipping and handling: Please add 25¢ for orders up to $2.50. For orders between $2.50 and $100, add 15%. For orders of $100 or more, please call Agricultural Communications (503-737-2513) for a quote on reduced rates.

Adams, Paul W., *Maintaining Woodland Roads,* Oregon State University Extension Service Circular 1139 (Corvallis, 1983). 75¢

Adams, Paul W., *Soil and Water Conservation: An Introduction for Woodland Owners,* Oregon State University Extension Service Circular 1143 (Corvallis, 1983). 25¢

Adams, Paul W., *Soil Compaction on Woodland Properties,* Oregon State University Extension Service Circular 1109 (Corvallis, 1983). 50¢

Garland, John J., *Logging Woodland Properties: A Worksheet for Landowners,* Oregon State University Extension Service Circular 956 (Corvallis, reprinted 1986). 50¢

Garland, John J., *Planning Woodland Roads,* Oregon State University Extension Service Circular 1118 (Corvallis, 1983). 25¢

Garland, John J., *Road Construction On Woodland Properties,* Oregon State University Extension Service Circular 1135 (Corvallis, 1983). 75¢

Garland, John J., *Designing Woodland Roads,* Oregon State University Extension Service Circular 1137 (Corvallis, 1983). $1.75

Garland, John J., *Designated Skid Trails Minimize Soil Compaction,* Oregon State University Extension Service Circular 1110 (Corvallis, 1983). 25¢

Other publications

Anderson, Henry, M.D. Hoover, and K.G. Reinhart, *Forests and Water: Effects of Forest Management on Floods, Sedimentation, and Water Supply,* General Technical Report PSW-18 (1976), USDA Forest Service, Pacific Southwest Forest and Range Experiment Station, Berkeley, CA.

Franklin, Jerry, and C.T. Dyrness, *Natural Vegetation of Oregon and Washington,* reprint, with expanded bibliography, of USDA Forest Service General Technical Report PNW-8, 1973 (Corvallis, Oregon State University Press, 1988). $22.95 plus $2.00 for postage and handling; order from OSU Press,101 Waldo Hall, Corvallis, OR 97331.

Ponce, Stanley L., ed., "The Potential for Water Yield Augmentation Through Forest and Range Management," *Water Resources Bulletin,* vol. 19, no. 3 (1983), American Water Resources Association, Bethesda, MD.

Grazing practice relationships: Predicting riparian vegetation response from stream systems

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Vegetation on upland sites will respond in relation to the kind of grazing management applied. That's also true for riparian vegetation, but in this case it's not only affected by the site but also by the nature of the stream system.

We believe the relationships discussed in this chapter will help you create better site-specific grazing prescriptions and thus be able to predict generalized responses.

Physical characteristics of stream systems are important: gradient, size and kind of rock, depth to bedrock, and type of soil. They're the factors that determine whether or not a stream and its associated riparian zone has 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 hasn't very much potential to erode or to trap sediments, even if sediments were in the water. Conversely, a low-gradient stream that's erosive and carries high-sediment loads has both the positive as well as the negative potential to change.

Grazing management can be either helpful or detrimental. Figure 6-1 illustrates these generalized relationships. The natural stress of a stream system (prevailing climate, gradient, soil, rock, water flow, etc.) ranges from stable to unstable (left to right on the horizontal axis). Stress, which we as human beings impose, is represented on the vertical axis. Management-induced stress (grazing intensity, season of use, logging practices, roading systems, etc.) can range from minimal (low stress) to dramatic (high stress).

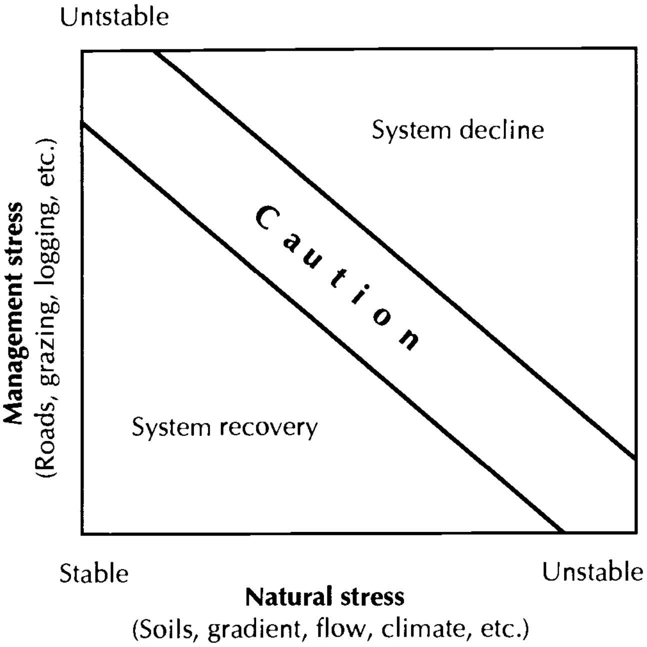


Figure 6-1.—Generalized relationship between natural and induced (management) stresses.

This point is important: No tw*o stream systems are alike—each one has its own level of ability to withstand natural and/or human-induced stresses.*

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 (figures 6-2 and 6-3): vertically unstable and laterally (horizontally) unstable.

As each kind of stream becomes degraded, it goes through definable stages of change. Although recovery can occur, it generally takes longer for 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 don't have a flood plain into which high waters can escape, they continue to erode their banks and bottoms during peak flows. Small engineering structures (check dams, etc.) are useless—they can't withhold the forces of the concentrated floods.

At the close of this chapter (after page 52), we include University of Nevada Fact Sheet 88-76, by Sherman Swanson. *Prioritizing Streams for Rehabilitation and Riparian Management* provides further details on these erosion processes and suggests some priority approaches to resolving them.

Grazing systems

"Grazing to maintain a healthy range," page 24, contains information on grazing systems, but some explanation here is desirable as well. Each approach has certain attributes, so each has a different name.

The next seven sections are generalized descriptions. You'll need to consider any of these systems in terms of the outcomes you hope for and the manner in which it would fit into the rest of your grazing operation.

Season-long grazing

Graze during the entire plant-growing season. In the interior Northwest, this would include grazing from early or mid-spring to mid- or late summer. In the California annual grasslands, it would be from late winter until April or May.

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 regrazed later in the year.

Deferred-rotation

Selected pastures aren't grazed until some stage of plant development is reached (flowering or seed set, or seed shatter). The deferred pasture is rotated among the other pastures each year on an annual basis.

Rest-rotation

To qualify as "rest," a given pasture must remain ungrazed for a full growing season. A three-pasture rest-rotation system would have one pasture grazed early during the growing season, another deferred until after seed formation, and the third rested all year.

Each year, the grazing use would then be rotated so that at the end of 3 years, each pasture would have experienced each grazing treatment.

Early growing season

Restrict livestock grazing to the early growing season and completely remove livestock before soil moisture is depleted. The idea here is that livestock removal comes not only while soil moisture is still adequate but also while temperatures will allow plants to complete their reproductive cycle during the remainder of the growing season.

Late growing season

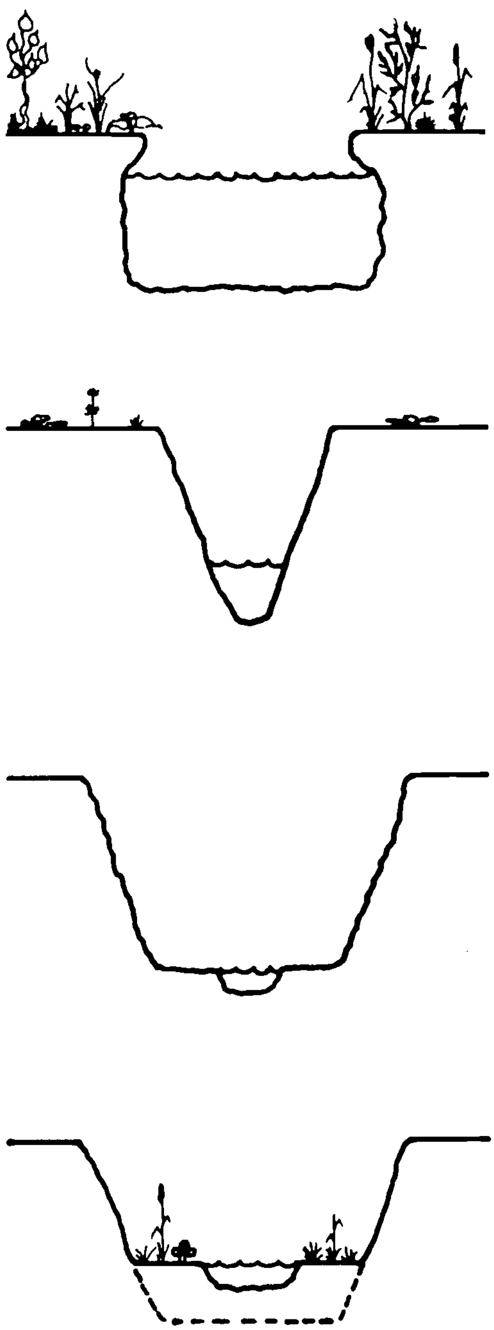
Allow livestock to graze after the vegetation has matured and completed its reproductive cycle. Remove them before fall rains and saturated soil conditions prevail.

Dormant season

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

Vegetation responses and grazing

Plants react according to the various stresses placed on them. So do grazing animals. Understanding basic grazing behavior helps in designing effective management prescriptions. Many riparian zones have, or could have, a mixture of herbaceous and deciduous woody vegetation.



STAGE

1 Most stable. Bank protection is important. Management should attempt to keep stream in this condition. High water rises out of stream channel and flows over well vegetated banks.

2 Incised (deepened) channel. Vegetation on banks likely reduced and can't hold well. Water table is dropping. Structures aren't useful to keep the stream from further cutting.

3 Channel becomes much wider. Both grazing management changes and installing small structures may be important to keep channel from complete degradation when large storm events occur. Water table on adjacent flood plain has dropped greatly.

4 Channel is rebuilding through increase in vegetation. Herbaceous vegetation starts first, often followed by woody vegetation. Small structures staggered over time are beneficial. With enough time and sediment catching, Stage 1 can again be achieved.

Figure 6-2.—Vertically unstable streams on alluvial soil

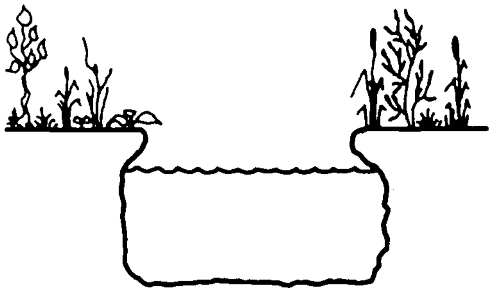
Managers want a variety of plants to develop because they realize such vegetation is necessary for a stream system to recover and reach its potential. This mixture of plants will provide the benefits of increased forage, reduced erosion, high water quality, and good wildlife habitat.

Woody riparian vegetation (willows or alders) is discouraged by grazing late in the growing season because at that time, most grasses, sedges, and rushes have completed their reproductive cycle and are entering or are in a dormant stage. Consequently, the herbaceous vegetation is frequently unpalatable, dry, lacking in succulence, and often low in protein and energy content.

The woody vegetation, by contrast, is still green and succulent, palatable, and high in protein and energy content. At this time of year, large animals (domestic or wild) will actively select woody vegetation. Consequently, heavy use during late season grazing will discourage shrubs and woody vegetation.

STAGE

1



Stable. Vegetation holds banks in place. High water events aren't damaging—flows move out of stream channel, slow down, and drop sediment load. Design management to encourage this type of stream.

2

Stream has started to widen; in this case, it's vertically restricted and can't cut down. Vegetation changes caused by too much management stress have occurred, allowing banks to deteriorate. The channel will widen and straighten when high water events occur.

3

Stream becomes quite wide and shallow. Even when vegetation can be reestablished, many years will be required for the banks to build and the stream channel to narrow and deepen as shown in Stage 4.

4

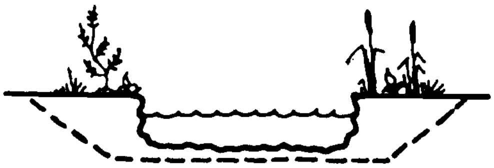


Figure 6-3.—Laterally unstable streams on vertically restricted soils

Maintaining or improving the woody vegetation component is generally considered desirable. Therefore, design grazing management to accomplish this goal. Grazing in the early part of the growing season doesn't appear to harm woody production, as long as herbaceous plants are abundant and growing actively.

Some evidence shows that summer use levels of below 50% on herbaceous vegetation along 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's conducive to their health and performance.

For example, commonly used three-pasture rest-rotation grazing usually doesn't promote improved woody riparian vegetation, even though it may be very positive for the herbaceous component. The reason is that, in a three-pasture system, a pasture is rested the first year, grazed early the second year, and deferred grazed the third year. The year it receives late-season grazing often makes the lighter use of the 2 previous years a waste of time—the third year allows too much use on the woody vegetation.

It's well to mention here, however, that there are a number of variations to rest-rotation grazing. For example, some five-pasture—and even seven-pasture—systems have been designed with different plans for rest, partial use, and full use. Obviously, you'll need to evaluate the effectiveness of a rest-rotation system in terms of frequency of stress induced by feeding on the vegetation. 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.

You can promote herbaceous material and plant community vigor, at differing rates of change, by appropriate use of each of the grazing systems when you compare it with season-long grazing:

- Season-long grazing is detrimental to both herbaceous and woody vegetation—animals are present to graze each plant species at its susceptible stage of growth without any planned rest.
- Rotation or deferred-rotation grazing schemes seem to combine the attributes of simplicity and plant protection to promote herbaceous growth.
- Late-growing-season grazing, before the 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-growing-season grazing may promote both shrubs and herbaceous vegetation. However, you must be alert to potential problems like lowered nutritional value—you may need to prepare supplements for your livestock. In addition, soil compaction problems may result, depending on soil moisture and frost conditions. A big economic advantage, however, may be the opportunity to reduce winter feed costs by grazing at this time.

Figure 6-4 (page 52) incorporates the basic grazing systems defined earlier and the following stream systems:

Slope

- Flat = 0-2% ; moderate = 2-4%; steep = greater than 4%.

Sediment load

- High = turbid waters; usually, bank and bottom materials tend toward clays, silts, and fine sands.
- Low = clear waters; usually, bank and bottom materials tend toward coarse sands, gravels, cobbles, and boulders.

Depending on the outcomes you want and the kind of situation you have along any particular part of the stream, a general grazing approach may be applicable. The matrix is designed to give an insight into the way a "typical" stream type might respond to a given management step.

Try figure 6-4. Suppose you had a steep-gradient, gravel- and cobble-lined stream that carried little sediment, and you wanted to build banks by eliminating livestock use:

- Enter the matrix under "Natural Conditions" at the lefthand column, "Steep, low-sediment load."
- Move down until you intersect the desired "Management Stress" category at the left (in this example, "No grazing").
- The response indicates that lack of grazing probably won't enhance your desired objective of building banks.

This makes sense; if there's little sediment being transported in the system, there will be little opportunity for bank building, with or without livestock present.

A word of caution

It simply isn't possible to devise a foolproof generalized approach—please interpret with care. We want this matrix to be a guide in helping you create site-specific grazing prescriptions; it's not a "by-the-numbers" recipe.

Summing up

What you should aim for is prescription grazing—a tailored grazing management scheme designed for your specific site, plant community, and set of management goals.

Appropriate management dictates that you must:

1. Evaluate every ecosystem for its unique combination of natural and human-induced factors.
2. Manage it by a prescription rather than a "blanket" grazing policy.

		NATURAL CONDITIONS					
		Low	Medium	Medium	Medium	Medium	High
MANAGEMENT STRESS		Steep, Low sediment load	Steep, High sediment load	Moderate, Low sediment load	Moderate, High sediment load	Flat, Low sediment load	Flat High sediment load
Low	No Grazing	Shrubs ↑ Herbs ↑ Banks ↔	Shrubs ↑ Herbs ↑ Banks ↔ ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑
Low	Dormant Season	Shrubs ↑ Herbs ↑ Banks ↔	Shrubs ↑ Herbs ↑ Banks ↔ ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑
Low	Early growing season	Shrubs ↑ Herbs ↑ Banks ↔	Shrubs ↑ Herbs ↑ Banks ↔ ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑
Medium	Late growing season	Shrubs ↓ Herbs ↑ Banks ↔ ↓	Shrubs ↓ Herbs ↑ Banks ↔ ↓	Shrubs ↓ Herbs ↑ Banks ↔ ↑	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↓ Herbs ↑ Banks ↑
Medium	3-pasture Rest-rotation	Shrubs ↓ Herbs ↑ Banks ↔	Shrubs ↓ Herbs ↑ Banks ↔ ↑	Shrubs ↓ Herbs ↑ Banks ↔ ↑	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↓ Herbs ↑ Banks ↑
Medium	Deferred rotation	Shrubs ↓ Herbs ↑ Banks ↔	Shrubs ↓ Herbs ↑ Banks ↔ ↑	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↓ Herbs ↑ Banks ↑
Medium	Rotation	Shrubs ↓ Herbs ↑ Banks ↔	Shrubs ↓ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑	Shrubs ↑ Herbs ↑ Banks ↑
High	Season long	Shrubs ↓ Herbs ↓ Banks ↓	Shrubs ↓ Herbs ↓ Banks ↓	Shrubs ↓ Herbs ↓ Banks ↓	Shrubs ↓ Herbs ↓ Banks ↓	Shrubs ↓ Herbs ↓ Banks ↓	Shrubs ↓ Herbs ↓ Banks ↓

↓ - decrease

↑ - increase

↔ - no change

Figure 6-4.—Generalized relationships among riparian vegetation response, grazing management practices, and stream system characteristics

FACT SHEET 88-76

University of Nevada Cooperative Extension

Prioritizing Streams for Rehabilitation and Riparian Management

Sherman Swanson, Extension Range Specialist
Range, Wildlife, and Forestry Department

HISTORICAL PERSPECTIVE

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 may gradually change over a period of many years. During this period of gradual change, 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 a gully. When a stream passes this threshold, it must progress through certain steps in 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 heavy-snow winters produced abnormally prolonged periods of high flow.

When approaching a threshold of gully formation, there can be substantial effect during a flood if the following conditions occur:

1. Streambank vegetation has been weakened and can no longer hold the streambank well enough to prevent serious bank erosion; or
2. The forces working on streambanks and channel bottoms become too great because the stream has straightened and become too steep or downcut and lost access to its floodplain.

FUNCTION OF RIPARIAN VEGETATION

Some Nebraska sedge dominated communities have an average of more than 100 feet of roots and rhizomes per cubic inch of soil near the soil surface ($2 m/cm^3$). It is no wonder that Nebraska sedge and other broad-leaved sedges have gained a reputation for stabilizing sediment and binding streambank 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 would otherwise erode, vegetation provides roughness at the water-land interface. This decreases water velocity and decreases the energy available for transport of sediment. The filtering effect of riparian vegetation is partly responsible for deposits of fine, fertile soils on many floodplains 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.

It is natural for low-gradient ($<$ 1.5 percent) streams with floodplains to meander. The process of forming meanders involves a balance of bank erosion on the outside turns and deposition on the inside turns. In order for meandering streams to remain stable, the rate of these two processes must remain 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 accordingly; it may break through meanders and the broad sweeping curves of the new channel lead to decreased stream length. The shorter stream must still drop the same elevation. Therefore, as the stream straightens, the slope steepens and velocity increases. Stream energy is thus expended over a shorter length of channel and may accelerate erosion.

FUNCTION OF FLOODPLAINS

Narrow meandering streams commonly flood a broad floodplain adding to a high water table (Fig. 1A). A high water table provides abundant water to vegetation that in turn provides bank stability upon which stream morphology and the high water table depend. The broad, flat floodplain is necessary for dissipation of energy during flood events. It also stores floodwater for future streamflow.

Tractive force, or the ability to detach and carry sediments, 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 floodplain increases depth only a small amount during a flood. Therefore, it can withstand floods of tremendous magnitude with little erosion. Floods on such streams will generally deposit fine sediment on the floodplain and build streambanks.

GULLY EROSION

Any net loss of channel material, such as bank erosion, causes a stream to lose some access to its floodplain. As a stream loses its opportunity to dissipate energy over a floodplain, 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 (Fig. 1B). The concentrated energy of flowing water then causes rapid erosion.

Immediately following gully development, the stream width is the same as the gully-bottom width. The old floodplain is a terrace, and there is essentially no floodplain. 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 (Fig. 1C).

The water table that previously supported dense vegetation on the old floodplain is often lowered as a result of downcutting. Riparian vegetation is then 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 floodplain in the bottom expands (Fig. 1D). As the floodplain widens, it grows vegetation, dissipates energy and collects sediment. Energy dissipation allows vegetation to grow stronger. It can then shape the active channel and form meanders and overhanging banks (Fig. 1E). Eventually the gully may fill and the terraces again become a floodplain.

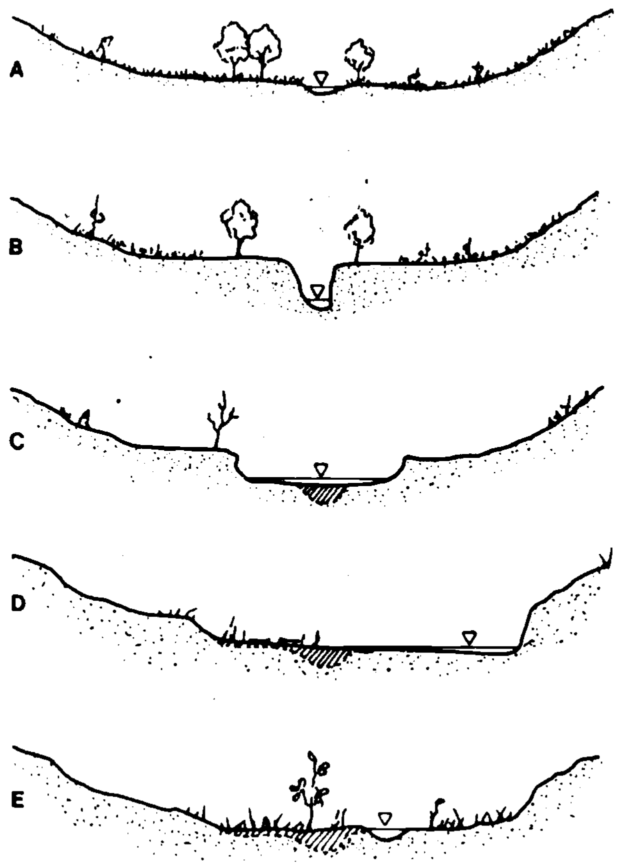


Figure 1. Phases in arroyo evolution (after Elliott 1979)

PRIORITIZING STREAMS

Land managers must accept the history of land use that has preceded 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 future results of one option must be compared with the future results of another option. 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 floodplain may be cheaper and provide more benefit.

HIGHEST PRIORITY STREAM REACHES

Highest priority streams still have and use their floodplain (Fig. 1A), but could, through improper management, lose access to it through downcutting. Streams that still rely on water-loving streambank vegetation will respond to improved riparian management strategies most quickly. This is due to the vegetative resilience that comes with water and nutrient availability, and the energy dissipation by the floodplain.

Proper management is critical in stream valleys that are long and deeply filled with erodible sediment. These streams have consistently depended upon vegetation for streambank 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 initiated.

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 where a stream has downcut and is totally confined in the bottom of a gully (Fig. 1B).

Protection or careful management may permit riparian vegetation to grow at the base of the gully wall. However, its effect controlling erosion or altering channel morphology will likely 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 at about the time the gully bottom becomes wider than the active channel (Fig. 1D). At this time the floodplain forming inside the gully can begin to dissipate flood energy. Riparian vegetation and management then becomes 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.

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Watershed management tools

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A watershed's primary functions are *capture, storage,* and *safe release* of water. Vegetation, soil type, and management practices influence the ability of the watershed to function properly. The extent to which these three components work together (or against each another) can determine the overall health of the system.

You'll need to address watershed management with long-range goals in mind. 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 don't address the problem of eroding uplands, poor infiltration rates, and excessive evapotranspiration from undesirable vegetation.

We've designed this chapter with you, the user, in mind. While we don't provide engineering specifications, we've 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.

At the beginning of each tool you'll find three categories: Capture, Store, and Safe release. A check for a category tells you that's a goal you can achieve through that tool (sometimes, all three are important).

We've also included a caution statement for each tool. It's designed to remind you about an important point: Constructing or implementing a single structure or practice rarely stands by itself—you'll need to implement it *with* a lot of other 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,
- volume of water at peak flow, and
- timing of peak flow.

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

- soil characteristics,
- precipitation,
- management goals and objectives, and
- 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 Soil Conservation Service technician can help you locate appropriate kinds of financial resources.

Juniper control

√ Capture
√ Store
√ Safe release

Features

Juniper tree numbers and/or cover is reduced when the trees are detrimentally influencing the watershed and associated vegetation.

Planning and design considerations

Site suitability for herbaceous production once trees are removed (i.e. seed source, residual plants, soil characteristics and fertility) are crucial components.

Site characteristics dictate appropriate control methods, which may include burning (figures 7-1 and 7-2), chaining, chain-sawing, chemicals, bulldozing, etc.

Maintenance requirements

Constant surveillance for reinvasion coupled with subsequent control of small trees.

Benefits

- Improved infiltration through increased herbaceous plant densities.
- Increase in soil moisture due to lower tree density and cover.
- Decreased precipitation losses via tree canopy interception.
- Decreased overland flows and potential erosion through enhanced herbaceous ground cover.
- Downed trees provide climatic microsite conditions for improved herbaceous plant establishment (figure 7-3).

Caution

If an adequate herbaceous seed source or seed bed is not available for immediate colonization of the site, implementing this practice will result in a decrease in soil stability. Subsequent management of the vegetation includes control of livestock use and recreational access by people and an understanding of wildlife needs. These are necessary in order to assure the success of this tool.

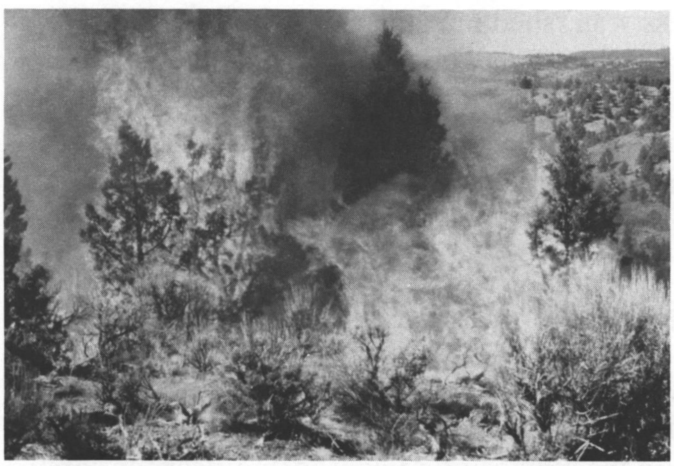

Figure 7-1.—A burning juniper; fire is extremely effective when enough ground fuels exist.

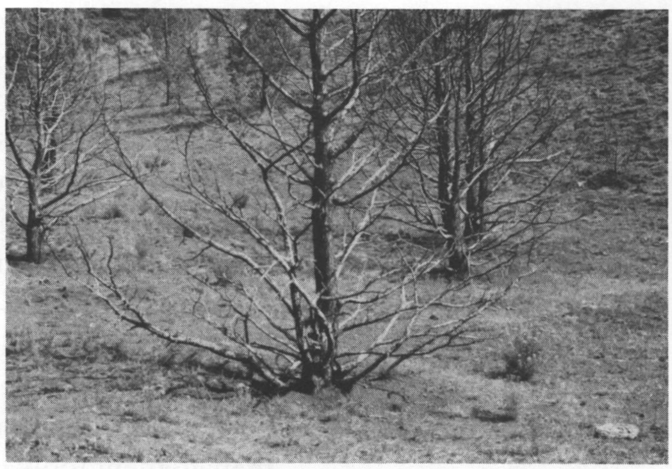

Figure 7-2.—Juniper doesn't sprout after a hot fire.

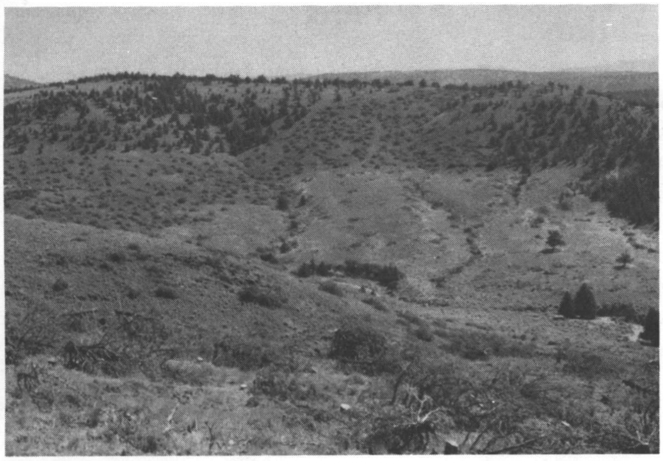

Figure 7-3.—This cleared site will provide most of the benefits listed.

Grazing management

√ Capture
√ Store
√ Safe release

Features

Managing grazing animals to maintain or improve vigor, composition, and density within the plant community.

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 different grazing strategies varies with different ecological units (see "Developing management strategies for your range," page 10). 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

Continuous monitoring of vegetation response and adjustment of the grazing management program to meet prescribed goals.

Benefits

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

Caution

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

Harvesting before the proper time negatively influences yields of the plant community, which in turn impacts infiltration, 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 within this category.

Planning and design considerations

Type, class and species of animal to be manipulated must be considered. Terrain, 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 method of control. 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

Management of the vegetation, which includes control of livestock use, recreational access by people 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.

Gradient-stabilizing (drop) structures

Capture
Store
√ Safe release

Features

Drop structures are of low height, constructed across the stream channel and keyed into banks and bottom. Overflow located at center of channel and a down stream apron to protect stream bottom and banks is imperative.

Planning and design considerations

Height of structure is less than average 2-year peak flow. Aprons can be constructed from a variety of materials (concrete, rock, etc.). Downstream length of an apron depends on stream velocity; material must be massive enough to dissipate energy without being moved. The structure itself is more or less impermeable, and it's most useful in small (1st or 2nd order) tributary streams on straight reaches (figure 7-4).

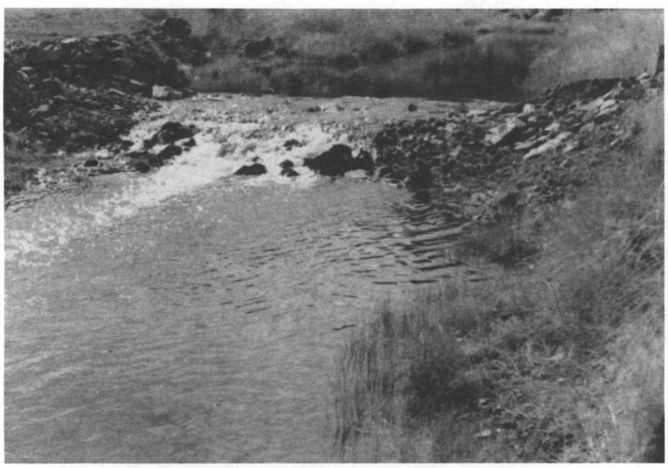

Figure 7-4.—Small structures are best. Built correctly, they won't wash out.

Maintenance requirements

Annual inspection of apron, overflow, and key.

Benefits

- Safe release of energy coupled with some sediment trapping upstream.

Caution

This practice doesn't stand alone. Trapped sediment offers a medium for the establishment of vegetation that will further aid in trapping sediment, protection of the streambank and storage of water.

Management of the resulting vegetation includes control of livestock use, recreational access by people, and an understanding of fish and wildlife needs. These are required in order to assure the success of this tool. 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 water behind them. They're keyed into the bank and project out into a portion of the stream channel.

Planning and design considerations

This structure needs to be properly keyed into the bank and bottom of the stream. They may be constructed from a variety of materials (for example, logs or rock), but must be heavy enough to resist water pressure.

They're most applicable on larger (greater than 3rd order) streams with low gradients. The length of the jetty or distance into the stream is based on a relationship to the total stream width (figure 7-5).

Figure 7-5.—Strength from a large rock is a must to slow water and break or divert its energy.

Maintenance requirements

Annual inspection of the key and its reconstruction if storm events have weakened it.

Benefits

- Stilled pool behind the structure for downstream bank protection along with some sediment trapping.
- Vegetation will reestablish on the downstream bank, allowing bank buildup and stabilization.

Caution

This practice does not stand alone. Trapped sediment offers a medium for the establishment of vegetation that will further aid in trapping sediment, protection of the streambank, and storage of water.

Management of the vegetation, which includes control of livestock use, recreational access by people, and an understanding of fish and wildlife needs, is required to assure the success of this tool. 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 when existing vegetation is either inadequate or undesirable for the watershed to function properly. This practice functions to improve infiltration, thus increasing the storage capability of the watershed and the safe release of water through subsurface flows.

Planning and design considerations

Selected plant materials must be adapted to site and suitable to meet management goals. The competitive relationships between other plant species and the new seeding must be considered. Impacts of grazing animals must be evaluated and accounted for.

Maintenance requirements

There must be a long term commitment to maintain a proper balance between the vegetation and its subsequent utilization by animals. Undesirable plant invasion must be monitored and corrective measures considered.

Benefits

- Increased 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 flows and erosion potential (figure 7-6).

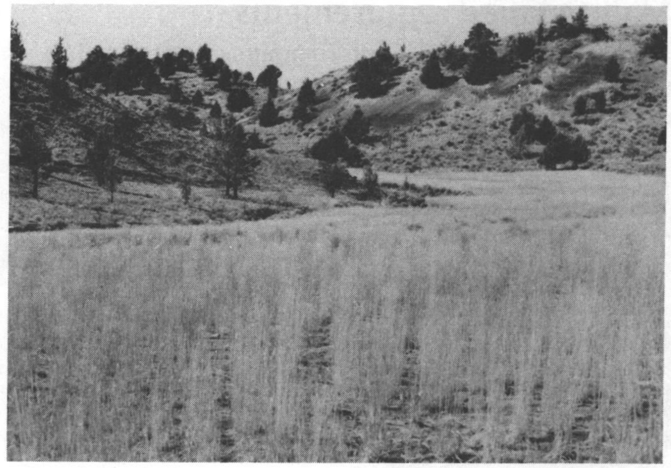

Figure 7-6.—Managing a seeding should include leaving enough residue on soil surfaces to minimize disturbance from rain and snow.

Caution

Survival of seeded plants is limited by the experience of those doing the selection, planting, and suitability of site and plant materials, and the competitive nature of other plants.

Management of the vegetation includes control of livestock use, recreational access by people, and an understanding of wildlife needs. These are required in order to assure the success of this tool.

Woody vegetation plantings in riparian zones

Capture
√ Store
√ Safe release

Features

Woody, streamside vegetation protects (through root binding and physical armoring) the streambank against erosion caused by high water flows and/or ice.

Planning and design considerations

Plant materials selected must be adapted to the site. Site selection (soils, water table, drainage, etc.) and season of planting are critical. Benefits may be derived from the application of root growth inducing hormones to planting stock. Potential use by domestic animals and wildlife must be considered and adequate protection provided to ensure good establishment.

Maintenance requirements

There must be a long term commitment to maintain a proper balance between the vegetation and its subsequent use by animals (figure 7-7).

Benefits

- Streambank protection
- Sediment trapping

Caution

Experience has shown that the success of this practice depends on several things. Survival of planted material is limited by the experience of those doing the planting, selection and suitability of the plant materials and site along with the competition by other plants.

Management of the vegetation, which includes control of livestock use, recreational access by people, and an understanding of fish and wildlife needs, is required in order to assure the success of this tool.

Figure 7-7.—Young trees have high growth potential. Within a very few years, such vegetation can be out of reach for many grazing animals.

Head-cut control devices

Capture
Store
√ Safe release

Features

These devices will dissipate energy at the head-cut so upstream channel cutting will be stopped. Rock placement begins above the cut, continues through the cut protecting 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. On a degrading channel, this is the *first* structure to be built.

Maintenance requirements

Annual inspections of these structures are necessary to ensure that the rock/soil interface is maintained and that cutting has not occurred on the back or sides of the control device. Further inspection is necessary to ensure that a 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 (figure 7-8).

Caution

This practice doesn't stand alone. Head cut structures are designed to prevent further cutting of the stream channel from a nick-point until vegetation stabilization can occur.

Management of the improved vegetation includes control of livestock use, recreational access by people, and an understanding of fish and wildlife needs. These are required in order to assure the success of this tool. Be sure to follow State water and fill-permit laws when you implement this practice.

Figure 7-8.—Rock of various sizes will minimize soil movement, to allow vegetation to become established.

Herbaceous plantings in riparian zones

Capture
√ Store
√ Safe release

Features

Existing vegetation is not adequate to provide sustained protection to the site. Thus, vegetation must be planted in order for streambanks and adjacent floodplains to be protected and stabilized through improved top growth and root production.

Planning and design considerations

Selected plant materials must be adapted to the site and chosen to meet management goals (for example, palatability, season of use, control of noxious weeds, streambank stabilization). Downstream implications of "escaped" plant materials (seed, for example) must be considered.

Maintenance requirements

There must be a long term commitment to maintain a proper balance between the vegetation and its subsequent use by animals.

Benefits

- Vegetation traps and stabilizes sediments.
- Herbaceous plants may serve to create an environment for the later establishment of certain woody species (figure 7-9).

Caution

Establishment and survival of the planted vegetation depends on the experience of those doing the planting, selection and suitability of plant materials and site, and competition by other plants.

Appropriate management of the vegetation once established must include control of livestock use, recreational access by people, and an understanding of fish and wildlife needs. These are required to assure the success of this tool.

Cut-tree riprap

Capture
Store
√ Safe release

Features

Protects banks from high water flows and acts as a physical barrier to grazing animals. Modifies microclimates, dissipates energy and reduces water velocities.

Planning and design considerations

Most useful on low gradient, high sediment streams. The butt end of the tree must be pointed upstream. Placement of trees along the stream should be on the outside curves where cutting action is most likely to occur.

Use trees large enough to resist movement by the water and make certain the butt of the tree is securely tied into the streambank. Trees should be partially limbed to assure good trunk to soil contact, which will minimize the stream cutting behind the tree placement.

Figure 7-9.—Introduced vegetation in early stage of succession. In a more conducive environment, woody vegetation may also develop.

Maintenance requirements

This is a low maintenance practice. Area should be monitored for sedimentation and vegetation establishment.

Benefits

- Traps sediments, prevents the erosion of streambanks and enables vegetation to reestablish along the streams edge (figure 7-10).

Figure 7-10.—Close contact of the tree trunk and the soil provides the best chance for the bank to become stable.

Caution

This practice doesn't stand alone. Trapped sediment offers a medium for the establishment of vegetation that will further aid in trapping sediment, protection of the streambank, and storage of water.

Management of the vegetation, which includes control of livestock use, recreational access by people, and an understanding of fish and wildlife needs, is required for this tool. Be sure to follow State water and fill-permit laws when you implement this practice.

Sediment-trapping devices

Capture
√ Store
√ Safe release

Features

These devices are of low height extending across the channel. They are generally of permeable construction, designed to slow but not stop, water passage at low flows and to safely permit over-the-top water passage at higher flows.

Planning and design considerations

The height of the structure should be less than the 2-year peak flow average. Keying the structure into the bottom of the channel is less critical than into its banks. The structure must have the overflow located at the center of the channel. The width of the overflow should take into account the eventual meander of the stream.

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.

Construction material can vary (rock, fencing materials, wood debris, etc.). Consider a staggered placement of second-generation devices when they're half full of sediment.

Maintenance requirements

Annual inspection of keyed banks and vegetation stabilization of trapped sediments.

Benefits

- Traps sediment, dissipates water energy, and extends time of water recharge from water table to stream flow (figure 7-11).

Caution

This practice doesn't stand alone. Trapped sediment offers a medium for the establishment of vegetation that will further aid in trapping sediment, protection of the streambank, and storage of water.

Management of the resulting vegetation, which includes control of livestock use, recreational access by people and an understanding of fish and wildlife needs, is required to assure the success of this tool in supporting the watershed. Be sure to follow State water and fill-permit laws when you implement this practice.

Figure 7-11.—This new structure will allow excess flow to pass over the center. Note the size of the rock.

Shrub management

√ Capture
√ Store
√ Safe release

Features

Undesirable woody vegetation is reduced in numbers and/or cover whenever their populations detrimentally influence the proper functioning of the watershed.

Planning and design considerations

Accurate predictions of existing herbaceous plant response after shrub control is necessary. If populations of desirable herbaceous species are inadequate to utilize the soil moisture and nutrients released from shrub control, some seeding practice may be desirable.

Choice of shrub management method and appropriate followup seeding or management can vary greatly and will be influenced mostly by economics on private land and technical and/or legal acceptability on public lands.

Maintenance requirements

Most shrub species cannot nor should not be eradicated. Monitoring shrub species population increases, combined with increased knowledge of their role in watershed health and stability, should indicate when any subsequent control will be desirable.

Benefits

- Improved infiltration through increased herbaceous plant densities.
- Increased soil moisture through its release by shrub reduction.
- Less interception of precipitation by the shrub canopy, allowing greater moisture amounts to reach the soil surface.
- Decreased overland and potential erosion through enhanced herbaceous ground cover (figure 7-12).

Caution

Allow adequate time for either existing or planted herbaceous species to become well established before subjecting to use. Followup management of the vegetation includes control of livestock grazing, recreational access by people, and an understanding of wildlife needs. These are required to assure the success of this tool.

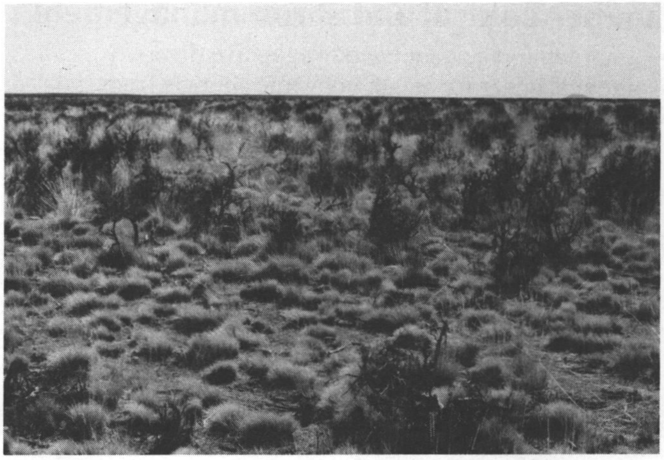

Figure 7-12.—Note the vigor and size of this bunchgrass. Both shrub management and appropriate grazing regimes were responsible for this.

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 proper application of each management tool will have the following effects.

Grazing management

- Improved wildlife habitat and feed quality.
- Provide for early forage green-up in spring.
- Encourage tillering of plants.
- Enhance forage and habitat for waterfowl.

Water developments

- Improved distribution of wildlife.

Fencing

- Improved feed quality for wildlife.

Herbaceous plantings

- Improved vegetation diversity.
- Improved forage production.
- Enhancement of seasonal feed (winter range).

Woody plantings in riparian zones

- Reduced water temperatures during summer.
- Improved cover for wildlife and insect populations.
- Food for big game and other wildlife.
- Nesting sites for some bird species.

Juniper control and shrub management

- Improve forage quality and vegetative diversity.
- Provide cover for small, nongame animals from downed trees.

Cut-tree riprap

- Improved fisheries via microclimate manipulation for improved insect habitat.
- Reduction in water temperature through shading.
- Cover for birds and nongame wildlife.

Gradient stabilizing and sediment-trapping devices

- Increased pool formation.
- Potential insect population increase on decomposing logs.
- Resting and habitat locations for waterfowl.

Jetties

- Improved pool-ripple ration for fish.
- Provide a spot for fish to live during low-flow periods.
- Improved potential for overhanging vegetation.
- Reduced water temperatures.

Regulations governing Oregon's watershed restoration work

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Management of watersheds and the use of specific restoration tools require both an understanding of ecological systems and a knowledge of regulations that govern watershed work.

Regulations that affect upland and riparian zones are often confusing and complex, with seemingly overlapping jurisdictions among agencies and levels of government. It's important to recognize two points:

- All three levels of government are involved—Federal, State, and local.
- Their regulations are promulgated out of the public interest.

Restoration work in water, or along the riparian zone, is subject to the most regulation. Regardless of the existing condition of the riparian zone, any disturbance of the soil or water beyond practices that modify the distribution of animals is subject to rules established by one or more local, State, or Federal agencies.

You can use table 8-1 (on page 67) to see if your watershed management tool is subject to regulations. Size and situation of the project will also determine if you'll need to comply with regulations when you establish the management tool.

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 process, 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 may also be required. Because local requirements vary greatly, you must contact your county or city planning office to determine local regulations.

Most often, when State and/or Federal permits are required, local planners are involved in the review process. Neither the Division of State Lands nor the U.S. Army Corps of Engineers will issue a permit for an activity that's not permitted locally.

On the other hand, local approval doesn't mean that State or Federal permits will be issued automatically.

State involvement

Oregon has a number of agencies that are involved in regulating watershed restoration work.

Division of State Lands administers Oregon's Removal-Fill Law. This law covers all waters of the State of Oregon, and it includes not only large lakes and perennial rivers but also small natural ponds, intermittent streams, overflow channels, and wetlands.

Water Resources Department handles water-use permits.

Department of Forestry administers Forest Practice Rules, which govern activities in the forest areas.

State Fire Marshal regulates how fire permits are obtained and when burns can take place for all open burning in the State.

Department of Fish and Wildlife administers a permit system for all blasting in the stream channel.

Federal involvement

At the Federal level, Section 10 of the Rivers and Harbors Act of 1899 gave 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 a 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, 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 with every decision on Section 10 and/or Section 404 permits. Once a permit is filed, internal Corps decision making involves requirements of the National Environmental Policy Act (NEPA) and the Fish and Wildlife Coordination Act.

Federal Forest Service and Bureau of Land Management lands are administered according to each agency's rules and regulations.

Important contacts

Since regulations change over time, it's important to current regulations as they will pertain to your proposed management tool. Visit your county or city planning department. Call or visit with the Division of State Lands in Salem and the U.S. Corps of Engineers in Portland (see page 66 for their addresses and phone numbers).

In addition, three other sources of information may be available to help:

Local Soil and Water Conservation Districts (SWCD's)

SWCD's are involved with soil and water conservation.Their close working relationship with the Soil Conservation Service makes them a good source of current regulations, technical help, engineering assistance, and knowledge of possible sources of funding for grants and cost-share programs.

Oregon State University Extension Service County Offices

Extension's role is to provide educational information for the wise use of natural resources. Through county Extension agents' contacts with statewide Extension specialists and others, they can provide valuable information to landowners about planning and implementing management strategies.

Oregon Department of Fish and Wildlife (ODF&W) District Offices

Locally, ODF&W personnel often have firsthand knowledge of local conditions, and they can provide technical assistance in developing stream- management tools and enhancing wildlife habitat.

If local, State, or Federal permits are required, ODF&W personnel are automatically involved in the review process.

Does my management tool require a permit?

This section deals primarily with private lands in a watershed. For lands intermixed with both private and public ownership, there's opportunity to work together with public land managers. Contact the public land agency(s) so that you and the agency staff can coordinate, together, management strategies for both public and private land.

Forested lands

Contact your local planning department to determine local regulations.

All forested lands are under Oregon's Forest Practice rules. For a discussion of these rules, read EC 1194. Contact: Oregon Department of Forestry.

Rangelands

Contact your local planning department to determine local regulations.

Upland zone

Wells for livestock water. Senate Bill 261 amended Oregon's Water Law in 1989 to include wells for livestock water. The law provides for a registration process to claim preexisting use from wells. Effective January 1, 1991, anyone who develops a well for livestock water must obtain a water-right permit. Contact: Water Resources Department.

Livestock water from seeps or springs. Springs, and seepage water that doesn't flow off an individual's property, aren't subject to water right laws. However, if the land is divided so that the spring *does* flow off the owner's property, a water right is needed. Contact: Water Resources Department.

Prescribed fires. Within an organized fire protection district (local fire protection district or forest protection district), a permit is required. The State Fire Marshal regulates how permits are obtained and timing of burns. Local fire protection districts implement these regulations. Obtain the permit from the fire protection district that has jurisdiction. Contact: local fire protection district.

Note. Oregon's forest fire protection districts cover nonforested as well as forested lands. Contact: Oregon Department of Forestry.

Outside an organized fire protection district. A permit is required. ORS 476.380 requires all open burning to be permitted through the county court or board of county commissioners or its designated representative. Frequently, the designated representative is the rural fire protection district closest to the proposed burn site. Contact: County Court or Board of County Commissioners.

Riparian zone

Water movement outside riparian zone for livestock watering. Senate Bill 150, passed in 1989, reduced permit fees ($300 to $50) to move water outside the riparian zone to water livestock. The intent was to provide incentive for improved watershed management. Contact: Water Resources Department.

Structure for stream bank stabilization, head-cut control. Examples: cut-tree riprap, jetties, sediment trapping devices, and drop structures.

A permit is required for almost all activities involving filling or removing material (see figure 8-1 for exceptions). A joint regulatory program between the Oregon Division of State Lands and the U.S. Army Corps of Engineers has been developed that allows both agencies to use the same application form. However, each agency issues its own permit.

Both perennial and intermittent streams and their associated riparian zones are included. Contact: Division of State Lands and Corps of Engineers.

Structures in stream specifically for fish enhancement. Special permits have been developed by the Division of State Lands and the Corps to speed up the process, to enable individuals to place structures or material in (or remove materials from) waters of the State, excluding wetlands.

Federal

An application doesn't need to be filed when authorized activities are covered under a nationwide permit, provided they meet certain conditions. Some authorized activities include:

1. Bank stabilization, provided the bank stabilization activity:
   - is less than 500 feet in length,
   - is necessary for erosion prevention,
   - is limited to less than an average of 1 cubic yard per running foot placed along the bank,
   - is a single and complete project, and
   - uses only clean material free of waste material, organic materials, unsightly debris, etc.
2. Fill material in streams with less than 5 cubic feet per second, provided less than 1 acre of waters of the United States is impacted.
3. Fill material that
   - doesn't exceed 10 cubic yards as a part of a single and complete project, and
   - isn't used for stream diversion.

State of Oregon

No permit is required if the activity proposes removing, filling, or altering less than 50 cubic yards of material within the bed or banks of waters in the State of Oregon.

Figure 8-1.—Federal and State exceptions to regulations governing permits for stream bank stabilization and head-cut control.

To be eligible, certain specifications have been developed for randomly placed rock, deflectors, check dams, gravel placements, pool construction, back/side channels construction, barrier removal, and placement of fishways.

In addition, the general permit is valid only if the proposed activity complies with certain conditions. Contact: Division of State Lands.

Blasting in the stream channel. An ODF&W permit is required for all blasting. Contact: Oregon Department of Fish and Wildlife.

If more than 50 cubic yards is blasted, a permit from Division of State Lands is required. Contact: Division of State Lands.

Where to go for help

You can get assistance with policy questions and information from these agencies. Find the address that's closest to yours.

Oregon Department of Forestry

2600 State St.
Salem, Oregon 97310 (503) 378-2511

Area offices

Northwest Area-ODF
801 Gales Creek Rd.
Forest Grove, Oregon 97116 (503) 357-2191

Southern Area-ODF
1758 NE Airport Rd.
Roseburg, Oregon 97470 (503) 440-3412

Eastern Area-ODF
Route 2, Box 357
Prineville, Oregon 97754 (503) 447-5658

District offices. Check for "Forestry Department" in the "Oregon State Government" section of your phone book.

Division of State Lands

775 Summer St.
Salem, Oregon 97310 (503) 378-3808

Water Resources Department

3850 Portland Rd. N.E.
Salem, Oregon 97310 (503) 378-3739

Soil and Water Conservation Commission

State Office
Agriculture Bldg.
635 Capitol N.E.
Salem, Oregon 97310 (503) 378-3810

Soil and Water Conservation Districts. Each district is served by the Soil Conservation Service, USDA. Check for "Soil Conservation Service" in the "U.S. Government" section of your phone book.

Fish and Wildlife Department

State Office
2501 SW 1st Ave.
Box 59
Portland, Oregon 97208 (503) 229-5407

Regional offices

Northwest Region ODF&W
Rt. 5, Box 325
Corvallis, Oregon 97330 (503) 757-4186

Southwest Region ODF&W
4192 N. Umpqua Highway
Roseburg, Oregon 97470 (503) 440-3353

Central Region ODF&W
61374 Parrell Rd.
Bend, Oregon 97702 (503) 388-6363

Northeast Region ODF&W
201 20th St.
La Grande, Oregon 97850 (503) 963-2138

Marine Region ODF&W
Marine Science Dr.
Building #3
Newport, Oregon 97365 (503) 867-4741

Columbia Region ODF&W
17330 SE Evelyn St.
Clackamas, Oregon 97015 (503) 657-2008

Oregon State University Extension Service

County office. Check for "OSU Extension Service" in the county section of your phone book.

U.S. Corps of Engineers

District Engineer
Portland District, Corps of Engineers
P.O. Box 2946
Portland, Oregon 97208 (503) 326-6995

For further reading

OSU publications

These publications are available from Publications Orders, Agricultural Communications, Administrative Services Bldg. 422, Oregon State University, Corvallis, OR 97331-2119.

Shipping and handling: Please add 25¢ for orders up to $2.50. For orders between $2.50 and $100, add 15%. For orders of $100 or more, please call Agricultural Communications (503-737-2513) for a quote on reduced rates.

Adams, Paul W., *Oregon's Forest Practice Rules,* Oregon State University Extension Service Circular 1194 (Corvallis, revised 1988). $1.00.

Good, James W., *Obtaining Permits for Waterway Development,* Oregon State University Extension Service publication SG 72 (Corvallis, 1982). 75¢

Other publications

Oregon Water Rights System, State of Oregon Water Resources Department.

Oregon's Removal-Fill Permit Program, Division of State Lands, September 1989.

U.S. Army Corps of Engineers Regulatory Program. Applicant Information, EP 1145-2-1, May 1985.

Recognizing Wetlands, U.S. Army Corps of Engineers, October 1987.

Regulatory Permit Program, U.S. Army Corps of Engineers, Portland District, GPO 1989-693-340.

Table 8-1.—Regulations governing watershed restoration work in Oregon

	Permit required?			Agency contact[a]				
Watershed management tool	Yes	No	Depends on situation	LPD	SL/CE	WRD	DFW	Other
1. Jetties			X	X	X			
2. Gradient stabilizing drop structures		X		X	X			
3. Herbaceious plantings in uplands		X						
4. Water development:								
Springs and seeps			X			X		
Wells	X					X		
5. Fencing								
6. Wood vegetation plantings		X						
7. Cut tree riprap			X	X	X			
8. Sediment trapping devices			X	X	X			
9. Headcut control devices			X	X	X			
10. Rock riprap			X	X	X			
11. Prescribed fires	X							X
12. Moving water outside a riparian zone to water livestock	X					X		
13. Blasting in stream	X				X		X	
14. Structures in stream for fish enhancement	X				X		X	

[a]LPD = Local planning dept.; SL/CE = joint application between Division of State Lands and U.S. Army Corps of Engineers; WRD = State Water Resources Dept.; DFW = Oregon Dept. of Fish and Wildlife; Other = closest rural fire district, State Dept. of Forestry office, or county court.

The Oregon State University Extension Service educates Oregonians by delivering research-based, objective information to help them solve problems, develop leadership, and manage resources wisely.

Extension's agriculture program provides education, training, and technical assistance to people with agriculturally related needs and interests. Major program emphases include food and fiber production, business management, marketing and processing, and resource use and conservation.

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