# Considering tools for remediation

RANGELAND HEALTH BROCHURE 4

BRITISH COLUMBIA

# Contents



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This brochure reviews tools available to the resource manager for upland and riparian remediation. Their nature, applicability, general usefulness, and limitations will be briefly discussed.

## Choosing appropriate tools

Resource managers have at their disposal a veritable “tool chest” of possibilities useful in reaching remediation goals. It is important to learn about each tool, its uses, and its limitations. None of the tools is inherently “good” or “bad.” Tools have different uses and impacts on the environment. Their costs can be high or low and they may or may not be perceived as desirable by the general public. It is up to the manager or resource management team to determine how appropriate and suitable a tool is for a particular task and goal.

It is also important to understand the many factors that may limit the use or effectiveness of a particular tool. Limitations usually fall into the categories of **ecological**, **economical**, or **social and legal** factors. A tool that is regarded as ecologically benign may not be economically feasible to use. A tool that is economically feasible may not be socially or legally acceptable. Every tool will have its limitations, strengths, and weaknesses.

## What the tools are used for

Tools are primarily used to affect the four ecosystem processes common to all terrestrial ecosystems: the **water cycle**, the **mineral cycle**, **plant and animal succession,** and **energy flow**. Each tool may have direct and indirect effects on one or all of the ecosystem processes. Refer to brochure 3 in this series for more information on these four ecosystems processes.

The manager or team must consider fully the consequences of applying a particular tool prior to selecting it. For example:

- prescribed burning may have a very positive effect on **energy flow** by reducing stagnation in a plant community and stimulating vigorous new growth. Conversely, the **water cycle** may be damaged by the fire if too much bare ground is exposed as litter is burned away.

- a herbicide may be directed at a target species such as Canada thistle without recognizing that other desirable broadleaf plants will also be killed, with a subsequent decrease in plant species diversity (**plant succession** and **energy flow**).
- an in-stream structure may provide excellent trout cover but negatively affect downstream bank stability (**water cycle**).

**Remember:** the overall or terminal impacts of any tool must be anticipated prior to its implementation.

## The tool chest

There are four basic categories of tools, as shown in Table 1. Each can be applied independently or in concert with one or more of the other categories to achieve a particular goal. The Remedial Measures Model, described in brochure 2 of this series, is designed to help you choose not only the most appropriate category but the particular tool for reaching a remediation goal.

The following is a list of tools by tool category in the manager's tool chest. The tool categories reflect the nature of the tool and the roles it may play in remediation. Some tools fall within more than one category.

**Table 1** Tools by category

| CATEGORY 1 Grazing Management | CATEGORY 2 Applied Disturbance | CATEGORY 3 Rehabilitation Treatments | CATEGORY 4 Riparian Structures |
|---|---|---|---|
| Grazing period | Prescribed burning | Seeding uplands | Bank stabilization |
| Rest period | Mowing and cutting | Riparian plantings | Channel modification |
| Class of livestock | Chemicals | Mechanical treatments | Fencing |
| Season of use | Scarification/ tillage | Mulching | Water developments |
| Attractants | Biological control | Beaver | |
| Herding | Animal impact | Wildlife control | |
| Fencing | Herd effect | Long-term rest | |
| Water developments | Logging and silvicultural practices | | |
| Stocking rate | | | |
| Stock density | | | |
| Animal impact | | | |
| Herd effect | | | |

Note: some tools are in more than one category

## Description of categories and associated tools

### *Category 1 - Grazing Management*

Livestock grazing is a particularly important management tool on rangeland. Rangeland is often land from which solar energy can be directly harvested and converted to usable products only by livestock and wild ungulates. Livestock production is often a predominant (but seldomly exclusive) use of upland and riparian areas, so that cattle, horses, or sheep are typically available as a potential tool. If grazing is properly administered it can provide its desired impacts on large expanses of land at relatively low cost.

In recent years, range scientists and managers have learned much about the positive effects of grazing, especially on lands where vegetation and herbivores have co-evolved. Many desirable plant communities not only tolerate grazing, but require it for optimum health. Much more is also known about the negative impacts of grazing and particularly about the nature of overgrazing of individual plants. Improved grazing schemes are available that limit overgrazing while allowing desirable features of grazing to be applied as a tool.

### Grazing management factors

**Grazing period:** Length of the grazing period is a powerful tool in stopping overgrazing and improving land health. By reducing grazing periods to a minimum number of days, livestock are denied the opportunity to regraze or browse plants that are still recovering from a previous defoliation episode. During conditions of rapid vegetation growth when soil is moist, temperatures are moderate, and light is abundant, short grazing periods are necessary to prevent a recovering forage plant from being grazed again. When plant growth slows or when plants are dormant, grazing periods can be much longer without the risk of overgrazing. Along with stock density, manipulation of the length of grazing periods has given managers an important new tool in improving and protecting range condition.

**Rest period:** Plants, soils, and riparian areas must be periodically protected from grazing and browsing and other impacts of livestock and/or big game. Plants need sufficient time to recover from the effects of grazing or browsing and to store food reserves for winter and other times of dormancy. Rest periods allow replacement of senescent plants by new seedlings and tillers. Soils also must have time to be relieved of compaction incurred through trampling, to accumulate new litter reserves, and to recharge with water. Riparian areas require time to re-armour, to rebuild filtering systems, and to recover habitat values for other uses. By controlling the length of rest periods, managers can ensure that plants, soils, and riparian areas receive sufficient rest, but not excessive rest. When rest periods become too long, vegetation may stagnate and offer less desirable forage, cover, and habitat conditions for diverse plant and animal populations.

Depending on the riparian area objectives, finances, and the time prescribed to reach objectives, rest (non-use) will at times be the best alternative for achieving rapid results on some types of rangeland. The degree of brittleness of a site will also affect the rate of success of a measure. Non-brittle sites respond rapidly to rest. Refer to brochure 3 in this series, or pamphlet number 3 in the Rangeland Health series, for more information on this topic.

**Class of livestock:** Sheep, goats, cattle, and horses all have behavioural characteristics and diet preferences that make them more or less suited for particular environments and circumstances on rangeland. Age, breed, and gender also influence animal behaviour and grazing characteristics. By knowing and understanding these varied animal characteristics, managers have added flexibility in applying grazing management as a tool. For example, some weedy plants that would be avoided by cattle will be readily consumed by sheep. Thus plant succession can be desirably altered by using a particular class of livestock. Because cattle nowadays are the primary type of livestock in use, the tool is more limited than it has been historically.

**Season of use:** Vegetation and soils respond differentially to grazing use depending on when they are exposed to livestock impacts. Managers have the option of selecting when livestock are introduced into a pasture and when they leave. This determines the season of use. When growing conditions for forage plants are very good—that is, when soil moisture is abundant, soil and air temperatures are warmer, days are long, and plants are growing rapidly—plants can recover very quickly from grazing events. Later in the season, as growing conditions are less favourable, plants need longer recovery periods. While the start of the **growing season** may be as early as April, managers may choose to wait until May or June to begin the **grazing season**; or they may choose to take an early short grazing harvest, let recovery occur in the favourable conditions that follow, and then harvest the regrown forage during the ensuing dormant period. This kind of management flexibility can favour the livestock producer as well as the forage plants.

## Livestock distribution factors

In concert with overgrazing, the most important factor resulting in range deterioration is poor livestock distribution. Poor distribution of livestock impacts leads to overutilization of some parts of the range and overresting of others. Areas that are *overutilized* (*too much* forage removed) often have most of the forage plants *overgrazed* (grazed *too frequently*) as well. Domestic livestock are creatures of habit. European breeds tend to be particularly troublesome. Among their habits and tendencies are the following:

- loitering at water access points, especially in shaded riparian areas
- limited use of upper slopes and higher elevations
- preference for particular vegetation types
- preference for previously grazed areas

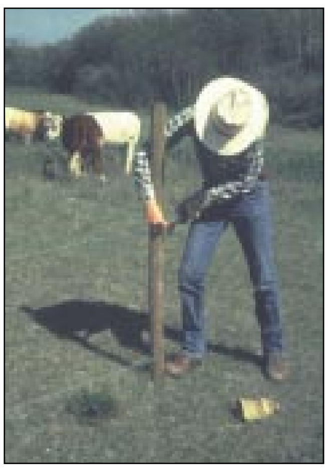
Improving stock distribution is one of the predominant goals of all grazing systems. The results of poor distribution are paradoxical—overgrazing and overresting occur in the same pasture. We have the means to improve distribution, but do we have the creativity to implement the tools under a daunting array of economic, physical, and social limitations?

Water, salt, and cattle oilers act as attractants

**Attractants:** Water, salt, minerals, feeding of hay or supplements, burning, and plantings of special forages can attract animals and improve their distribution throughout a landscape. Overutilization of riparian areas may be alleviated by attracting animals to other forage sources during critical periods. Habits of cattle managers are often hard to break. For example, we still find ranchers placing salt and minerals near water access points and streams to make them readily available to stock. By using attractants to distribute livestock, better utilization of pastures can result while simultaneously relieving grazing pressure on preferred areas. Attractants can also be used to create and apply "herd effect" as a tool. The cost of attractants may be a limiting factor.

**Herding:** Herding livestock is a most useful tool, but, with the exception of sheep operations, is seldom applied. High labour requirements and limited awareness of the benefits of herding have minimized its use. Herding can direct the impacts of livestock and control forage utilization throughout a pasture. It can help ensure that particular areas, such as riparian zones, are not overutilized. It can also help livestock in large pastures discover areas of good forage they might otherwise miss.

Adequate fencing, water, and salt seldom result in proper use of all the suitable range without the aid of a rider. Riding and herding not only improve animal distribution, but allow for implementation of grazing systems, monitoring of utilization, and improved herd management.



**Fencing:** One of the keys to success in many grazing operations is the tool of fencing. Properly applied it can control animal distribution, stock density, watering patterns, timing of use, animal impact, and other factors. The great variety of fencing materials and designs allows fencing to be a highly flexible and effective tool. Creative application of fencing can help achieve many of the overall goals of grazing management. The value of fencing in livestock management cannot be overstated.

Such a valuable tool also has its limitations and disadvantages. Fencing can:

- be expensive
- need maintenance
- require more management
- restrict wildlife movement
- restrict human access to and enjoyment of riparian areas

A fenced dug-out and water trough

**Water developments:** This tool is important in animal health, productivity, and distribution. Water is an effective attractant. Water development can become a potent tool in maintaining healthy riparian systems by providing alternative water sources. Creation of additional water access points and regulating water availability can control timing and distribution of livestock grazing. Costs of water development can be high, particularly if deep wells are necessary and electrical power must be available.

## Animal impact factors

**Stocking rate:** Stocking rate is the number of livestock placed on a unit of land for a given period of time. It is a variable that can be matched to the carrying capacity of a unit of land to achieve a general level of utilization. Overstocking or understocking may each limit success in reaching management goals. Proper stocking rate is critical in avoiding overutilization of range.

**Remember:** it is **time** (length of the grazing period) and not livestock **numbers** that results in overgrazing!

Decreasing the number of livestock is the first, and often the only, proposed remedial action for non-functioning or at-risk riparian areas. **Stocking rate does need to be assessed and balanced with the forage supply.** However, even under light stocking rates, livestock will overgraze preferred areas and concentrate in riparian vegetation. Left to themselves, livestock will graze where and when they choose.

**Stock density:** Stock density is the number of animals on a unit of land at any moment during the grazing period. It is expressed in animals per hectare or hectares per animal. As a variable, stock density can greatly alter livestock grazing behaviour as well as animal impacts on soils and vegetation. Some grazing systems deliberately achieve stock densities as high as 100 animals per hectare during the grazing period to achieve particular management goals. High stock densities are normally coupled with short grazing periods of only 1–5 days. Additional fencing or herding is required to achieve the levels of stock density necessary to enable its use as a tool.

**Animal impact:** Animal impact refers to all the things grazing animals do besides eating, including dunging, urinating, rubbing, trampling, and trailing. Such impacts in a campground would be considered negative and undesirable, but on the range they may be highly beneficial and desired. Standing dead plant material cannot break down biologically until it contacts mineral soil and the decomposer organisms contained therein. Animal impact, especially at higher stock densities, presses litter down and helps incorporate it into the soil surface. Dunging and urinating also benefit the soil mineral cycle and at the same time provide the surface with materials that improve the water cycle. Excessive animal impact can break down and damage trees and shrubs, damage streambanks, pollute water, and contribute to soil erosion. As with any tool, animal impact must be applied properly to achieve its beneficial effects. Animal impact works best on brittle sites.

**Herd effect:** Herd effect reflects the differences in animal impacts that occur when only a few animals are present as contrasted to an entire herd. The milling and trampling of an excited herd of cattle stimulated by salting, feeding, or herding tends to have a dramatic physical impact on soils and plants. This impact can be used as a tool to damage undesirable brush, to shape streambanks, or to create firebreaks. Range managers in Oregon have used herd effect to re-shape streambanks and revegetate some badly deteriorated riparian systems. It is not uncommon for ranchers who use intensive grazing management to pasture as many as 2000 head of cattle in one herd. The tools of stock density, animal impact, and herd effect become simultaneously available and may be applied to achieve such goals as uniform forage utilization, improved animal distribution, enhanced mineral cycling, or high animal production per hectare. Such intensive grazing requires skilled management and constant attention to avoid overutilization and habitat damage. Herd effect is usually best applied on brittle sites.

### *Category 2 - Applied Disturbance*

Among the tools available to land managers are those that are essentially "technology-based." They tend to be products of human systems that have found application in natural environments. Each has particular impacts on rangeland that can potentially be very beneficial in our manipulation of natural systems. Research in each of the following areas of discussion has been especially intensive and elaborate. A large body of scientific knowledge and management expertise has resulted from interest in and profit from their application. However, these tools have often been applied inappropriately and without regard for their ancillary effects. The Remedial Measures Model is especially effective in screening these tools to determine their applicability to certain tasks and under a variety of circumstances.

A prescribed burn

After a prescribed burn

**Prescribed burning:** People have used fire effectively as a tool for millennia, including management of vegetation and animals. As we have learned the more subtle uses of fire, such as prescribed burning, it has become a much more specific and valuable tool. Prescriptions that define the precise circumstances under which a burn will be conducted can greatly limit potential fire damage and enhance the benefits of burning. While there is always some risk in burning, trained personnel with advanced equipment and methods have been able to successfully apply burning in many habitats for many purposes. Studies of fire behaviour and development of control and management technologies allow fire to be a much safer, less expensive, and more predictable tool. Fire is best applied in relatively non-brittle environments.

**Mowing and cutting:** Equipment to mow and cut herbaceous vegetation and trees and brush has become quite sophisticated. Rough or rocky terrain no longer limits all mowing and cutting as a management tool. Plant control, forage harvest, and habitat modification by mowing or cutting can be properly timed and conducted to achieve a variety of purposes. As one of the more expensive tools, this technology is often


After brush mowing


Shrubs killed by herbicide

not broadly applicable. Mowing is best applied in relatively non-brittle environments.

**Chemicals:** Herbicide and fertilizer applications on rangelands have been more carefully scrutinized in recent years. Health considerations, as well as ecological impacts and repercussions, have limited the unrestricted use of herbicides. High costs of fertilizers and herbicides have also played a role in limiting their application. While herbicides can be particularly valuable in weed control, especially in early stages of infestation, they are not particularly selective. The target species may be only one of 20 or 30 species in a plant community killed by an application of herbicide. This lack of specificity or selectivity is a major problem in general application of the tool. Fertilizers have been used in limited circumstances to improve forage production and to improve livestock distribution.

Properly applied under appropriate circumstances, chemical treatments have proven to be a valuable tool in achieving certain management goals. For example, aerial application can quickly treat large areas at relatively low cost per hectare.

**Scarification/tillage:** Chiselling, pitting, furrowing, and scalping are just a few of the mechanical treatments that have been successfully used to enhance forage production, alter plant succession, and improve water cycling on uplands. Scarification has been particularly useful where plant succession to higher levels has been arrested by competitive species such as clubmoss, pussytoes, phlox, or blue grama. Mechanical treatment often encourages more desirable species such as western wheatgrass and a variety of larger forbs. In addition, scarification can increase water infiltration and limit surface runoff from rain and snowmelt. Limitations for scarification include terrain and soil conditions and potentially high cost. This tool is best applied in relatively brittle environments.


Discing

**Biological control:** Biological control promises enormous potential for dealing with invading weedy plants. However, research is necessarily slow and painstaking with relatively few successful examples readily available. In British Columbia, control of St. John's-wort (Klamath weed) was possible through introduction and release of the leaf-feeding *Chrysolina* beetles. Control of musk thistle has been achieved with a seedhead weevil (*Rhinocyllus conicus*). Managers are increasingly aware of the opportunities for biological control using domestic livestock. Grazing programs involving goats, sheep, and cattle, as well as exotic ungulates, have contributed to limited control of leafy spurge, spotted knapweed, and even unwanted sagebrush. The advantages of biological control are primarily in the specificity of control, the low cost of implementation once a bioagent is approved, and the limited associated environmental impacts of the treatment.

*Cyphocleonus achates* attacks knapweed

**Animal impact and herd effect:** The disturbance created by livestock herd effect and animal impact can be used as a tool to manipulate vegetation as well as soils. Managers have shown that trampling by hooves can loosen crusted soils as well as incorporate litter and mulch into the soil surface. Some controversy exists as to the desirability of livestock trampling and whether it is beneficial. The physical impacts of large animals, as well as their abundant manure and urine, may be used in brief applications to stimulate soils and vegetation and bring about desired ecological changes. As with any tool, use of herd effect or animal impact will be appropriate only under certain circumstances (usually brittle environment) and in the pursuit of particular goals. The decision to use these tools depends on the manager's needs, perspectives, and experience, and on the particular situation.

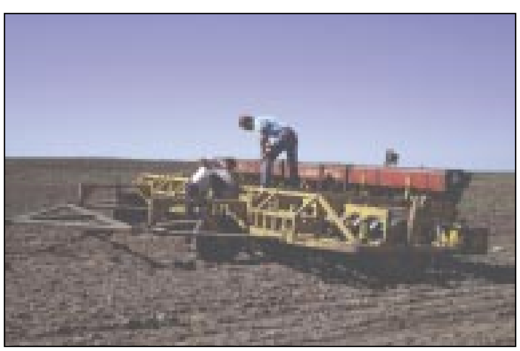
**Logging and silvicultural practices:** Logging provides an additional means of harvesting solar energy on forested grazing lands. It can also be a valuable tool in treating watersheds, manipulating wildlife habitat, and providing improved forage sources. Associated silvicultural practices such as planting, thinning, slash burning, and watershed protection provide opportunities for directly affecting water and mineral cycling as well as energy flow and succession. High costs of logging and associated practices as well as its primary goal of lumber and pulp production are limiting factors.

Silvicultural treatment

### *Category 3 - Rehabilitation Treatments*

Damage to uplands or riparian areas is often so severe that rehabilitation treatments are necessary. These treatments are sometimes needed to repair the consequences of destructive grazing or logging, including erosion or flooding, loss of desirable plant species, lowered productivity, and squirrel infestation. Wildfires, wildlife depredation, mudslides, and other natural phenomena may also require rehabilitation. Habitat improvement programs for a variety of wildlife typically include planting, seeding, and other treatments. Costs of rehabilitation can range from minor to very expensive depending on location, environment, and technologies involved. Considerable expertise is necessary for successful rehabilitation. Otherwise, the consequences of the treatment may be as unhappy as those of the initial problem.

**Seeding uplands:** Seeding of uplands and logged areas is an action program that appeals to many managers, because its potential for forage production, site stabilization, and enhanced cover often appears very great. However, it is not a substitute for good management and it is typically costly and risky. The need for seeding must be carefully evaluated, weighing the cost of treatment and consequences of failure with potential benefits. Seeding is often associated with logging activities and may play an important role on transitional ranges such as cutblocks. Many cultivars of



Rangeland seeding

A successful forage seeding

highly selected forage and conservation species are now available that reduce the risk of failure and offer attractive performance characteristics. Experience, equipment, site characteristics, and management skills are necessary elements in successful seedings. Seeding sometimes reduces plant and animal species diversity on treated areas, which may be counter to management goals.

**Riparian plantings:** A well-vegetated, and hence stable, streambank preserves water quality and improves fisheries and wildlife habitat. Riparian plantings are a tool that can be used to enhance streamside vegetation that has been severely degraded. Plantings can be used alone to stabilize eroding streambanks or they can be integrated into strategies using several tools.

Trees and shrubs have particularly useful roles in restoring damaged riparian habitats. They typically provide critical cover and food values for many wildlife species. They also stabilize and protect streambanks and floodplains from erosional forces while shading watercourses and sheltering fisheries. Planting is labour intensive, expensive, and risky due to often harsh environmental conditions, including wildlife depredation. Hardy plant materials, improved planting technologies, and trained personnel can do much to improve the chances for successful tree and shrub planting.

Shrub planting

**Mechanical treatments:** Many special range treatments have been developed to rehabilitate poor-condition range or improve watersheds. Among them are pitting, gouging, furrowing, interseeding, discing, dozing, trenching, terracing, and ripping. Whenever equipment and fuel is involved on rangeland, cost per hectare is high in relation to land value. This means that extra care must be taken in choosing and applying the tool to minimize financial risk. Wherever soils are dramatically disturbed, ecological risks may also be high. Wind and water erosion may be severe, weed infestation is possible, and successional changes are not always predictable.

**Mulching:** Watersheds and waterways may receive damage that requires immediate stabilization procedures. In such cases, mulching is a timely, fast, and effective tool. Dozens of natural and synthetic mulches are locally and commercially available. Mulch can range from grain straw to woven fibreglass mats, and costs vary widely. Often the cost of application is greater than the cost of the material itself. Where water quality is threatened by erosion from steep slopes, cutbanks, logging, or livestock trampling, mulching may provide the only practical and immediate solution.

Mulching

**Beaver:** The elimination of the beaver was probably the first major human-caused influence in riparian habitats. Elimination of beavers from streams has altered site hydrology, leading to changes in nutrient processes and vegetation dynamics. The beaver is a keystone species in many riparian ecosystems. Their activities influence flow rates, stream temperatures, nutrient cycles, aquatic organisms, and vegetation structure. Their eradication can result in decreased surface water, decreased channel diversity, and conversion of wetland plant communities to xeric plant communities.

However, beaver can also be a nuisance, especially in British Columbia's moister northern areas. Uncontrolled, they can flood entire valley bottoms, killing trees and shrubs and precluding use by livestock. Beaver can even pose a human health risk because they are amplification hosts of *Giardia duodenalis*, a parasite that causes intestinal disorders in humans.

Beaver can be an asset or a liability. It is the resource manager's role to assess their suitability as a management tool. The publications *Beaver: water resources and riparian habitat manager*[1] and *Beaver ecology and management in North America: a bibliography of prominent*

1 R. Olsen, and W.A. Hubert. 1994. *Beaver: water resources and riparian habitat manager*. Univ. Wyoming, Laramie, Wyoming.

*literature*[2] are good resources describing the role of beaver in riparian restoration.

**Wildlife control:** When wildlife are causing environmental damage beyond normal and acceptable levels, control may be necessary. Big game populations undergo cyclic changes that may endanger the health of both upland and riparian areas through excessive grazing and browsing. Irreversible damage to both soils and vegetation may result. Timely action through wildlife management programs should forestall such damage. Special hunting seasons or other means of control constitute an important management tool.


Vole damage in a fescue grassland

When small animal populations become very high, as in the case of ground squirrels, habitat damage may result. If another factor such as grazing management is the underlying problem, it must be dealt with, but control work may also be required to re-establish the desired balance and restore range health. Control may be an environmentally and socially sensitive issue, as well as potentially costly.

**Long-term rest:** Some areas may require several years without grazing to allow streambanks to reform, desired plants to establish and build root reserves, and litter to accumulate. Sites where woody riparian species such as willow are being re-established benefit particularly from this strategy.

### *Category 4 - Riparian Structures*

Among the tools available on rangelands is a short list of structural developments. Fencing, water development, bank stabilization, and channel modification are management-intensive tools that are directed at very specific goals in remediation and are especially important and valuable in riparian remediation. They can be limited by high costs, but environmental regulations may also play an important role in their

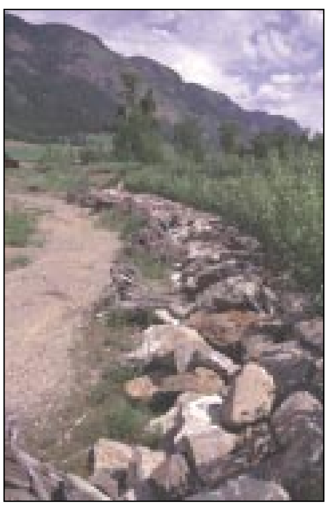
2 R. Olsen, W.A. Hubert, and D. Brown. 1994. *Beaver ecology and management in North America: a bibliography of prominent literature.* Cooperative Extension Service, Univ. Wyoming, Laramie, Wyoming.

application. Where stream channels are directly involved, building of structures, shaping of banks, and livestock watering facilities may affect water quality. Restrictions on these activities must be considered early on to avoid legal problems.

**Bank stabilization and channel modification:** In-stream structures are potential tools for bank stabilization. Unfortunately, they tend to treat symptoms, not the problem. Used as a substitute for proper grazing management, investments in structures may be wasted. In-stream structures may accelerate stream channel and riparian damage if improperly designed or deployed. Instead of applying a quick fix to the symptom, look upstream and **upland** for the source of the problem and begin there.

Bank stabilization

Structures are sometimes necessary. If it appears that in-stream structures are appropriate, consult with hydrologists, engineers, and stream biologists. Remember, approval is usually required for installation.



Rip-rap

Proper management of riparian and upland grazing is usually the best, most cost-effective treatment for stream channel instability and watershed deterioration caused by improper grazing. In some cases, in-stream structures such as weirs, rip rap, and gabions can help reduce streambank erosion, stabilize the stream channel, reduce down-cutting of the streambed and lowering of the water table, and trap sediment to rebuild streambanks.

Most of the discussion of in-stream structures is also applicable to channel modification. The hydrologic and legal ramifications of channel modification require special expertise beyond the scope of this brochure. Consult qualified hydrologists and get them involved if there is good evidence that channel modification truly will address the **cause** of a problem and not a **symptom**.

**Fencing:** Fencing appears in both Category 1 - Grazing Management and in Category 4 - Riparian Structures. Fences are structures that can have very long service lives and as structures they can be directed at very specific goals in riparian management. This is particularly true of problem areas such as stream crossings, water access points, and areas where bank damage has occurred from grazing and/or flooding. These areas may need special protection during rehabilitation or they may need long-term exclusion from grazing by domestic and wild ungulates. Fencing can range from temporary electric to permanent barbed wire fences, to snake or pole fences. It may exclude livestock from a campground or enclose livestock in a pasture. By choosing and designing appropriate fencing, it can be a very flexible and effective tool.

A riparian fence

Controlled access to water

**Water developments:** Water developments can play a pivotal role in application of grazing management. They can improve livestock distribution, increase the carrying capacity of range, and improve animal performance. If larger herds are used for shorter grazing periods, daily livestock water requirements may exceed the capacity of a well, spring, or stream. Water storage may then be necessary to allow grazing management tools such as stock density and shorter grazing periods to be applied.

Wildlife may also benefit from such springs, stock tanks, and water access points. In some areas, water is considered a major controlling factor of large ungulate populations and distribution. Even populations of water and upland fowl may be influenced by water development.

Design of good water systems includes consideration of potential trailing damage, water pollution, trampling, and potential weed infestation. Advances in solar energy technologies, powerful and efficient pumps, well-drilling, and water delivery systems have provided new sophistication in water development.

## Constraints in using tools

At the beginning of this brochure, we noted that a particular tool is neither good nor bad, suitable or unsuitable, effective or ineffective. It is in the **choice** and **application** of a tool that we may find a limitation or a problem. Some of the constraints in the uses of tools are obvious and others are more subtle. We have pointed out that the constraints typically fall into three categories, as shown in Table 2.

**Table 2** Important constraints in applying range management tools

| ECOLOGICAL | ECONOMIC | SOCIAL and LEGAL |
|---|---|---|
| Climate | Financial resources | Health and safety issues |
| Soils | Costs and expenses | Laws, rules, and regulations |
| Physiography | Markets | Community values and beliefs |
| Plant and animal populations | Land values | Political considerations |
| Ecosystem stability and function | | Human paradigms |
| Brittleness | | |

In addition to these constraints, we must also consider some other basic factors that may become superimposed in a particular situation. These include:

1. The **type of situation**. For example:
   - a riparian zone damaged by flooding
   - a noxious weed infestation
   - trampling damage at a stream crossing
2. The **type of ecosystem**. For example:
   - a high alpine meadow with a short growing season
   - a relatively dry prairie grassland
   - an aspen woodland
3. The **severity of the situation**. For example:
   - some slight topsoil loss through erosion
   - sheet and rill erosion
   - massive soil loss and gully formation

These examples illustrate that a great range of conditions and circumstances will influence when a tool may be used and how it will perform. Personnel "on the ground" are in the best position to judge, select, and apply tools and these are the people for whom this brochure is intended.

There is a saying that "ecosystems are not only more complex than we think, they are more complex than we **can** think." Consideration of the difficulty in selecting tools and the constraints in applying them may overwhelm the manager. It seems that there is just **too much** to anticipate and understand about tools used in range remediation. The Remedial Measures Model, as explained in brochure 2 of this series, can narrow the choice of tools in a typical range problem situation, direct the application of the tool, and monitor its performance.

Once you have read the brochures in this series and some of the suggested references, you should have the confidence to select and apply a tool or tools appropriate to your situation.