

# Understanding ecosystem processes



RANGELAND HEALTH BROCHURE 3



BRITISH  
COLUMBIA

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## What is rangeland?

All areas of the world that are not barren deserts, farmed, or covered by bare soil, rock, ice, or concrete can be classified as rangelands.<sup>1</sup>



Upland



Riparian area

Times are changing. For much of British Columbia's history, its rangelands were thought of in terms of how much livestock grazing they provided. Uplands were managed for forage production. Riparian areas were considered "sacrifice areas" impractical to manage within the context of vast uplands. Wetlands were "wastelands" to be drained and put to "productive" use.

Those days are over. One of the most powerful forces of change is society's growing awareness of the value and vulnerability of western rangeland watersheds and their associated riparian areas and wetlands. This awareness is being translated into a growing body of laws, policies, and regulations.<sup>2</sup> These require rangeland grazing practices that will protect and enhance ecosystem diversity and water quality on rangeland watersheds.

As the Forest Practices Code is implemented, the range resources of the province are being assessed and managed to achieve broad land use goals. One of these goals is to assure that Crown range is utilized properly to maintain or improve all resource values. This brochure will help you gain an understanding of ecosystem processes and how they operate in upland and riparian range at Properly Functioning Condition (PFC). Refer to brochure 4 in this series for details on management tools that can be used to achieve or maintain PFC.

1 J.L. Holecheck, R.D. Pieper, and C.H. Herbel. 1995. *Range management: principles and practices*. 2nd ed. Prentice Hall Inc., Englewood Cliffs, N.J.

2 E. Chaney, W. Elmore, and W.S. Platts. 1993. *Managing change: livestock grazing on western riparian areas*. Northwest Resource Information Center Inc., Eagle, Idaho.

## Products, uses, and values

Rangeland produces renewable products such as:

- water
- forage
- browse
- habitat
- wood fibre

These products support a variety of uses and activities, including:



- livestock grazing
- wildlife grazing
- wood products
- outdoor recreation
- hay-cutting
- photography
- plant collecting
- wildlife viewing



Society also values rangeland for its:

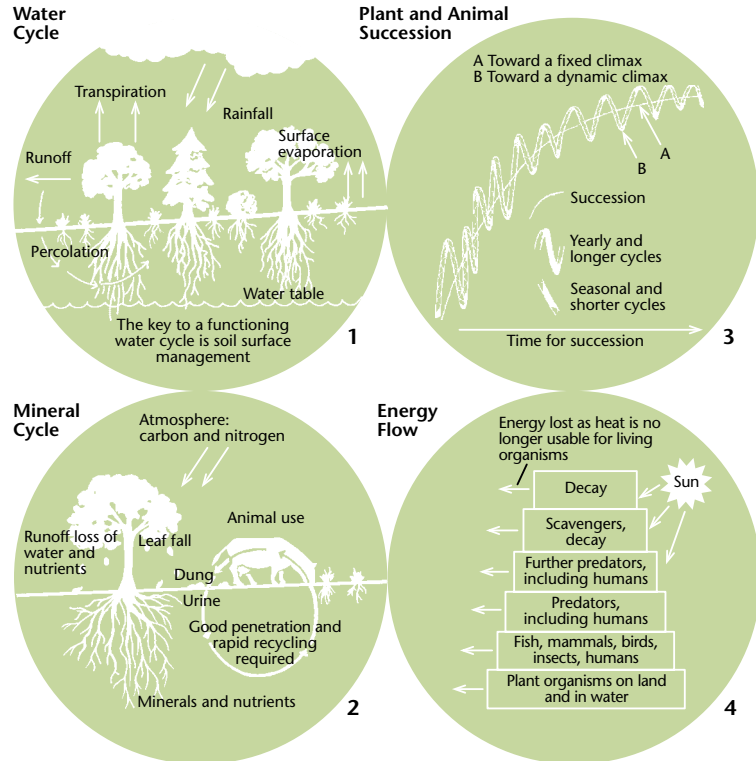
- biodiversity
- wildlife habitat
- scenic beauty
- water quality/quantity
- nutrient cycling

## Key concepts

### *Ecosystem processes*

There are four ecosystem processes that are fundamental to all terrestrial ecosystems:

1. The Water Cycle
2. The Mineral Cycle
3. Plant and Animal Succession
4. Energy Flow



A report by the U.S. National Research Council on rangeland health suggests that evaluating and monitoring these processes is the best approach to proper ecosystem management.<sup>3</sup> Here is a brief review of each process.

**The Water Cycle:** Precipitation that falls on the soil surface may infiltrate and enter the soil profile as water. Some will be stored and



some will continue to percolate until it becomes part of the ground water. Some stored water will evaporate and re-enter the atmosphere as vapour and some will be taken up by plants and transpired or stored in plant tissues. Precipitation that does not enter the soil system may be evaporated from the surfaces of plants, rock, litter, and other materials, or it may run off the site as surface flow. This constant process of pre-

<sup>3</sup> F.E. Busby. 1994. *Rangeland Health. New methods to classify, inventory, and monitor rangelands.* NRC, Washington, D.C.

precipitation, transpiration, evaporation, and surface and ground water flow is called the **water cycle**. The effectiveness of the water cycle and its overall functioning are directly influenced by land management practices.



**The Mineral Cycle:** The **mineral cycle** may also be referred to as the nutrient cycle. Nutrients follow cyclical patterns as they are used and re-used by all living organisms. Most nutrients are cycled through decomposer organisms in the soil system, but some, including nitrogen, are atmospherically involved. Organic materials, such as plant litter, dung and urine, and decaying animals that are deposited on the soil surface, are decomposed and reincorporated into the soil by living organisms. Physical processes such as oxidation, photo-decay, mechanical breakage, fire, and actions of wind and water are non-biological facets of the mineral cycle. The manner and rate at which nutrients are cycled play a critical role in rangeland health and are directly influenced by land management practices.

**Plant and Animal Succession:** The process of change is the only constant in all ecosystems. Populations of plants and animals change continually in response to all sorts of environmental pressures. Among these are climate and weather, grazing and browsing, disturbance by fire, farming, hunting, and logging, as well as hundreds of other factors. This process of continual change is termed **succession**. There appears to be an almost universal tendency for plant and animal com-



munities to develop toward states of greater complexity and diversity. These are sometimes referred to as climax states, steady states, or potential natural communities (PNCs). As resource managers, we have learned to manipulate succession through a variety of means, sometimes successfully, and sometimes not. We have many tools at our disposal that may be used to advance, arrest, or reverse succession.

**Remember:** the closer an ecosystem is managed to allow for natural ecological processes to function, the more successful that management strategy will be.<sup>4</sup>



**Energy Flow:** All of us have solar-powered hearts. The energy that keeps us moving and breathing comes from the sun via photosynthesis and the process of **energy flow**. Energy is not cycled and must be continually supplied to the earth by the sun. Energy can also be stored in a variety of forms, including fossil fuels such as coal and oil.

Regardless, the flow of energy is one way—from the sun to the earth—and back to outer space as radiation. This flow of energy in our ecosystems is sometimes referred to as the carbon cycle because carbon is involved in all energy storage and transfer. Some of the solar energy captured by green plants is transferred to the animals that eat them.

Some is used by the plants themselves for their own life functions. Energy is again transferred to the animals that eat the herbivores. Decomposer organisms that break down the remains of plants and animals utilize the last remaining energy as they carry out their work. Energy that is not incorporated into tissues is expended as heat through the activities of organisms so that eventually there is no net energy remaining. Energy is never destroyed, only transformed.

Energy flow is closely related to the other ecosystem processes—water cycling, mineral cycling, and succession. It in fact drives these activities and makes them possible. As humans we are in the business of constantly attempting to manage energy flow, sometimes successfully, and sometimes not! When we harvest hay with machinery or harvest forage with livestock, we are in the midst of the energy flow process. Energy flow is a critical process on rangelands and is directly influenced by land management practices.

<sup>4</sup> W. Elmore and B. Kauffman. 1994. *Riparian and watershed systems: degradation and restoration*. In *Ecological implications of livestock herbivory in the west*. M. Vavra, W.A. Laycock, and R.D. Pieper (editors). Society for Range Management, Denver, Colorado.

**Brittleness<sup>5</sup>**

All environments fall somewhere on a continuous scale from “brittle” to “non-brittle,” as contrasted in the following chart:



Brittle



Non-brittle

Brittle (desert)	[10 ← → 1]	Non-brittle (rainforest)
<ul style="list-style-type: none"> <li>• unreliable precipitation regardless of amount</li> </ul>		<ul style="list-style-type: none"> <li>• reliable precipitation regardless of amount</li> </ul>
<ul style="list-style-type: none"> <li>• highly irregular humidity</li> </ul>		<ul style="list-style-type: none"> <li>• consistent humidity throughout the year</li> </ul>
<ul style="list-style-type: none"> <li>• slow biodecay rates</li> </ul>		<ul style="list-style-type: none"> <li>• high biodecay rates</li> </ul>
<ul style="list-style-type: none"> <li>• much decay occurs through oxidation</li> </ul>		<ul style="list-style-type: none"> <li>• most decay is biological</li> </ul>
<ul style="list-style-type: none"> <li>• very slow rates of successional development</li> </ul>		<ul style="list-style-type: none"> <li>• high rates of successional development</li> </ul>

Brittleness is a distinguishing characteristic of natural environments that regulates most ecological processes. The most important factors that characterize an environmental setting are precipitation patterns, decay processes, decay rates, and successional rates. Degree of brittleness is used to describe an environment (on a scale of 1 to 10), taking into account all of these factors. This concept is especially useful in range remediation because it affects or controls the four ecosystem processes (water cycle, mineral cycle, succession, and energy flow). (For example: Amazon rainforest = 1, Sahara desert = 10. In British Columbia a high alpine range may be considered brittle and a range riparian area non-brittle.)

Because remediation tools and various management practices can operate so differently in dissimilar settings, it is important to determine site status in regard to the brittleness scale. Generally speaking, brittle sites are most problematic in terms of remediation treatments.

<sup>5</sup> A. Savory. 1988. *Holistic Resource Management*. Island Press, Washington, D.C.



### **Watersheds**

British Columbia rangelands are **watersheds**. A watershed is the area drained by a distinct stream or river system and separated from other similar systems by ridgetop boundaries. A watershed may be as small as your backyard or as large as the Fraser River drainage.



Watersheds catch, store, and release precipitation into stream channels. The objective of good watershed management is to maintain desirable and abundant vegetative cover on uplands and riparian areas, so that water enters the soil, is stored within the soil, and is slowly released into the stream over an extended period of time.

Uplands often comprise more than 99% of the watershed's area, with the floodplain and stream channel making up the rest.



#### Watershed function

Properly functioning	Poorly functioning
• good infiltration	• poor infiltration
• less overland flow	• more overland flow
• less erosion	• more erosion
• less sedimentation	• more sedimentation
• lower peak flows	• higher peak flows
• more late-season runoff	• less late-season runoff

**Uplands** make up the largest part of a watershed and are key to water quantity, quality, and delivery regime. They should **capture** and **store** most of the moisture received when precipitation occurs. Upland vegetation dissipates the energy of water, slowing the flow to stream channels and allowing more water to enter the soil and percolate down into the aquifer. Less erosion occurs on well-managed uplands.



**Riparian Areas** are the “*areas of and that are adjacent to streams, rivers, lakes or wetlands, and contain vegetation that, due to the presence of water, are distinctly different from the vegetation of adjacent upland areas.*”<sup>6</sup> The riparian area should safely **release** the moisture captured in the uplands.



While riparian areas represent a small percentage of the land in a watershed, they are vitally important because of their functions and the life forms they support. They provide critical physical and biological linkages between terrestrial and aquatic environments. Riparian areas are the most important habitat for the majority of western wildlife species and are essential to many as well. Fish, of course, are totally dependent upon the surface waters within riparian areas. Riparian areas support rare and endangered plant species. As recreationists we find riparian areas attractive because of their diversity of life, their proximity to water, and the unique physiography and natural beauty they contribute to the landscape.

Riparian areas provide livestock with assured sources of water, forage, and shelter. The favourable moisture regime also means that forage plants regrow and recover more quickly from grazing than in upland areas. Consequently, riparian areas may provide much greater quantities of forage and browse per unit area than associated uplands. Their importance belies their relatively small area.

6 B.C. Ministry of Forests. 1996. *Forest Practices Code*. Queen’s Printer, Victoria, B.C.



The charts below list the benefits and functions characteristic of riparian areas:

<b>BENEFITS</b>			
Cultural	Economic	Diversity	Water
recreation	trapping	fish	quality
tourism	timber	wildlife	quantity
outdoor class-rooms	livestock grazing	plants	reliability
natural areas	sport fishing		

<b>FUNCTIONS</b>	
• dissipate flood energy	• increase storage capacity
• filter sediments and improve water quality	• increase duration of flow
• stabilize and build banks	• recharge aquifers and increase water table

## Managing the whole



Non-functioning or at-risk riparian areas cannot be improved by focusing on the narrow bands of green. There is potential for resource managers to spend enormous amounts of time and money building in-stream structures that do not correct problems. Perceptions need to be broadened to include uplands and entire watersheds. The degraded stream channel is not a problem in and of itself, but rather a symptom of a degraded water cycle (and, more than likely, other degraded ecosystem processes) in the entire watershed.

A functioning water cycle means that precipitation infiltrates upland soil and flows underground to riparian and eventually aquatic zones, rather than eroding the soil surface. A functioning water cycle means that floodwaters flow out over lowland floodplains, where they are slowed by vegetation and topography, rather than focus their erosive power in stream channels.



Healthy vegetation is the key to maintaining a functioning water cycle: it slows the flow of water off uplands, allowing infiltration; it slows the flow of water on floodplains to build banks and ensure the channel has access to its floodplain; and it provides a filter to slow and trap silt and debris before it enters streams and other water bodies.

You should now have an understanding of how ecosystem processes operate in properly functioning upland and riparian areas.