How Green is My Valley?

Riparian 101

Why do I need to know this stuff? Good question! An understanding of how riparian areas are formed and how they function is the first step in figuring out how to successfully maintain their productive nature for your farm or ranch. Think of this section as a shop manual for riparian areas.

Water Horsepower

Streams and rivers flowing through riparian areas have three common elements:

- the water in their channels has mass (or weight);
- the mass of water is dragged downhill under the influence of gravity; and
- the water flows at some speed (or velocity).

The stream's engine is the mass of water moving downhill. How much horsepower the stream's engine has depends on slope, amount of flow and resistance along the bank and channel. Horsepower, whether measured in a car, a tractor or a stream tells us how much work can be done.

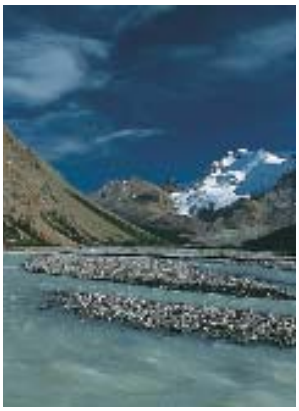
The work of a stream is to erode material from its banks or bed and then to transport that material downstream. Streams meander in order to balance the work they do with the energy they have and the material they carry.

If the engine idles, not much horsepower is generated; the stream isn't doing much work. However, when the engine races its horsepower is unleashed, allowing the stream to work harder at eroding and transporting.

A simple doubling of the speed of a stream's flow allows it to erode four times as much and to carry 64 times the amount of material. That's power! Too much power can translate into things like the loss of productive bottomland pastures to erosion.

Producers need to understand these simple physics, to avoid unleashing a problem, without knowing how it happened.

Streams erode the outside of meander bends and deposit material downstream on the inside of meanders.

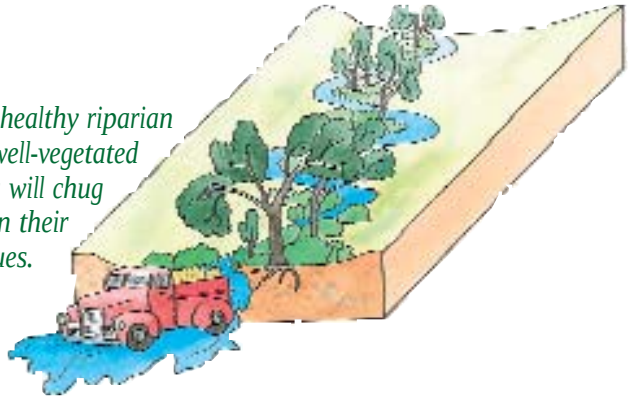


Eroded material is transported downstream either suspended in water or by rolling on the stream bottom.

Stream channels are seldom straight. Streams meander to balance water speed, valley slope and the amount of sediment to be transported.

Stream horsepower: don't let it get away on you!

Streams will respond to straightening and vegetation removal by racing. The chain reaction can reduce the productive nature of riparian areas.

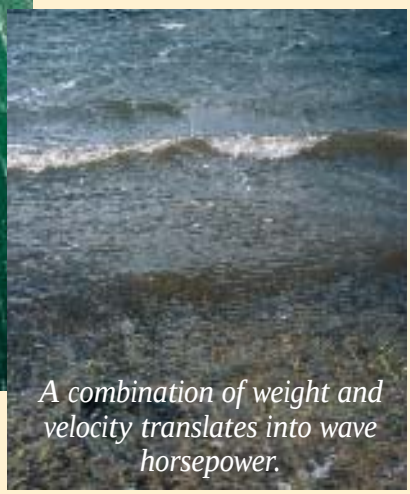


Streams with healthy riparian areas that are well-vegetated with meanders will chug along and maintain their function and values.

Shorelines - Water in Motion

Water in motion, in the form of waves on lakes and wetlands, has power. The amount of power relates to the weight of water, a relatively heavy substance (1000 kg/m^3), and how fast that water is moving (velocity). Waves are wind powered and the greater the expanse of water over which winds blow the greater the potential wave height, length and velocity. Water thrown up on shore by waves loosens unconsolidated materials, which are then transported by the undertow, the returning volume of water. Spring melt, accompanied by winds, drives ice onto shorelines. This is an annual occurrence and an additional source of water power.

Unlike streams, where the volume of flow is constantly replaced, lakes and wetlands are sinks, where the volume of stored water is exchanged very slowly. The exchange rate in wetlands and lakes can be years, to fully replace the stored volume with new water. That is why nutrient and sediment additions can be an issue, since once added they may linger for long periods of time.



A combination of weight and velocity translates into wave horsepower.

A shoreline composed of deep-rooted plants, especially trees and shrubs, resists the action of ice during spring breakup.

Understand the force!

Banks and Shores
Riparian Foundations

Banks and shores resistant to stream horsepower and wave action form the foundation of a stable riparian area.

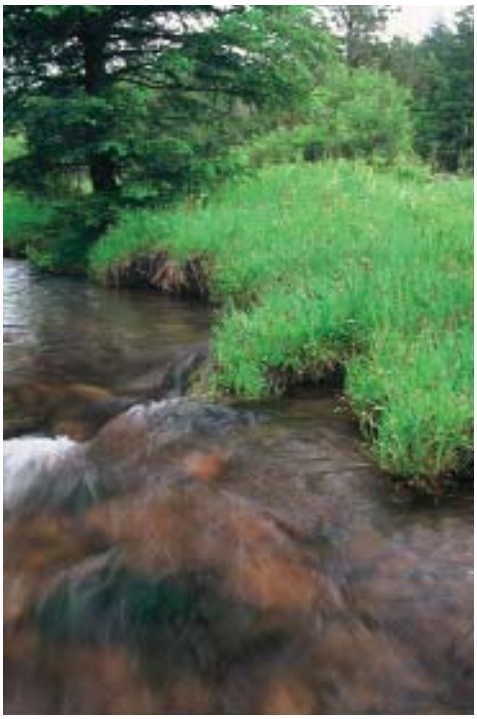
- Deeper, narrower streams flow through valleys where soils are finer in texture.
- Finer soils are more cohesive; they bind better than those composed of coarse gravel and rocks.
- Soil types and shoreline stability are linked to vegetation cover - its health, diversity and abundance. Continuous livestock use of banks and shores leads to a crumbling of the foundation.
- Shoreline trampling and streambank collapse occur with high livestock use of riparian areas.
- High livestock use can also alter, reduce or eliminate bank vegetation.

Stream channels and shorelines reflect the history and use of riparian areas.

- A wide, flat channel with low banks may not be what a stream wants to be; these features may represent our influence on the stream.

Changes in channel shape, to wider, shallower forms, can take years, decades and even generations to stabilize and evolve back to narrow, deep channels again.

- Healing takes revegetation, sediment deposition and bank rebuilding.



A good foundation is built with careful vegetation management.

Hoof power can't be underestimated. Cattle exert about 10 times the weight or pressure per unit area as a D9 cat with a blade. The foundation can't withstand this pressure for prolonged periods.

Banks and shores: build a good foundation for riparian areas and for your place.

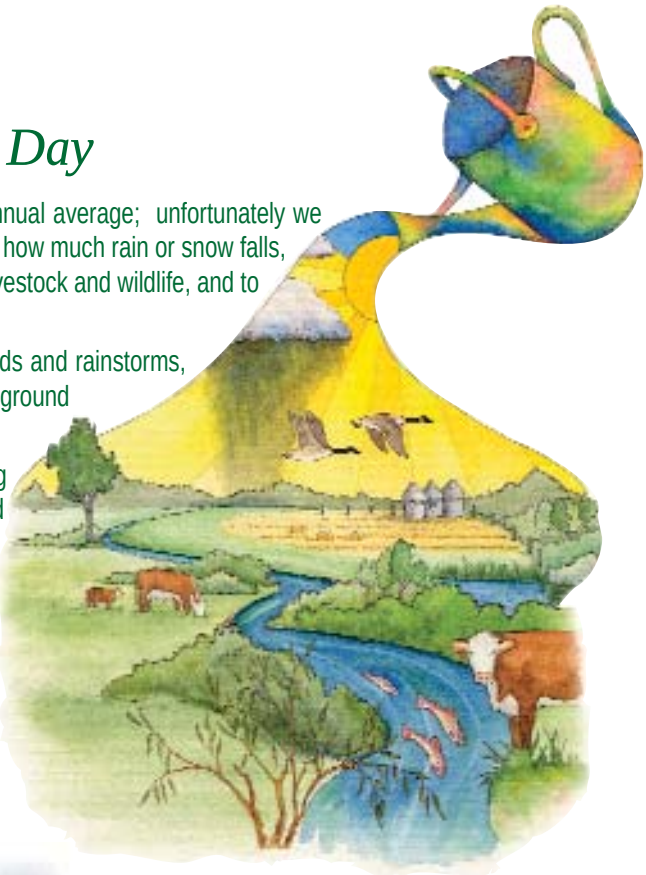
Water in the Bank

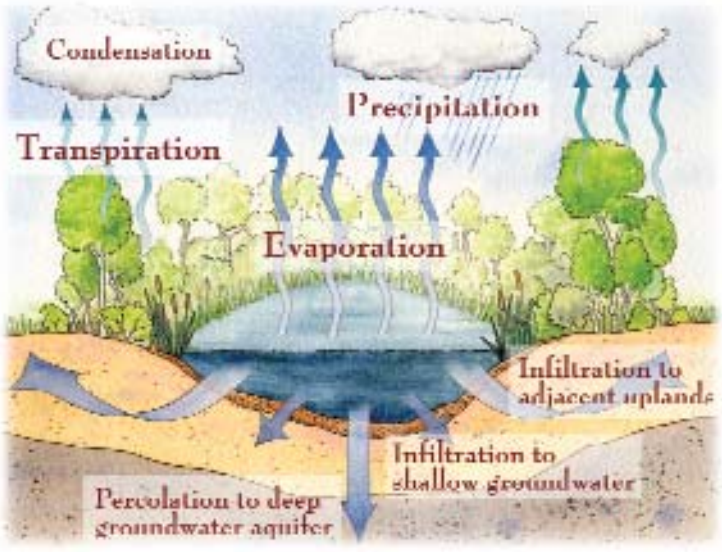
Putting Water Away on a Rainy Day

We live in a land where precipitation varies greatly around an annual average; unfortunately we can't count on the average every year. Although we can't change how much rain or snow falls, we can influence how much stays, to fuel plant growth, to water livestock and wildlife, and to provide flow in streams and water levels in lakes.

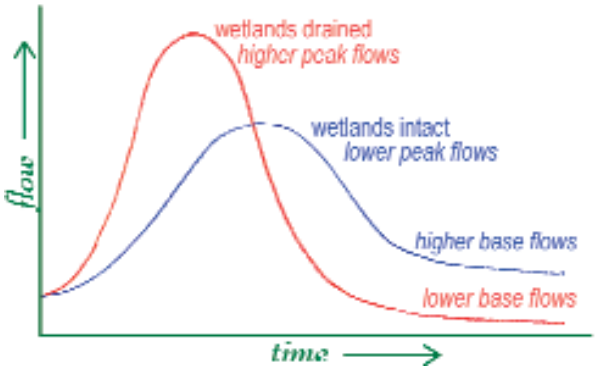
Stream valleys, wetlands and lake basins store water during floods and rainstorms, like a "sponge". How much they store and how quickly the underground reservoirs empty are affected by how we treat riparian areas.

Streams and rivers are the sum of many tributaries including dozens, sometimes hundreds of smaller streams, channels and drainages that collectively are known as the watershed. Watersheds also include wetlands and lakes. Even though these may not have surface drainage, water moves underground between wetlands, lakes, rivers and streams. Watersheds, in simple terms, shed water. They collect and deliver the water from rainfall or snowmelt. The physical characteristics of the watershed, the abundance, diversity and health of vegetation plus land uses, reflect the pattern of runoff.





Changing and removing vegetation cover combined with wetland drainage can cause runoff to occur more quickly as well as produce higher peak flows. That translates into more stream horsepower to do damage plus less retention time for water to soak into the soil and underlying substrate.



Draining wetlands has a direct effect on local stream flows. When wetlands are drained, higher peak flows (flooding) and lower base flows result. Where wetlands are intact, they store water and release it slowly. The net result is less flooding, increased base stream flows and groundwater replenishment.

	Maximum	Minimum	Average (mm)
Medicine Hat	642 (1927)	148 (2001)	340 (1911-2002)
Camrose	734 (1973)	236 (1929)	434 (1929-2002)
Rocky Mountain House	743 (1965)	335 (1950)	546 (1945-2002)
Lac La Biche	685 (1977)	216 (2002)	455 (1959-2002)
Fairview	606 (1973)	215 (1981)	386 (1944-2002)

"Average" precipitation is a theoretical figure, not something to be counted on every year. These are some average precipitation levels, plus the highs and the lows, for several Alberta locations.

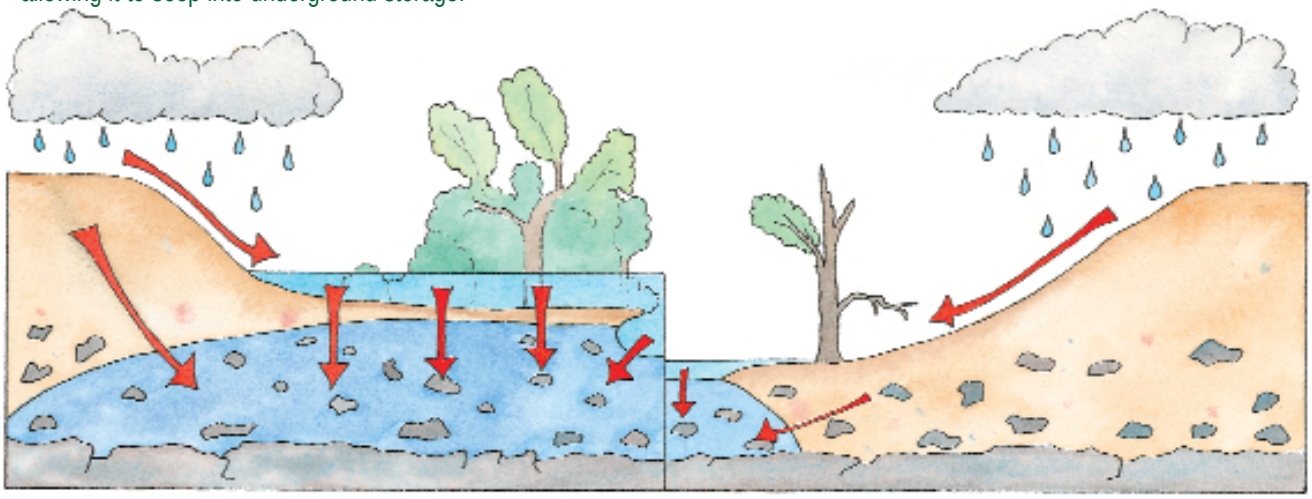
An understanding of how a watershed collects, stores and releases water may help us to save more water and benefit from it, especially during those years of below average precipitation.

Water Investments

Deposits

Flooding is one way of putting water in the bank, figuratively and literally; water saturates the floodplain and raises the water table. Most floods in Alberta occur during spring and early summer.

In years without flooding over banks and shores, water enters the floodplain through the bottom and sides of the channel or basin, adding to groundwater. Stream channel meanders, wetlands and a well-vegetated riparian area slow water down, allowing it to seep into underground storage.



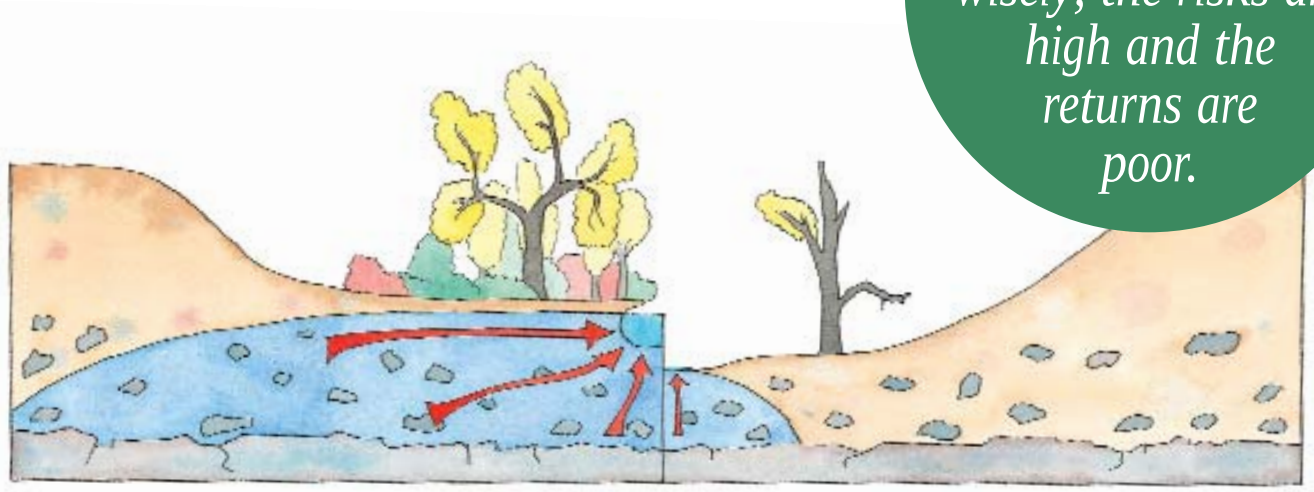
Healthy floodplains, which are well-vegetated, slow the flow of water, allow it to spread and soak in effectively.

Water speeds over floodplains with poor vegetation health, with channelized portions or cutoffs, and does not linger long enough to fill the underground "sponge".

Withdrawals

For most streams, flow for the late-summer, fall and winter months depends on groundwater storage, a withdrawal of the spring investment. The maintenance of water levels in wetlands and lakes also depends on that stored, spring water.

Water investments: if you don't plan wisely, the risks are high and the returns are poor.



In healthy, well-managed watersheds, stored groundwater is released back into the stream and riparian area.

Watersheds with poor groundwater storage capability may suffer low stream flows as the limited storage is exhausted. Streams may become intermittent in flow during crucial times and water may become unavailable for livestock, wildlife and fish.

Good Mud/Bad Mud

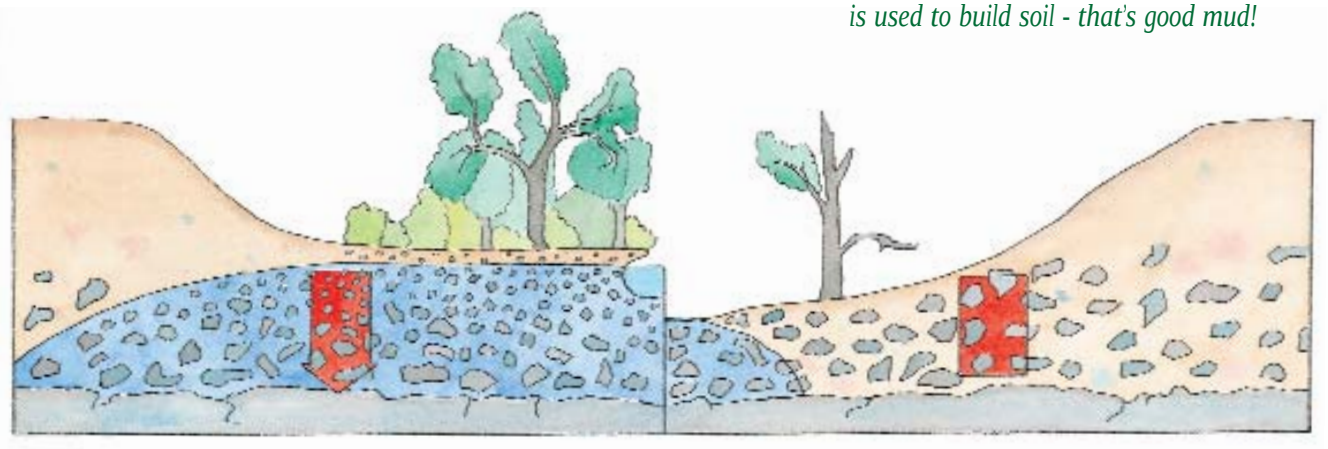
Sound planning for water investments starts before the water hits the stream or the lake. To maintain stream flow and lake levels throughout the year the riparian area must not only be recharged each year, it must be in a condition to first hold and then store water to be released later.

The type and volume of floodplain material - gravel, sand, silt or clay - determines the riparian areas' capability to hold, store and release water. Water moves more slowly through silt or clay than through sand or gravel.

During overbank flooding, areas that are well-vegetated catch more fine sediment than areas that are not. Sediment aids in the ability of soils to hold and store moisture by providing a base for plant growth. Plants return organic matter to the soil which increases the soil's water holding capacity. Organic material can hold nine times its own weight in water.

Nutrients, contaminants and pathogens attach themselves to sediment particles. Improving water quality starts with reducing erosion and sediment transport. Healthy riparian vegetation traps sediment before the load of problems is delivered to downstream water drinkers. Bad mud is transformed into good mud when it is trapped and stored in the riparian area, away from the water.

Plants bind soil in place and trap moving sediment - when sediment is captured and is used to build soil - that's good mud!



Sediments build more quickly on well-vegetated riparian areas. The cycle of flooding, sediment deposition and soil building increases the capability for water absorption and storage.

Where vegetation is lacking, less sediment is captured, the capability for water absorption and storage suffers and water quality can deteriorate.

Soil holds water and supports vegetation - give it a home on your riparian area.

Vegetation - The Roots of the Solution

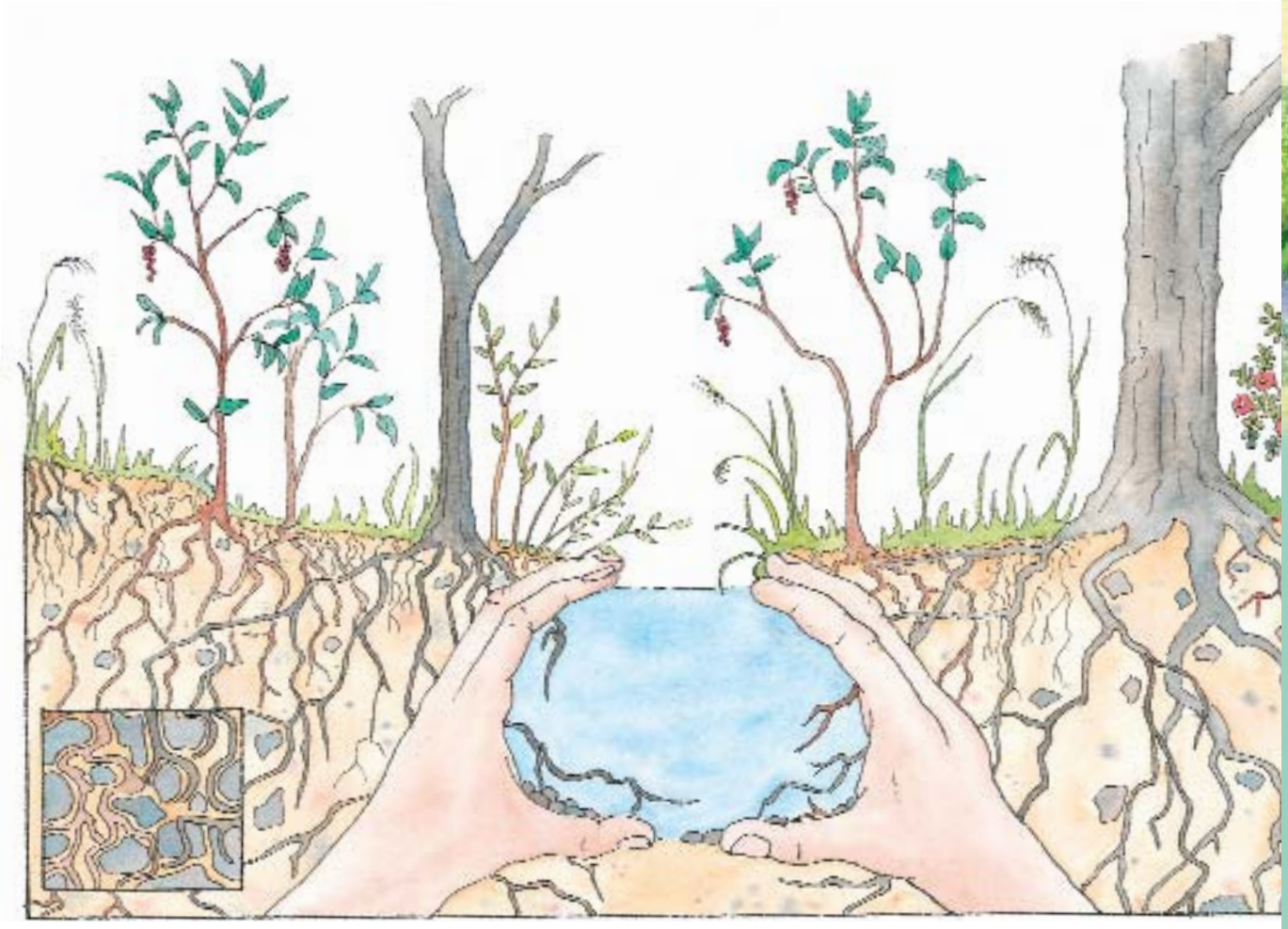
The riparian areas of streambanks and shorelines are glued together by a diversity of plants with strong, deep root systems, especially those of woody plants.

Riparian vegetation reduces horsepower by slowing water down through friction. A five centimeter deep rootmat resists erosion up to 20,000 times better than bare soil streambanks or shorelines.

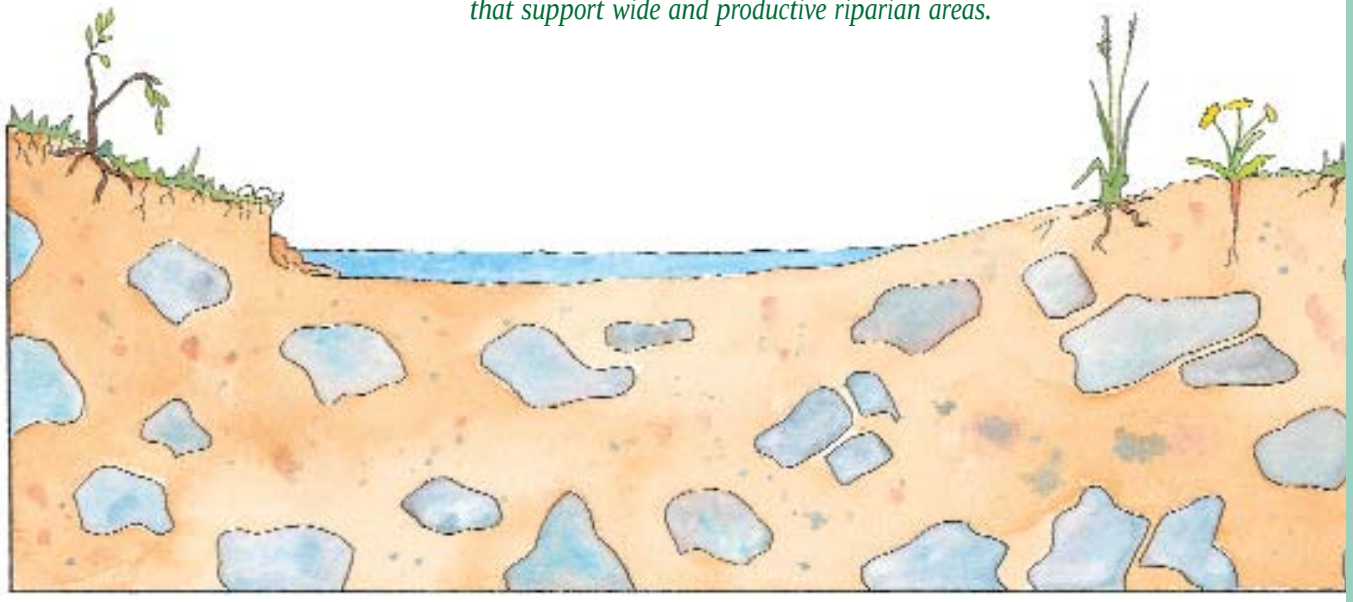
Deep rooted sedges glue together the riparian area of this small, low gradient stream.

For larger, higher gradient streams and rivers, shrubs and tree species are needed to stabilize streambanks.

As the percentage of roots in streambanks and shorelines increases, erosion decreases.



Well–vegetated streams tend to be narrow and deep due to the binding nature of plants and their root systems. They tend to be stable and have groundwater tables that support wide and productive riparian areas.



Where vegetation has been removed by heavy grazing, logging or other development, the cohesive nature of streambanks breaks down and streams become wide and shallow. These channels can be unstable, with lower water tables that shrink the size of the riparian area and its productive nature.

Diverse, healthy vegetation has a major influence on stream channel shape and on shoreline stability.

Big Wood - The Floodplain Builder

The roots of trees and shrubs stabilize streambanks and shorelines. Logs that fall into the stream channel assist in the development of broader floodplains which provide forage for livestock, habitat for wildlife and recreation sites. Flooding behind logs and other woody debris helps recharge the floodplain with water and nutrients.

"Big wood" dissipates stream horsepower and wave action, aids in channel development and forms important aquatic habitat.

When the deep, binding roots of shrubs and trees are absent, shallow-rooted grasses cannot withstand erosion forces....

but add a deep-rooted shrub like willow and the streambank starts to recover. Woody vegetation adds reinforcement to stream banks.

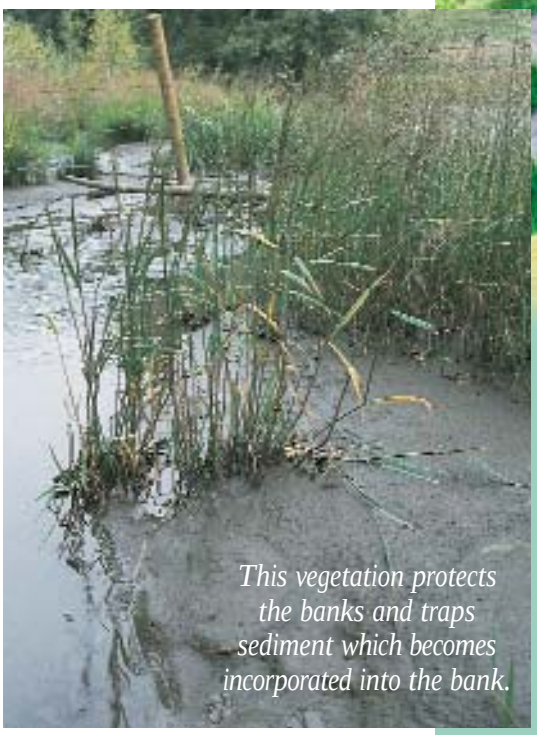
Wood is good!

As trees are incorporated into stream channels they modify slope and reduce stream horsepower.

Building a Riparian Area

Riparian areas slow water velocity, filter water passing through and hold water for later release.

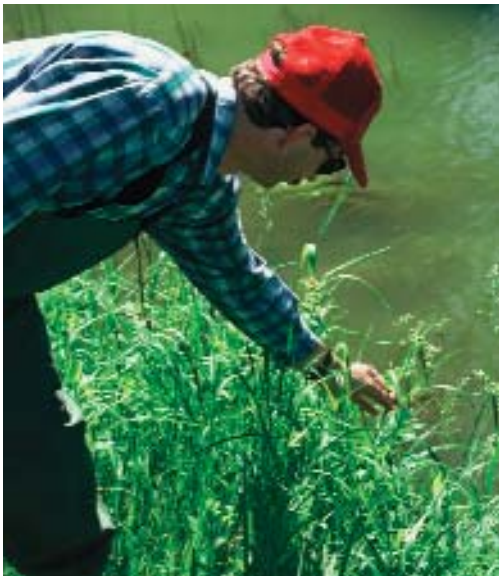
- When floods occur, flowing water is slowed by riparian vegetation and by the ability of the stream to access its floodplain; flood water is stored temporarily in wetlands, lakes and floodplains.
- Vegetation helps build and maintain streambanks, shorelines and riparian areas.
- Water quality is enhanced when sediment is trapped and incorporated in the riparian area.



This vegetation protects the banks and traps sediment which becomes incorporated into the bank.

Streambank vegetation "squeezes" stream flow upwards, slows it down, and allows more water to be added to groundwater and bank storage. The groundwater table moves upwards and sideways, increasing the size of the green zone.

- Nutrients are used by riparian plants, improving water quality.
- Vegetation helps keep streams flowing and water levels higher during low flow periods.
- Diverse types of vegetation are key to riparian area development because they add complexity, strength and reinforcement.



Many plants with high forage or habitat values respond to the higher water tables in well-managed, well-vegetated valleys.

Riparian vegetation "grabs" sediment, "holds" it and "sucks" up nutrients.

Vegetation: it's the root of the solution for riparian management.

Beavers - Riparian Managers

Beavers have been building and modifying riparian areas for thousands of years. Historically, most of our stream drainages contained beaver, and, under close examination, show some level of beaver modification today. Beaver "manage" riparian areas with their extensive dams and through their harvest of trees and shrubs. In the short term this management can sometimes conflict with our uses of riparian systems. Over long periods of time stream valleys evolve under beaver management.

Beavers modify riparian areas with dams that hold water and trap sediment.

Beaver modified valleys are fragile and need deep-rooted plants to resist downcutting through accumulated sediment.

Beaver modified valleys can produce a diversity of vegetation including large quantities of forage.

Even though beaver may be missing from the picture, their influence shows in sediment capture and wider, productive valleys. Each beaver dam can capture tons of sediment – that sediment builds deep soils and productive riparian areas.

Beaver dams reduce stream gradient (and horsepower) which allows sediment to accumulate. As sediments are trapped and slowly build behind dams the shape of a stream valley can change, often to a wider one, with gentle slopes. Beaver modified valleys represent productive, diverse and valuable portions of the landscape.

Beavers - another element in the understanding of riparian areas.

Riparian Actions that Create Problems

Often, because of our impatience with spring flooding we cut through bends to "speed" the water through, or straighten and channelize to protect buildings.

Straightening and widening stream channels increases stream horsepower and often the flooding or erosion is transferred to downstream neighbours.

Bridges are expensive, so culverts become the choice for many stream crossings.

Culverts increase stream velocity because friction between the water and the culvert material is reduced. If improperly sized or installed, culverts increase horsepower and downstream erosion is certain.

The "too soon, too long, too much and too often" type of grazing fails to protect riparian areas.

Excessive removal or alteration of vegetation by unmanaged grazing decreases friction on the banks and increases water horsepower. The defense against erosion is reduced.

Because we like to live beside water and establish our towns and cities there, we often develop the riparian area out of existence.

Drainage or removal of wetlands can increase flood risk, reduce water storage and negatively affect water quality.

Cultivation and logging, when undertaken without appropriate buffers, remove key elements of the riparian area.

Stream horsepower is increased with the removal of the friction provided by streamside vegetation. The extra energy is used to increase erosion of the streambanks (lateral erosion) or stream bed (vertical erosion).

All of these actions can result in more pressure on the gas pedal, more speed, more energy and more erosion.