Agriculture in the classroom MANITOBA INC.

agrobiodiversity & water

grade 8

Funding for this resource was provided by

COVERING NEW GROUND
MANITOBA AGRICULTURAL SUSTAINABILITY INITIATIVE

Ages 13-15

An introduction

Biodiversity (biological diversity) refers to the variety and variability of all living organisms (animals, plants, and micro-organisms) on Earth. Agricultural biodiversity or agrobiodiversity refers to the variety and variability of living organisms important to food and fibre production. It includes organisms that are harvested as well as the unharvested organisms that support agricultural production. Agrobiodiversity includes a mix of naturally occurring organisms and organisms introduced by farmers

While biodiversity at first glance may not seem to have much to do with water, biodiversity in general, and agrobiodiversity in particular, do play significant roles in maintaining our water resources so that they can be used by humans, animals and plants.

Water is extremely important in the agricultural environment. Without it, there would be no agriculture. Too little water, crops don't yield well. They may even die. Too much, the same thing happens. The amount of water in the agricultural environment directly affects how much food we have.

Farmers can't change how much precipitation falls on their farmland, but once it does fall, they can affect what happens to it, how well it is used, and how it impacts the environment.

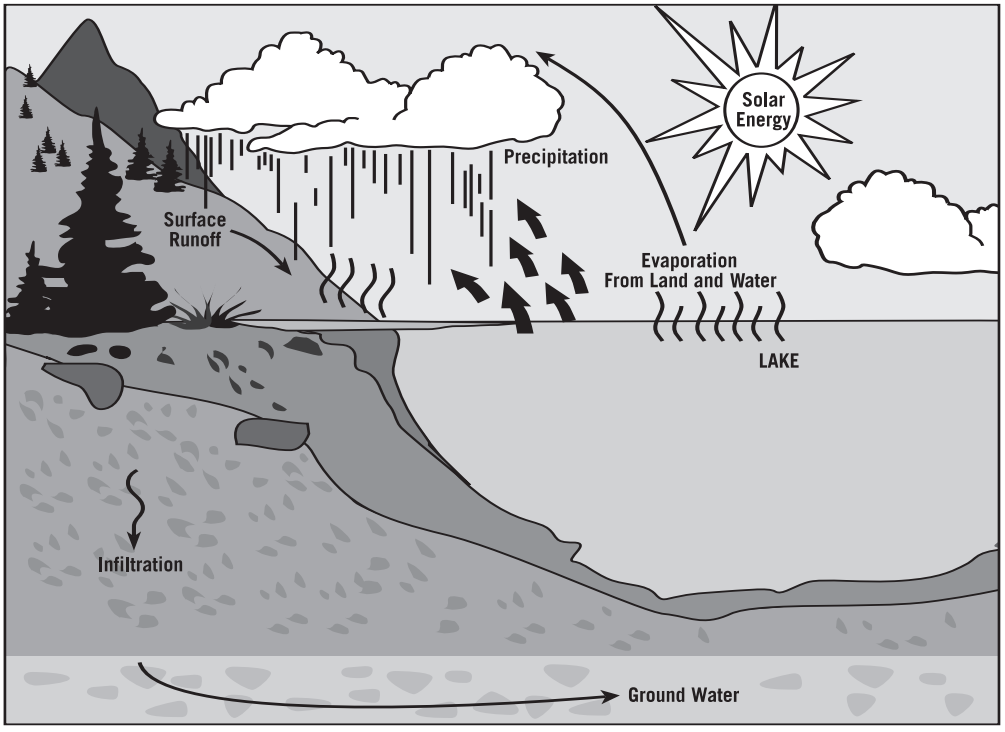
The water cycle and watersheds

The water cycle is how water moves from the atmosphere to land and back to the atmosphere again in its various forms: vapor, liquid and solid; and throughout Earth's systems: oceans, groundwater, streams and atmosphere. How we interact with the water cycle will determine whether we have enough water at the right time of the year for food production.

Activity 1: The water cycle

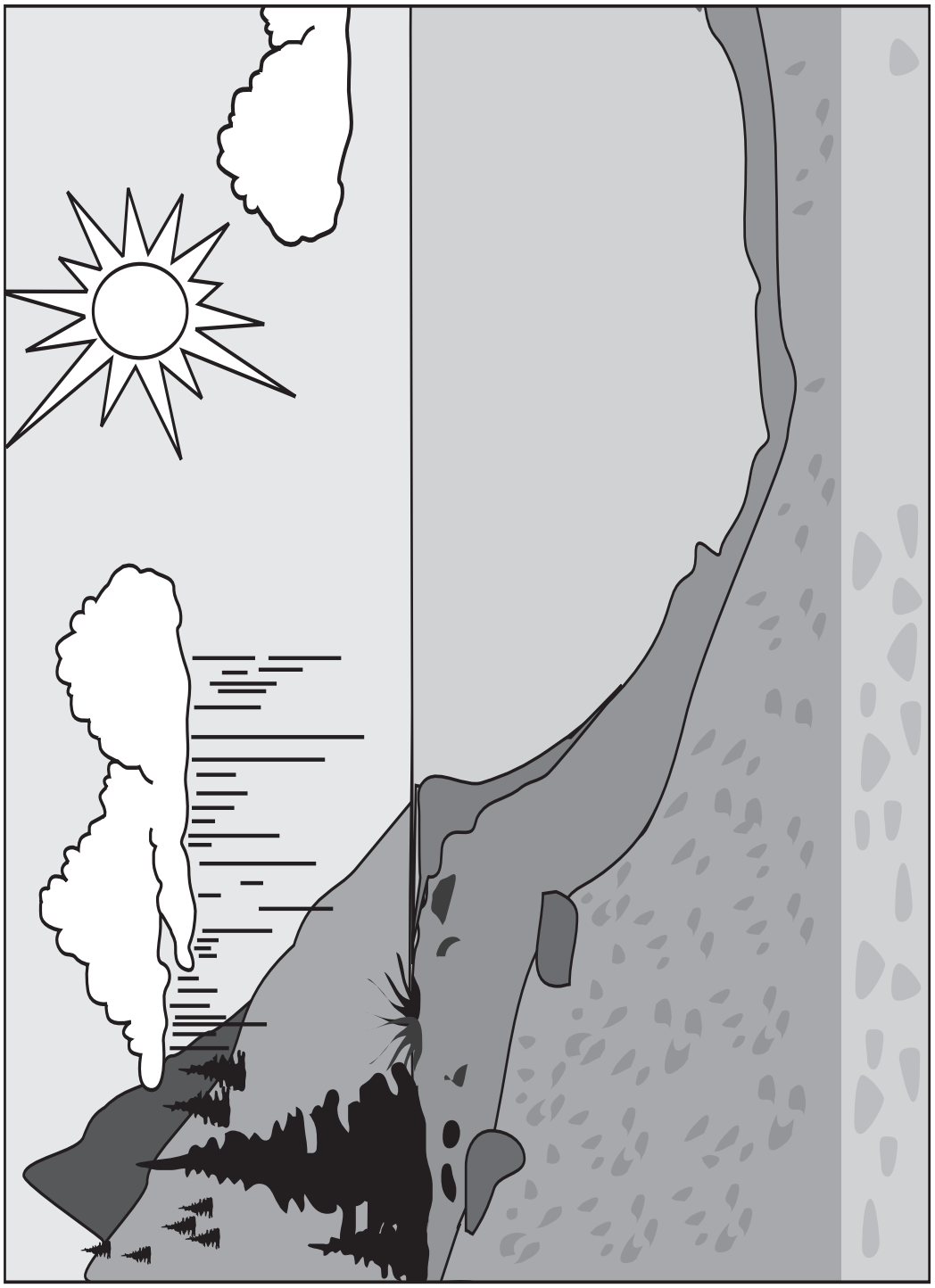
Use the blank diagram as a student handout to show all the parts of the water cycle and how water moves through it. Use arrows to show how water moves.

Answer Key for Activity 1



Ages 13-15

HAND OUT



Ages 13-15

A watershed is the distribution system for water on land. A watershed includes all the water that starts as rain or snow and drains to one common point through canals, channels, streams, lakes and rivers. The length of time the water has to soak into soil and how quickly the water drains away through the watershed depends on the natural characteristics of the watershed and how human activities in the area are managed.

Activity 2: Your local watershed

Using a map of Manitoba as a source, draw the watershed(s) in your region. Include as many names as possible of creeks, streams, rivers and lakes. Indicate the direction of water flow by putting arrows along the watercourses. What is the major destination for the water in your area? What separates one watershed from another in your region? Include any built structures such as drainage diversions, canals, and water retention ponds. How might these structures affect water and land downstream?

It should be recognized that urbanization, with its concrete and paved surfaces, changes drainage patterns by reducing the amount of water that infiltrates the soil. More water runs off.

How water affects land

In an agricultural setting, the effect of surface water is obvious. You can see evidence of where surface water has carried off topsoil. You can see channels and gullies created by a heavy rain or flash flooding. What is not always so obvious is how groundwater can affect the chemical make-up of the soil, and in turn the soil's ability to grow crops.

Soil is made up of minerals that were weathered or broken down from parent rock material that is now well below the soil surface. Some of the minerals are salts that dissolve in water. Soils become saline when the salts in the groundwater are moved through capillary action into the root zone and onto the soil surface. When the water evaporates, the salts are left behind. As groundwater continues to carry the salts to the surface, year after year, the soil in the root zone may become so saline that it will not support most crop growth.

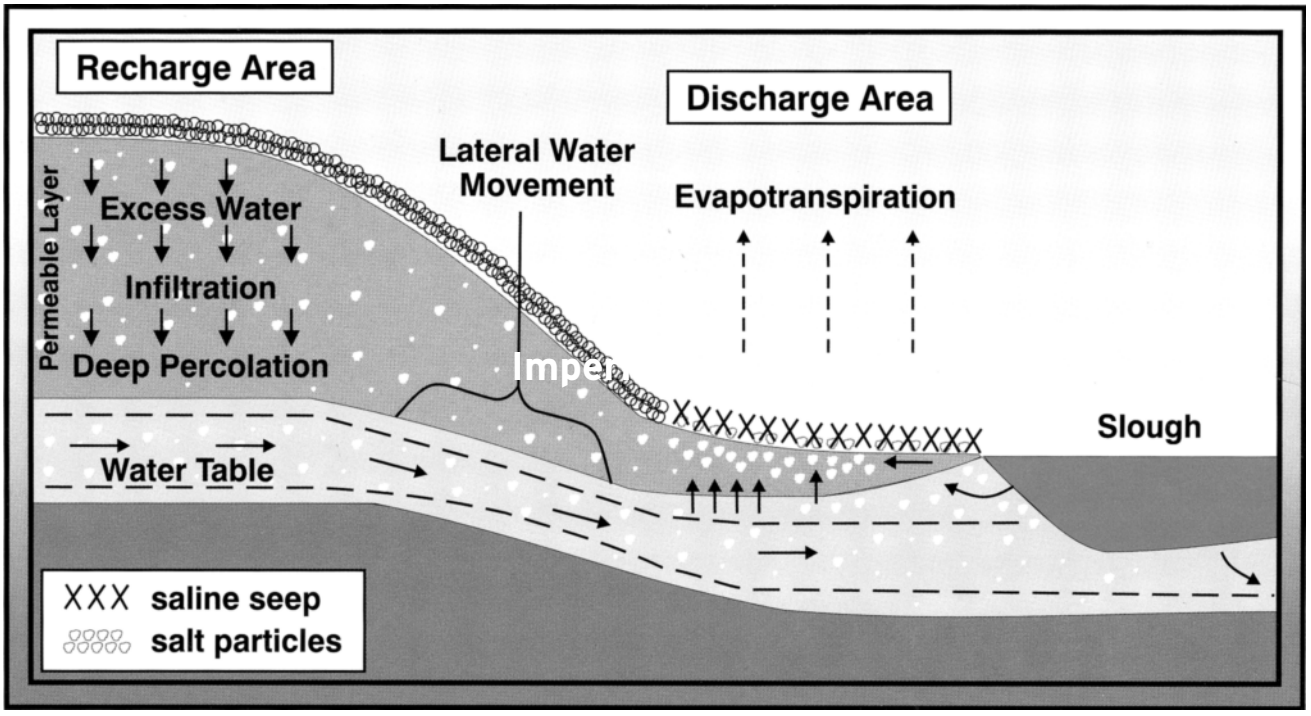
To visualize the effects of soil salts, think about watering your houseplants with salt water. It's just not something you would do. The plants wouldn't survive very long. Think about a crop growing in a soil affected by salinity. It's as if its roots are in salt water.

Activity 3: Erosion journal

Select a farmed area, preferably one with several different fields, and fields that had different crops in them during the previous growing season; example: corn, canola, cereals, pulses, forage or pasture. Observe and describe what type of ground cover is left on each field after harvest. Is the amount of cover related to the type of crop or the farmer's harvesting and after-harvest land management practices? Consider soil texture, land slope and amount of organic matter. Where do you expect erosion to occur in each field? Through the fall, winter and spring observe the fields, particularly after rain or wind and following spring run-off. Did erosion occur? Did it occur where you thought it would? Why or why not? What did the farmer do that prevented erosion? What could the farmer have done better? (Before entering a farmer's land, ask the famer's permission.)

Activity 4: Identifying salinity

Saline soils commonly occur in low-lying areas where there is a seasonally high water table; in sloping areas where groundwater seeps to the surface; and along roads due to soil compaction. Have you seen evidence of salinity? Think where you might see it. What is a telltale sign of salinity? What plants grow in saline areas?



Source: *Forages for Improving Saline Soils,* Manitoba Agriculture and Food Fact Sheet.

Ages 13-15

Activity 5: Capillary action

Take three clear plastic open-ended tubes, 3 to 15 cm (1 to 6 inches) in diameter and place a fine screen on the bottom. Fill each tube with a different material – gravel, sand, and clay. Place the tubes in a pail of water. What happens? Which has the greatest capillary action? Why?

How land affects water

How agricultural land is managed can affect both water quality and quantity.

For quality water, the water should be free of abiotic or biotic contaminants that affect human or animal health or that change the habitat for water-dwelling organisms. For example, abiotic soil particles that are carried by wind or water erosion into streams, rivers and lakes change the quality of the water as a drinking source for animals and a habitat for fish and micro-organisms that fish feed on. Soil particles make water murky and gritty. Fish prefer clear water. Water treatment is more difficult and costly when sediment must be removed. Animals don't like to drink gritty water so they consume less. This can be a problem for farmers because their animals may gain weight more slowly or produce less milk.

Manure from livestock that are pastured too close to, or that drink directly from, surface water can introduce to the water biotic organisms, such as bacteria, viruses and parasites, that make it unhealthy as a source of drinking water for people and animals.

Ages 13-15

The quantity of water kept in an agricultural area to be used by crops or for livestock can be affected by land cover (the type of crop and natural plants); and drainage activities (canals, culverts and retention ponds).

The buffer between land and water

Where agriculture and water meet is in riparian areas. A riparian ecosystem exists between a body of water and the surrounding drier upland. It is the green ribbon of lush vegetation beside rivers, creeks, lakes, springs, wetlands and coulees. It can be described as "wetter than dry" but "drier than wet". The width of a riparian area is the furthest point that the body of water influences soil and vegetation. It is also called a floodplain.

There are a number of clues to a riparian area. Water is present seasonally or all the time. Water is either on the surface or near the surface. The amount of water can vary during the year or from year to year. The area stays greener longer than surrounding areas. Plants that do well in a riparian area are those that need lots of water to survive. There are more and different types of plants than in an upland area. The soil is different from the upland area because it has been changed by the action of water and abundant plant growth. There is more sediment – fine soil particles that have been carried by erosion from the uplands. There is usually more organic matter due to lush plant growth and the variety of plant species.

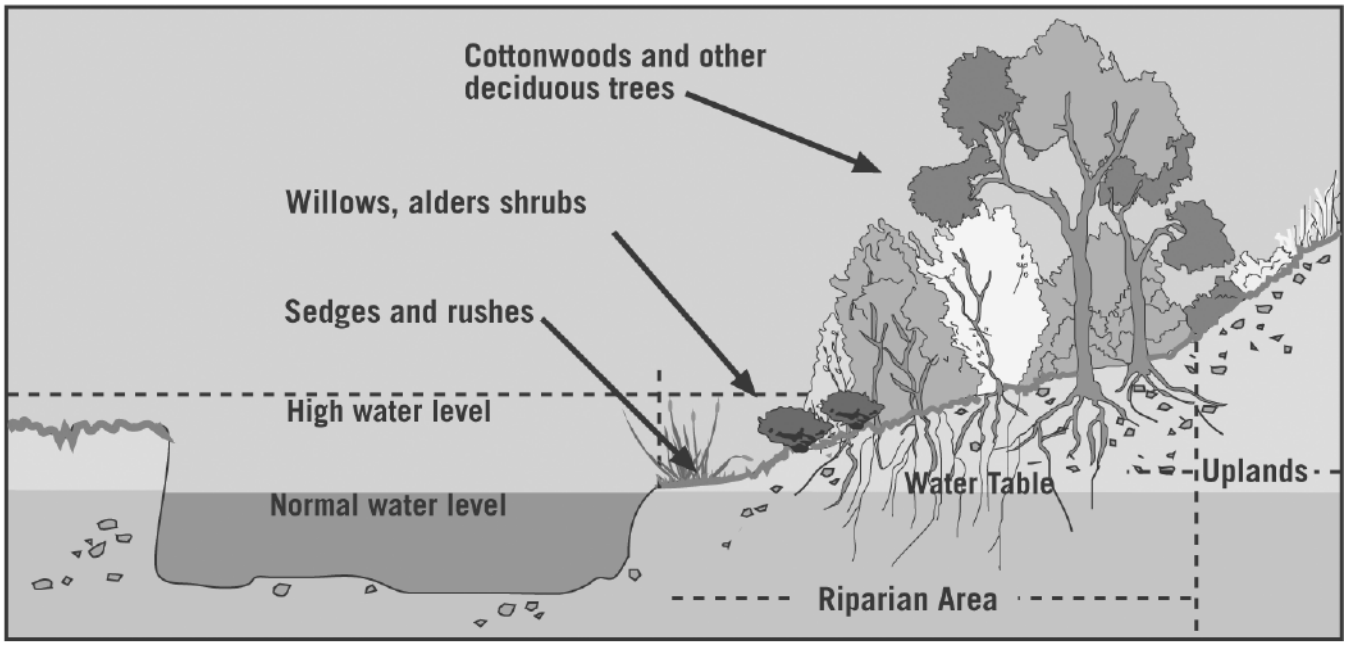
Did you know? Riparian areas account for only one or two percent of the total land base of the Prairies, however they provide important environmental and economic benefits!

Riparian areas are important because they act as a buffer, protecting the water from the effects of the activity that happens in the upland. A riparian area can act as a buffer because of the biodiversity of its plant life. The more native biodiversity a riparian zone has, the more effective it can be. Different plants contribute to the health of the riparian area in different ways.

Healthy riparian areas provide us with:
- resiliency – the ability to bounce back from floods, drought and human-caused problems;
- ecological services – (see the next section); and
- stability – landscapes that maintain themselves and are sustainable.

The vegetative cover in riparian areas does a number of important things:
- reduces erosion by slowing water speed and protecting the bank:
- traps sediment and stabilizes banks and shores;
- naturally purifies water;
- slows and reduces flooding by slowing snowmelt, allowing the water to soak into the ground rather than run off;
- allows water to move into the soil to recharge the groundwater;
- reduces the rate of evaporation; and
- provides feed and shelter to wildlife and livestock.

Ages 13-15 Riparian areas can be fragile if they aren't taken care of. In order to keep riparian areas healthy, it is important to understand the role of the natural plant biodiversity and how to maintain it. Riparian areas are highly productive. They can produce significantly more forage than adjacent upland areas. Riparian areas can be used successfully for pastures if the needs of plants are kept in mind.



Ages 13-15

Vegetation – an indicator of riparian health

The type and variety of plants in a riparian area are important indicators of whether it is healthy or in decline. An area that is well covered with plants returns lots of organic matter to the soil. This increases the soil's ability to hold water.

Invasive alien species and disturbance species indicate that the riparian area is not as well as it could be. They get a foothold because something has interfered with the environment that the native species prefer. Often it is due to the activities of humans – clearing bush, damming or draining areas, or overgrazing livestock.

Invasive alien species or weeds appear in a riparian area because there is bare ground in which their seeds can germinate. Several plants of an invasive alien species mean there is threat of quick invasion. Any benefit from invasive species is outweighed by the damage they do. They do not start growth early enough in the spring to trap sediment or protect banks and shorelines from run-off. They prevent the growth of beneficial species that contribute to bank and shore stability, biodiversity and productivity for feed.

Did you know? Organic matter can hold nine times its own weight in water!

Disturbance species can be present in small amounts in a healthy riparian area. If the area has been disturbed, they quickly invade. While they have more value than invasive species, they are not as useful as native species because:
- they are shallow rooted and are less productive;
- they don't stabilize banks or prevent erosion very well; and
- they slow the establishment of preferred species.

Trees and shrubs, also called woody vegetation, are an important part of a healthy ecosystem. Their root systems are deep and broad enough to be very effective in stabilizing banks. Their roots play a key role in taking up nutrients that would otherwise decrease water quality. The canopies formed by trees and shrubs provide shade, creating a microclimate in the riparian area and cooling the water which provides better fish habitat.

Without shade, sunlight warms the water and reduces its ability to hold oxygen. This can increase the growth of algae, some of which can be harmful to animal health. At the very least, the water will need more treatment to make it acceptable for drinking water for people. The combination of less oxygen and increased algae make the water poor habitat for fish.

A healthy riparian area has a mix of all ages of trees and shrubs. If there are few or no young trees and shrubs to replace the older ones, the long-term health of the riparian area is at risk. A significant number of dead and dying trees is a sign that something has changed the water flow over a period of time.

Ages 13-15

Whether the woody vegetation is used, and how it is used, also has an impact on the long-term health of a riparian area. Animals can eat tree leaves. Livestock will often browse woody plants, especially in late summer, fall and winter. Wildlife, including beaver, makes use of woody plants year-round for food and shelter. Trees and shrubs are used by animals to rub themselves; young woody plants can be trampled. Mowing, trimming and logging remove woody species. Woody plants can survive low levels of use or damage, but heavier levels of animal or human activity can:

- deplete root reserves;
- prevent establishment and regrowth;
- cause the loss of preferred woody species;
- lead to replacement by less desirable species and lead to invasions by disturbance or alien species, resulting in reduced biodiversity.

A good mix of native grasses and broad leaved plants is preferred because these plants are adapted to riparian areas. They emerge and grow at different times of the year, ensuring that there is protection for the soil surface at all times. They are adapted to withstand periods of flooding without losing productivity. They have deep and broad root systems to stabilize banks.

A sign of a healthy, stable riparian area is a deep, narrow stream channel. This indicates that the banks of the steam have enough vegetation to resist erosion. This is because the roots of woody and herbaceous plants bind the soil together preventing the channel from gradually "eating away" at the soil that supports the bank. A narrow channel does not mean the riparian area is necessarily narrow. A meandering stream can cover a wide area, creating a wide riparian area. A well vegetated riparian area will store floodwater that can be used by plants throughout the growing season, ensuring a wider riparian area.

Activity 6: How roots stop soil erosion

In this activity, you will:

1. demonstrate the importance of vegetation cover and organic matter to reduce soil erosion.
2. find answers to where soil goes when it leaves the farm.

Did you know?
A five-centimeter deep root mat resists erosion up to 20,000 times better than bare soil stream banks!

This experiment can demonstrate how increasing organic matter can reduce soil movement by water.

Materials required;

- 1 - 5 gallon aquarium, or two large jars (10 cm or larger top opening).
- 2 mesh sacks (15 cm x 15 cm - 1 cm open mesh), or fabric to make some.
- two lumps of soil about the size of a baseball. Obtain one sample from a dry, frequently tilled field or garden, and a second sample below grass and shrub vegetation, or along a fence, where more roots and organic matter remain in the soil. Gather more soil than you need so that you can look closely at it after the experiment.
- a magnifying glass or simple microscope.

To see how roots and organic matter hold particles together and help soil resist erosion:

1. Fill the aquarium (or jars) with water about 15 cm deep and at least 10 cm below the top.

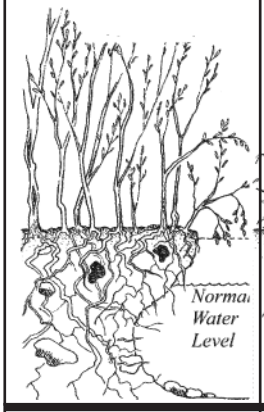
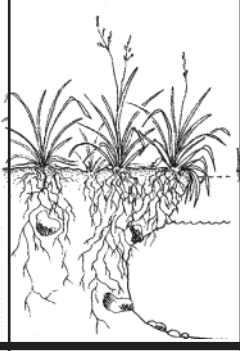
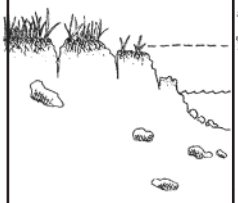
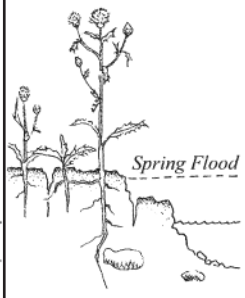
Ages 13-15

2. Construct a mesh sack 15 cm x 15 cm and fill with a lump of "organic" soil about the size of a baseball.
3. Construct a second mesh sack and fill with a lump of soil that has been frequently tilled.
4. Tie both bags at the top with string, leaving enough string to suspend the sacks of soil in water.
5. Place the sack of "organic" soil into water first. Push it gently under the surface, if necessary. Watch to see how much soil escapes.
6. Place the sack of "frequently tilled" soil into water. Push it gently under the surface, if necessary. Watch to see how much soil escapes.
7. Compare the amount of soil that escapes through the mesh of both sacks. Explain why the difference.

Now examine plant roots with a magnifying glass, and feel the texture of the remaining soil from both samples. What do you find when you examine plant roots with a magnifying glass? How do roots hold soil together? Imagine what a whole field of plants could do to stop soil erosion!

Where does eroded soil go? When soil particles are separated from each other they can be easily moved elsewhere by wind and moving water. Where do they go?

Species in a riparian area

Trees & shrubs*	Preferred species	Disturbance species	Invasive alien species
			
Alder Cranberry Dogwood Honeysuckle Pin and chokecherry Saskatoon Silverberry Willow Aspen Birch Conifers Poplar Cottonwood Manitoba maple Green ash	Bunch grasses Cattails Rushes Sedges Tufted hairgrass	Clovers Dandelion Foxtail barley Kentucky bluegrass Plantain Smooth brome Stinkweed Timothy	Canada thistle Hound's tongue Knapweed Leafy spurge Nodding thistle Toadflax

Source: *Caring for the Green Zone: Riparian Areas: A User's Guide.* Cows and Fish, Lethbridge, AB

*Woody species that are not preferred because they don't have a good root structure or are invasive: rose, snowberry, Russian olive and tamarisk.

Ages 13-15

Other factors that affect the health of a riparian area

Changes to the physical structure of a streambank or shoreline by human activity can affect the stability of the land at the water's edge and, in turn, the shape of the stream channel or a lake's shoreline. This can lead to increased erosion, more sediment in the water, faster moving water (in a stream), different, less preferred plant species – in short the riparian ecosystem is eventually completely changed.

Did you know? A 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!

Bank or shoreline changes caused by humans can occur as the result of recreational trails, flood or erosion control methods, timber harvest, irrigation requirements, drainage or damming, bridges/culverts, planting non-native species, and grazing livestock. The meanders in a stream may be cut through to straighten a channel to increase drainage or protect buildings.

The soil in a riparian zone can be very prone to becoming compressed or compacted because it is usually moist or wet. Plant roots and mircro-organisms create soil structure that allows water to enter the soil and be stored there. When the soil is compacted by animal hooves or vehicles, the space between the soil particles is pressed together, and the water is squeezed out. Think about a sponge. It is made up of sponge material and lots of spaces. When you squeeze a wet sponge, it compresses, and it can't hold water. Riparian soil is similar to a sponge, only once it is compacted it doesn't bounce back as quickly as a sponge. It takes awhile for plant roots to penetrate the soil and micro-organisms to re-establish themselves. In the meantime, the environment has changed for the water-loving plants that live in the area.

Vehicles cause ruts, as do animals by creating trails. Animal hooves create pugs and hummocks, giving the affected land a bumpy appearance. Pugs are the depressions created by animals walking over wetland, while the hummocks are the little hills that surround the pugs.

Did you know? Cattle hooves exert 10 times the weight or pressure per unit area as a D9 caterpillar tractor with a blade!

Bank or shoreline change due to human activity can cause another problem in riparian zones. The water body may be prevented from reaching all or part of its floodplain. Floodplains are important because they act as a safety valve by letting the water that the channel cannot hold escape into a wider area. Floodplains allow water to be stored, reduce the speed of water flow and allow sediment to be deposited over a wider area than just the channel. During a flood, water saturates the flood plain, increasing the amount of groundwater and raising the water table.

If water does not have the ability to access its floodplain, the following can happen:

- a lowered water table, reducing the ability of some plants to live in the area;
- more erosion and bank instability due to faster moving water; this can have effects both up and downstream from where the water is prevented from reaching the floodplain as the stream tries to adjust to the physical change;
- less water storage leading to lower flows or no flow at all in the stream during parts of the year;
- less trapped sediment leading to water quality problems;
- less resilience to rebound from natural or human impacts; and
- less feed, shelter and biodiversity.

Riparian areas depend on a regular supply of water. Adding or removing water as a result of human activity directly affects riparian health. Riparian areas are adapted to, and depend on, the volume and timing of annual peak flows and levels. The degree to which streams are controlled by dams or diversions upstream affects the delivery of water downsteam. Water may arrive at a time other than when plants need it, or at levels higher than the system can handle.

Activity 7: Assess the health of a riparian area

Look at how much of the area is in trees, shrubs, disturbance species, native plants, introduced species and bare ground. Are there dead trees? What is the age range of the trees? Has the drainage pattern been changed? Can the water reach its ful floodplain? Use the following sheet to assess how healthy the area is. What can be done to make it healthier?

Riparian Health Assessment

Location:_____ **Date:**_____

General Site Description: _____

When rating each area below, the highest number indicates the best state.	**Score** Actual	Possible
1. Vegetative cover: how good is the cover? 6 4 2 0		6
2. Invasive species: how much is there and how dense is the infestation? 3 2 1 0 3 2 1 0		6
3. Disturbance species: how much is there? 3 2 1 0		3
4. Preferred tree and shrub presence and regeneration. 6 4 2 0		6
5. Use of preferred species: how much is being used for browse (feed)? 3 2 1 0		3
6. Dead and dying trees and shrubs. 3 2 1 0		3
7. Protection of streambank or shoreline by root mass: you can judge by amount and type of plants present. 6 4 2 0		6
8. Human-caused bare ground 6 4 2 0		6
9. Streambank or shoreline alteration by human activity (ex. cutting down trees) 6 4 2 0		6
10. Pugging, hummocking and/or rutting 3 2 1 0		3
11. Ability of the river or stream to reach its full flood plain? 9 6 3 0		9
	Total	57
As a percentage: x/57		

Rating your riparian assessment.
A score between 80 percent and 100 percent indicates a healthy riparian area. What needs to be done to maintain this rating?
A score between 60 percent and 79 percent means there are signs of stress, and more attention needs to be given this area. What things need to be changed to improve riparian health?
A score of less than 60 percent indicates that the area is in trouble and needs attention. What are the things that need to be addressed first to bring some stability to the area?

Ages 13-15

Vocabulary

browse: tender shoots of shrubs or trees eaten by wildlife or livestock; the act of eating the tender shoots of shrubs and trees.

capillary action: movement of water upwards in the soil through very small spaces between soil particles.

evaporation: change in water from a liquid to vapor.

groundwater: water stored under the surface of the earth.

potholes: small depressions in the ground formed when chunks of ice from retreating glaciers were buried. As the ice melted the soil covering it collapsed forming the pothole. They fill with water each spring from run-off or are refilled from groundwater. They also serve as reservoirs for snow melt. Potholes are an important part of the water cycle. Some water evaporates into the atmosphere, providing a source of water for showers. The remainder soaks into the soil, adding to the water table.

percolation: the movement of water downwards through large spaces between soil particles.

precipitation: forms of water that fall from the atmosphere – rain, hail, snow, sleet.

run-off: the water that is not absorbed into the soil; instead it runs off moving from areas of higher elevation to lower ones.

salinity: a condition caused by water soluble salts moving up from deep in the subsoil to the rooting zone of plants and the soil surface. Most plants do not grow well in saline or salty soils.

soil erosion: the wearing away or moving soil by the action of water, wind

Ages 13-15

Resources:

For presentations on this topic, contact Manitoba Agriculture, Food and Rural Initiatives – local agricultural representative.

A list of agricultural representatives can be found at www.gov.mb.ca/agriculture/contact/agoffices.html

For students in or close to Winnipeg, Fort Whyte Centre offers a riparian area you can visit. The Oak Hammock Marsh Interpretive Centre near Stonewall, Manitoba also has riparian areas.

Information Resources:
Caring for the Green Zone: Riparian Areas: A User's Guide to Health; and *Riparian Areas: Grazing Management;* Cows and Fish, Fish and Wildlife Division, 2nd Floor, YPM Place, 530-8 Street South, Lethbridge, Alberta, T1J 2J8. Also www.cowsandfish.org

Managing the Water's Edge. Manitoba Agriculture, Food and Rural Initiatives.

Prairie Farm Rehabilitation Administration:
www.agr.gc.ca/pfra/land/riparian_e.htm and
www.agr.gc.ca/pfra/water/quality_e.htm

Agriculture in the classroom MANITOBA INC
COVERING NEW GROUND PROGRAM UPDATE
Funding to produce this curriculum guide was provided through Covering New Ground, Manitoba's Agricultural Sustainability Initiative, 2004.