Grassland Ecosystems in British Columbia

GCC

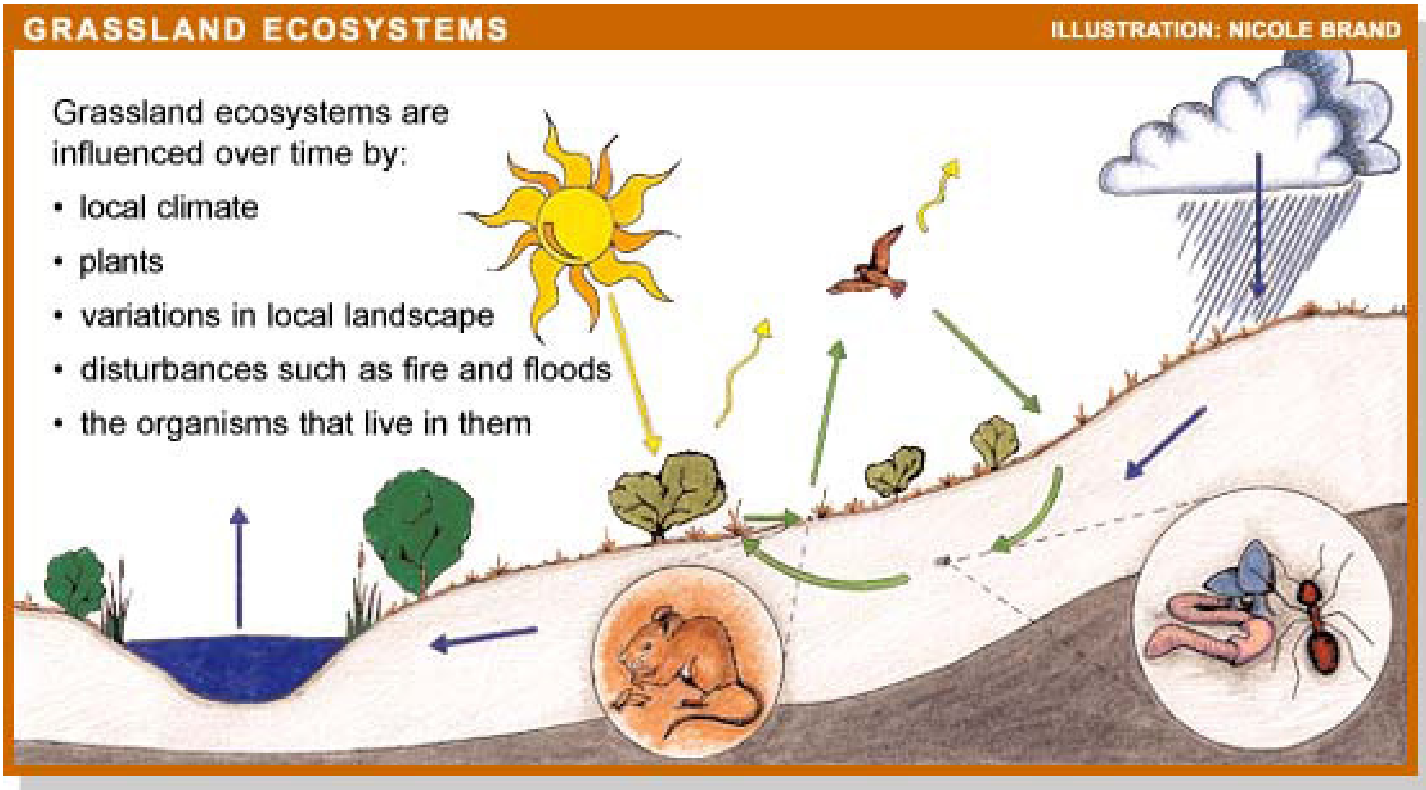
The Grasslands Conservation Council of British Columbia's mission is to:

- Foster understanding and appreciation for the ecological, social, economic, and cultural importance of BC grasslands.
- Promote stewardship and sustainable management practices to ensure the long-term health of BC grasslands.
- Promote the conservation of representative grassland ecosystems, species at risk, and their habitats.

&/OR
Acknowledgements for original author and illustrator

&/OR
Another message that it makes sense to include. Maybe the mission in simple language.

Grasslands Conservation Council of British Columbia. (Year). *Grassland Ecosystems in British Columbia*. Kamloops, BC: Author.



Grassland Ecosystems

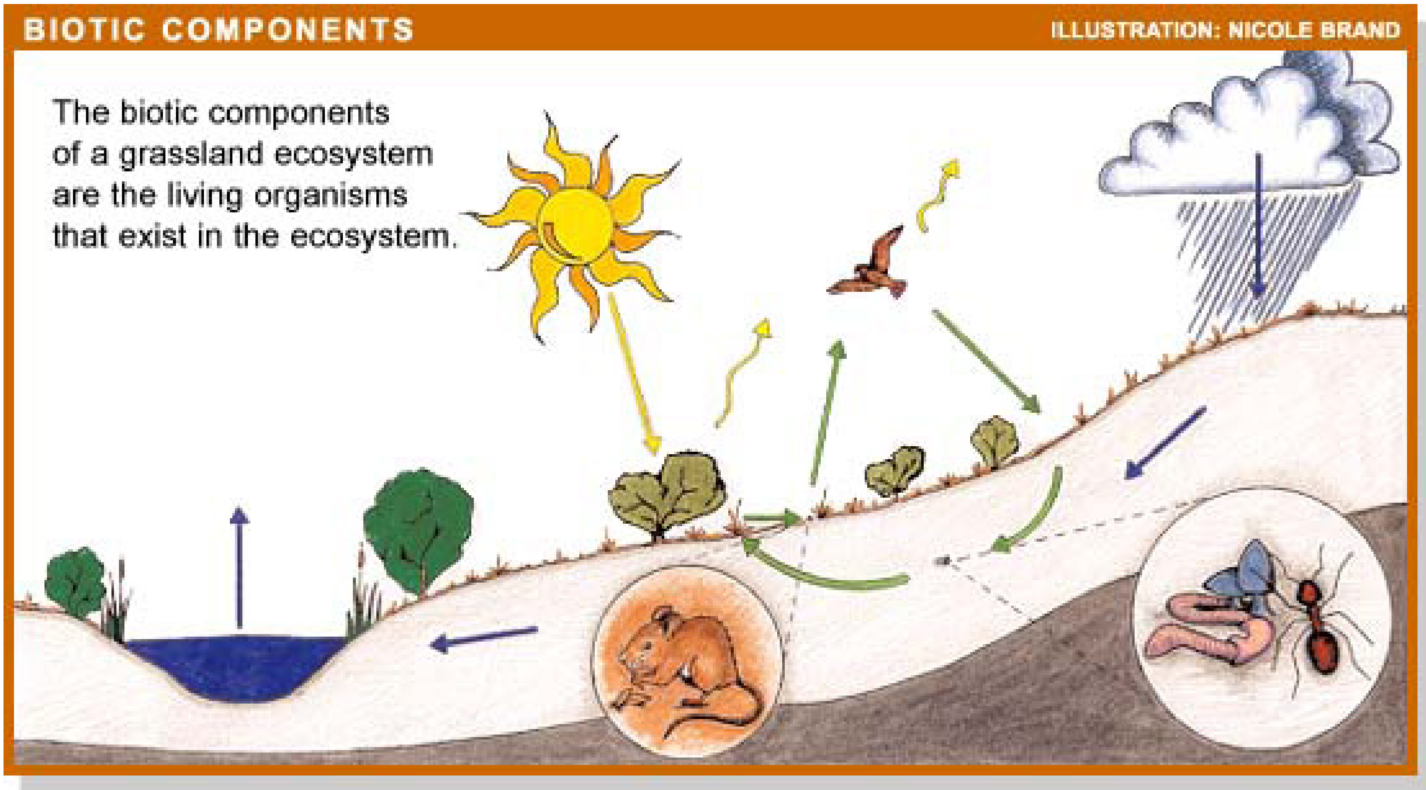
Ecological systems (ecosystems) consist of all the living organisms in an area and their physical environment (soil, water, air).

Ecosystems are influenced over time by the local climate, the parent material under the plants, variations in the local landscape, disturbances such as fire and floods, and by the organisms that live in them.

Grassland ecosystems in British Columbia generally occur in areas where the climate is hot and dry in summer and cool to cold and dry in winter. The parent material is often composed of fine sediments, and grasslands are most often in valley or plateau landscapes. The organisms that live in them include plants and animals that have adapted to the dry climatic conditions in a variety of ways.

Differences in elevation, climate, soils, aspect, and their position in relation to mountain ranges have resulted in many variations in the grassland ecosystems of British Columbia. The mosaics of ecosystems found in our grasslands, including wetlands, riparian areas, aspen stands and rocky cliffs, allow for a rich diversity of species.

Some grassland plants, such as grasses, have many long, fine roots to search for water at and just below the surface; others, such as big sagebrush, have long tap roots that penetrate deep below the surface to find water. Many animals migrate or dig burrows underground for protection and to avoid cold winter or hot summer temperatures.



Biotic Components

The biotic components of a grassland ecosystem are the living organisms that exist in the system. These organisms can be classified as producers, consumers, or decomposers.

Producers are able to capture the sun's energy through photosynthesis and absorb nutrients from the soil, storing them for future use by themselves and by other organisms. Grasses, shrubs, trees, mosses, lichens, and cyanobacteria are some of the many producers found in a grassland ecosystem. When these plants die they provide energy for a host of insects, fungi and bacteria that live in and on the soil and feed on plant debris. Grasses are an important source of food for large grazing animals such as California Bighorn Sheep, Mule Deer and Elk, and for much smaller animals such as marmots, Pocket Gophers, and mice.

Consumers are organisms that do not have the ability to capture the energy produced by the sun, but consume plant and/or animal material to gain their energy for growth and activity. Consumers are further divided into three types based on their ability to digest plant and animal material:

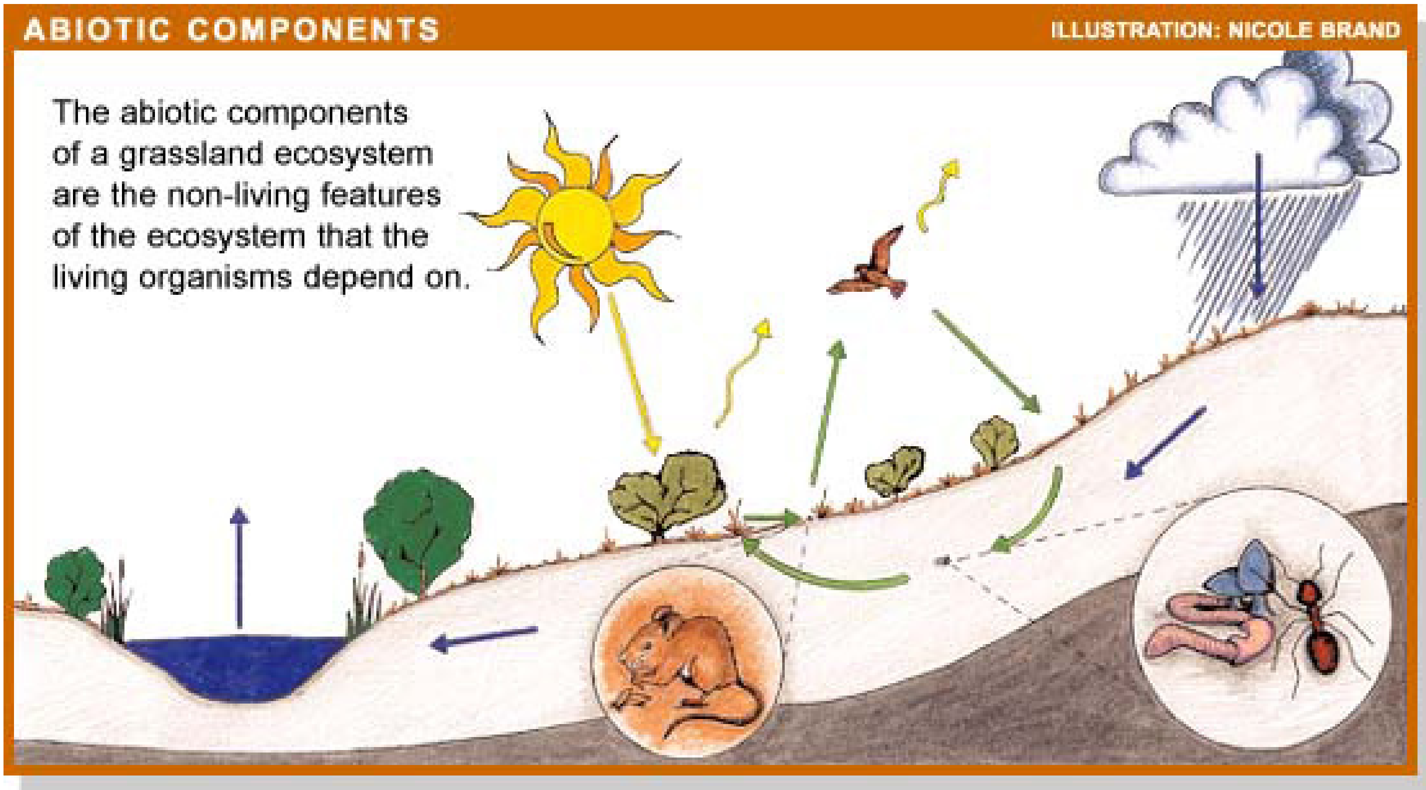
Herbivores eat only plants—for example, the elk that graze the grasslands of the Columbia Valley, or an insect nibbling on the leaf of a sticky geranium.

Omnivores, such as the black bear, eat both plants and animals.

Carnivores eat only animals—for instance, the red-tailed hawk or western rattlesnake.

Decomposers include the insects, fungi, algae and bacteria both on the ground and in the soil that help to break down the organic layer to provide nutrients for growing plants. There are many millions of these organisms in each square metre of grassland.

Soil has many biotic functions in a grasslands ecosystem. It provides the material in which plants grow, holds moisture for plants to absorb, is the "recycling bin" for plant and animal matter, and provides an important habitat for soil organisms. Soil is a vital link between the biotic and abiotic parts of a grassland ecosystem.



Abiotic Components

The abiotic components of a grassland ecosystem are the non-living features of the ecosystem that the living organisms depend on. Each abiotic component influences the number and variety of plants that grow in an ecosystem, which in turn has an influence on the variety of animals that live there. The four major abiotic components are: climate, parent material and soil, topography, and natural disturbances.

CLIMATE

Climate includes the rainfall, temperature and wind patterns that occur in an area, and is the most important abiotic component of a grassland ecosystem. Temperature, in tandem with precipitation, determines whether grasslands, forests, or some combination of these two, form. The amount and distribution of the rainfall an area receives in a year influences the types and productivity of grassland plants.

The climate in our grassland ecosystems is usually hot and dry in the spring and summer growing season, and cool or cold in winter dormant season. Precipitation in the winter falls mostly as snow rather than rain. During the hottest months of the year (the height of summer) more water evaporates from parts of the grasslands than falls as rain, creating a moisture deficit.

PARENT MATERIAL AND SOIL

Parent material is the geological material that lies on top of the bedrock and is the foundation on which soil has developed. Much of the parent material underlying BC's grasslands was deposited as the last ice sheets melted away. The actual composition of the material at any specific location depends on how and where it was deposited in relation to the ice. In the Rocky Mountain Trench, for example, some material was deposited under a moving glacier, while on the Chilcotin plateau some was deposited under a stationary ice sheet; in many places throughout the grasslands material was carried and deposited by water on, in, or under the ice.

The material dropped in place under the ice varies in thickness from a thin veneer to several metres, and contains all sizes of rocks and particles from boulders to silts. Rivers and streams that flowed on, under and beyond the ice left hummocky ridges of water-rounded materials of all sizes. Material deposited in ice-damned lakes formed layers of fine silts. Winds picked up fine particles and blew them across the newly ice-free land surface, depositing thick layers of the particles in some places. These wind-blown materials are called aeolian deposits.

Soil develops in the upper portion of the parent material and is a mixture of abiotic and biotic components: minerals, organic matter, water and air. The type of parent material in a particular area influences the texture of the soil, how well water flows through it, and hence the chemistry and nutrients of the soil. This combination of texture, water flow and chemistry determines the vegetation that grows in the area.

The fine silt soils found on the terraces of the Okanagan, Kootenay and Thompson valleys hold water near to the surface where it either evaporates or is soaked up by the dense fine roots of grasses; trees are not common in these areas. By contrast, in areas with gravelly soils water moves quickly down to depths below the grass roots to levels where tree roots grow. As such, more trees are likely to be found in these areas.

Grasslands have a rich layer of organic matter that forms the top surface of the soil. This layer has developed largely as a result of the breakdown of plant roots. Roots form as much as half the volume of a grass plant and up to 50% are replaced every year.

SOIL PROFILE

Grassland soils developed on the glacial till (C) deposited by the ice as it melted 12,000 to 10,000 years ago. These soils have a deep organic-rich layer (A) that results from the breakdown of the roots and plant material each year. The organic layer increases in depth with increases in elevation and moisture.

TOPOGRAPHY

Topography is the variety of shapes found on the landscape determined by slopes, elevation and aspects. The topography of grassland ecosystems is a varied landscape of gently rolling hills and prairies, rock outcrops, cliffs, gullies, and low lying areas. Diverse topography is what gives incredible variety to grassland ecosystems.

Aspect refers to the direction in which a piece of land is facing. Areas that face towards the south, or the sun, are hotter and drier than areas that face north, or away from the sun.

The **slope** of an area is the angle at which the land lies. Slope is important in our grasslands as water may run downhill rather than soak into the ground where it is available for plants. An area that slopes with a southern aspect will be much drier and hotter than an area that slopes with a northern aspect.

Elevation describes the height of land above sea level. Temperatures are generally cooler and rainfall is higher as elevation is gained.

NATURAL DISTRUBANCE

Natural disturbances change grasslands in many ways, adding to the diversity of these ecosystems. Some types of disturbance, such as annual flooding of riparian areas along rivers and streams, can be predicted while others, such as a fire after a lightning storm, happen unexpectedly.

Flooding occurs every spring in the riparian areas along the large rivers and lakes in the grassland areas of the province. The water comes from melting snow in the surrounding hills and mountains. The amount of water that flows down from the mountains and hills may rise very suddenly if:

- the snow is deeper than normal
- high temperatures cause the snow to melt very fast
- there are heavy rainfalls on the snow

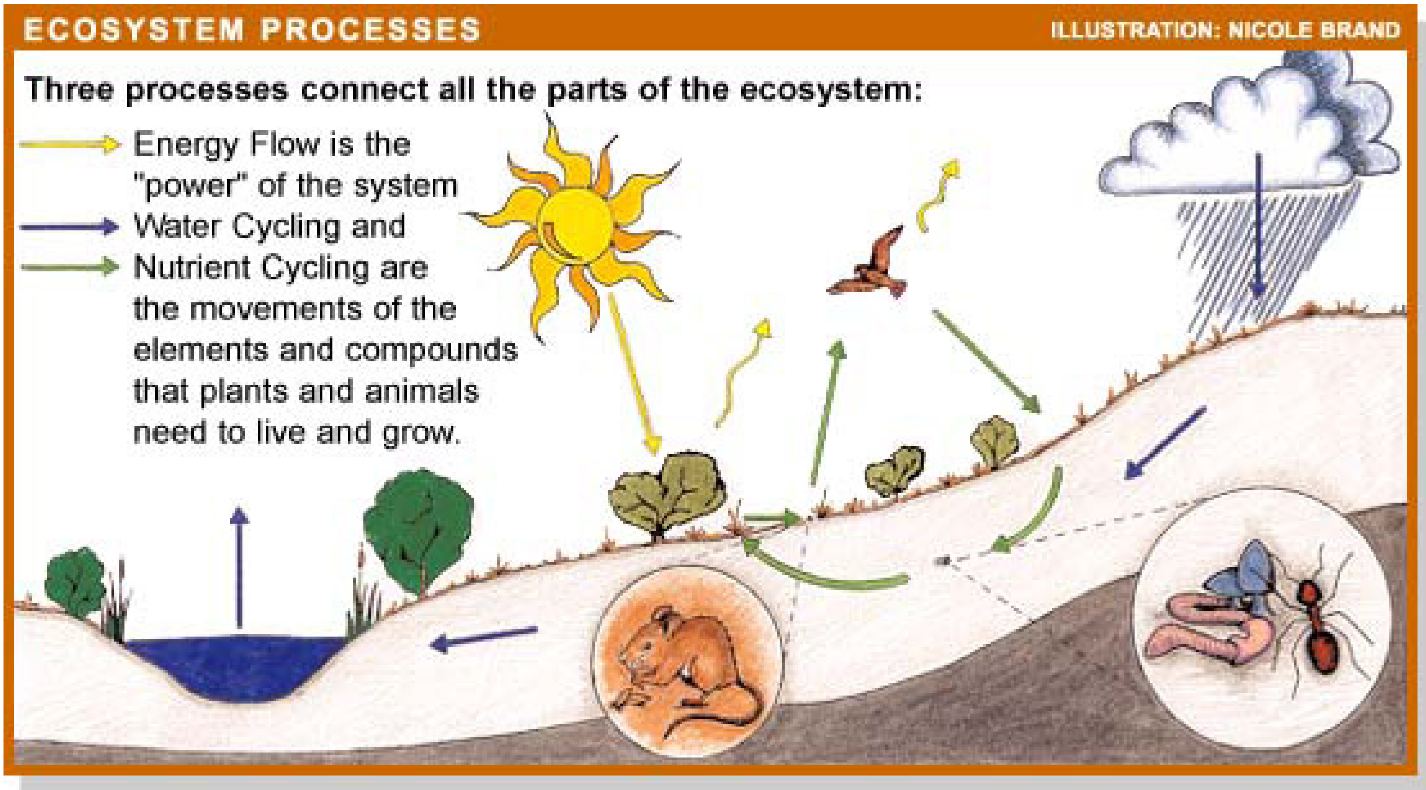
The flooding waters can alter stream and river banks and move soil, broken trees and shrubs downstream.

Lightning storms are a common sight on a dry summer evening in the grassland areas of the interior of BC. Trees struck by lightning can explode into flames, spreading fire to the trees around them and onto the surrounding grasslands. Small trees are usually killed, but shrubs, grasses and other plants are able to survive.

Most grassland grasses are in a dormant state before the heat of the summer when most lightning fires start. Grasses such as bluebunch wheatgrass, fescues, and needlegrasses start to regrow from the base and from underground parts as soil moisture increases in the fall. Many forbs, such as sagebrush mariposa lily, have underground bulbs that will sprout again the following spring. Shrubs may grow new shoots from unburned stems or underground parts. Mobile animals, such as California Bighorn Sheep, and animals in the soil usually survive, but those unable to flee or find cover may be killed.

The seeds of some plants actually need fire to grow. The thick bark of big ponderosa pine trees protects it from fire in two ways: by insulating the living part of the tree from the heat of the fire and by popping off pieces of bark as they catch on fire.

Fires are important for returning nutrients to the soil. Since grassland plants burn readily, fire spreads very quickly, and is thought to have been an important factor in maintaining the grasslands ecosystem.



Ecosystem Processes

ENERGY FLOW

Refer to the yellow arrows in the diagram to help you understand the way that energy moves through an ecosystem.

Energy enters an ecosystem in the form of heat from the sun. This energy is absorbed by organisms such as plants, and is then converted to other forms of energy and stored. Once stored, energy is used for necessary life functions, such as growth, movement and reproduction. Plants, animals and microorgnaisms release energy in the form of heat, for example through breathing and sweating. Energy is also released from an ecosystem during a fire.

Plants only capture about one percent of the energy that reaches the earth from the sun. In grasslands, that small amount of energy is used by the grasses and other plants, or producers. Some animals eat only these plants. Other animals eat both grasses and other plants, and animals, while yet other animals only eat animals. Animals are called consumers.

FOOD CHAIN

This movement of energy from producers to consumers is called a food chain.

Food chains are found in two parts of an ecosystem. The “grazing” food chain includes the producers and consumers that cycle energy from living plants. The “detritus” food chain cycles energy from non-living remains of both plants and animals (also called detritus).

The **“grazing” food chain** has a number of steps that start with the producers, or the plants, and flows through a series of levels of consumers. At each step only about 10% of the energy is passed up through the chain. The rest is passed back into the atmosphere as heat through breathing and decomposition.

In the first step plants convert the sun's energy to chemical energy through a process called photosynthesis. The chemical energy is stored both as food and as structural elements in the plant.

The next step involves the primary consumers, animals that eat only plants. In a grassland ecosystem this includes animals such as California Bighorn Sheep, Mule Deer, Elk, marmots, Pocket Gopher and mice. At step three are the secondary consumers, also called predators; these animals eat primary consumers. In a grassland ecosystem this includes a Coyote eating a mouse, a woodpecker eating an ant, or a frog eating an insect. At step four are the tertiary consumers that eat secondary consumers, and sometimes primary consumers as well. In a grassland ecosystem this includes a snake eating a frog.

The **"detritus" food chain** is a system where the energy produced by the breakdown of dead plant and animal matter is cycled into the "grazing" food chain. Detritus is organic matter formed by decaying animal or plant tissue, or fecal matter. Detritus eaters (or detritivores) such as insects, worms and other small organisms feed on dead plants, waste products from animals and dead animals. Decomposers are fungal or bacterial organisms that work within the dead material to help break it down, activating decay and decomposition. This important part of the ecosystem takes the last of the energy that was originally absorbed by the plants and returns it to the soil.

Carbon can be traced through the ecosystem in a cycle that is similar to the water cycle. Plants take in carbon in the form of carbon dioxide from the atmosphere through respiration. Through a process called photosynthesis, the carbon dioxide combines with oxygen to form carbohydrates that range from simple sugars to the complex carbohydrate cellulose, which forms cell walls. When plants are eaten the carbon is transferred to the consumers. As plant material is broken down in the digestive system of an animal, carbon is absorbed as a nutrient for use by that animal. It is released back into the atmosphere as carbon dioxide through respiration and through the decomposition of dead animals and fecal matter. Grassland fires also release carbon dioxide into the atmosphere.

WATER CYCLING

All organisms require both water and nutrients (food) to survive.

Where do the water and nutrients come from and how do they move around a grassland ecosystem? The water cycle is illustrated by the blue parts of the diagram.

Water exists in three forms: solid (ice and snow), liquid and gas (water vapour). Water is the vital link between the ecosystem and the weather or climate.

Water falls from clouds onto the grasslands as rain or snow.

Rain runs off plants and rocks onto the ground, where some water is absorbed into the soil. The rest runs over the surface of the ground and collects in low areas to form into wetlands, lakes and rivers. Finally, some water that reaches the ground is evaporated back into the atmosphere.

Snow, which is crystallized water droplets, may form a blanket over the grasslands during the winter. Snow undergoes similiar processes to rain when it reaches the ground. Some of it evaporates back into the atmosphere, and as snow melts, the water produced is absorbed into the soil, or runs over the ground into wetlands, lakes and rivers.

Plants take up some of the water contained in the soil through their roots. Other water that permeates (soaks through) the soil flows into wetlands, lakes, and rivers. The rest becomes part of the water table. The water table is water that remains in the soil, filling the pores between rocks and soil particles. Water is returned to the atmosphere as water vapour through evaporation and transpiration. Transpiration is a process performed by plants whereby water molecules leave the plant's surface through evaporation.

The water that reaches wetlands, lakes and rivers flows eventually to the ocean, with some of it evaporating along the way. Evaporation provides the moisture in clouds that condenses to form droplets of rain or snow. These droplets of water return to the earth as precipitation, and the cycle starts again.

The portions of grassland ecosystems that occur in low elevations and especially on south-facing slopes suffer from a water deficit during the hottest and driest months of the year. The amount of water that is released into the atmosphere through transpiration and evaporation is larger than the amount that falls as rain at this time of year. Grassland plants have adopted a variety of ways to survive under these difficult growing conditions.

Bright yellow sagebrush buttercups are some of the earliest flowers to be seen in the grasslands early spring. They start to grow before all the snow has left the grasslands, their shallow roots take advantage of all the water stored in the thawed upper layers of the soil. By the end of May the available moisture is well below the reach of the roots of the plants, and little remainsof the sagebrush buttercup but some dried out leaves.

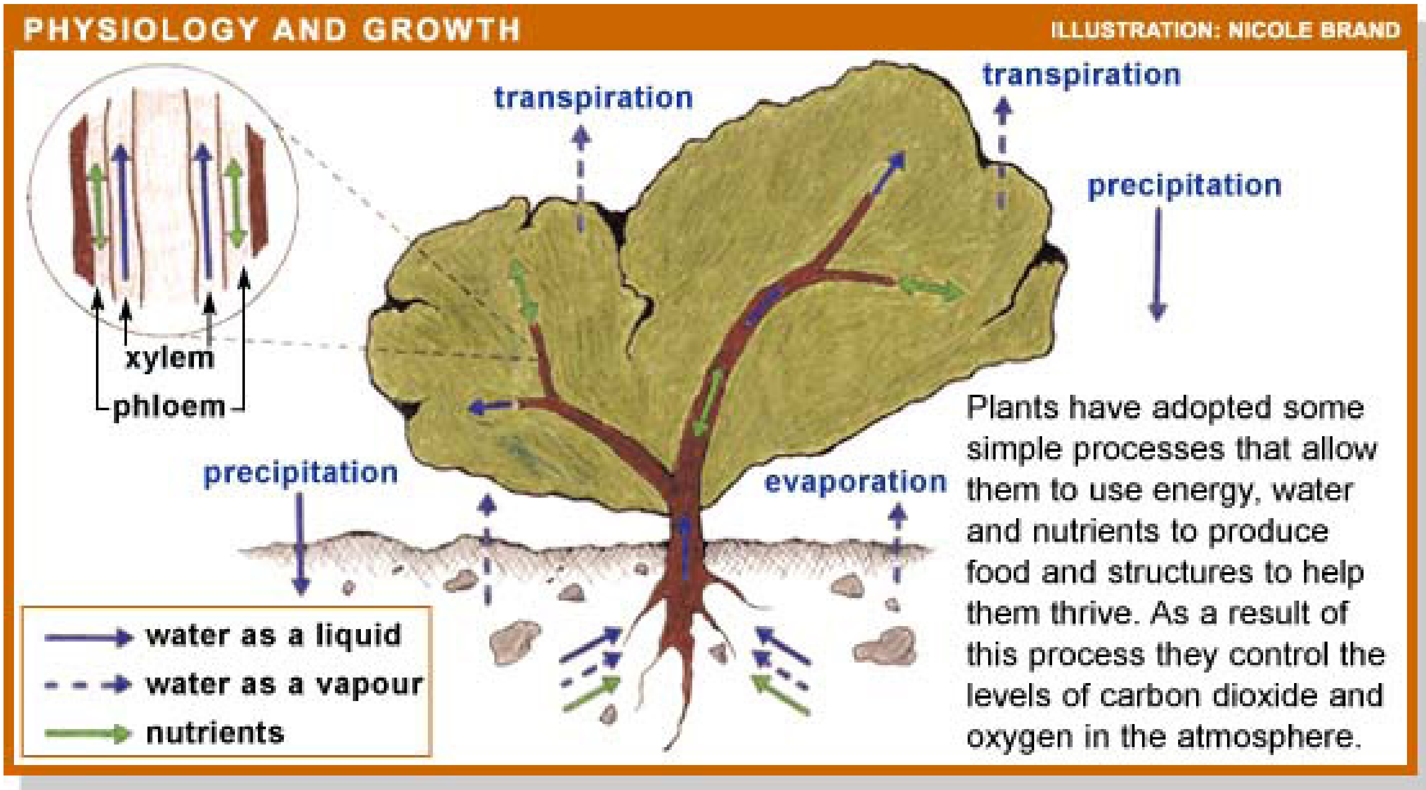
Plants such as low pussytoes and silky lupine start growing a little later in the spring and bloom before the summer drought begins. They may grow again as soil moisture increases after fall showers. Some of the bunchgrasses have a similar early growth habit but become semi-dormant during the summer drought. They put on a significant amount of growth when fall rains arrive. Deeply-rooted shrubs such as big sagebrush and rabbitbrush start growing later in the year and are covered with yellow flowers in the fall.

NUTRIENT CYCLING

The nutrient cycle follows the green parts of the diagram below.

All organisms need many nutrients, for food and for proper functioning, in order to thrive. Nutrients are found in the soil as the products of decomposition of dead matter, both plant and animal, and of waste materials such as animal feces and urine; dust; water runoff and erosion; and through weathering of rocks. They are also released from plants by fire and through nitrogen fixation by cyanobacteria.

Nutrients combine with water in the soil and are transported through the roots of the plant to those parts that need them. They are then passed through the food chain as the consumers eat the plants and each other. The final decomposition of both producers and consumers returns the nutrients back to the soil.



Physiology & Growth

Plants have adopted some simple processes that allow them to use the basic elements in the ecosystem, combine them in different ways, and use them to produce food and structures to help them thrive. As a result of this process they have a great impact on the levels of carbon dioxide and oxygen in the atmosphere.

Photosynthesis is the process by which plants make food in their leaves. On the under side of leaves are minute openings called stomata where carbon dioxide from the atmosphere enters the leaf. The cells of the plant absorb energy from the sun and the roots draw water from the soil. All those elements are combined with the help of microscopic green chlorophyll pigment within the cell walls of the leaves.

Food in the form of starches, fats and simple sugars (carbohydrates) is produced through complex chemical processes. Some is used immediately for growth and development of the plant, some combines with other nutrients to create compounds needed for plant health and structure, and some is stored for use at later stages of the plant's life.

Plants rely on stores of carbohydrates in their roots to maintain the plant over winter and for early stem and root development. Photosynthesis increases as leaves expand providing new stores of food for growth and reproduction in the summer. Extra demand is put on the plants' carbohydrate stores as they produce flowers and seeds in late summer.

Oxygen is essential to all life. It makes up about 20% of the atmosphere, is a component of the rain and snow that falls from clouds, and, along with carbon, is part of the basic structure of all living organisms. Oxygen is produced as a by-product of photosynthesis, passing out of the plant through the stomata and into the atmosphere.

WATER CYCLING AND REQUIREMENTS

Water is needed for plants to carry out the process of photosynthesis. An internal "plumbing" system of minute "pipes" links the veins in the leaves to the roots of the plant. A small amount of water is absorbed by the leaves themselves. Xylem cells carry the water from the roots out to the leaves and phloem cells take food back through the plant. Water not needed for photosynthesis evaporates from the stomata in the leaves. This evaporation process is called transpiration.

In hot, dry weather plants may lose more water through transpiration than can be found from the soil by the roots. Plants wilt when there is not enough water to perform photosynthesis and to keep the cells of the plant healthy.

Grassland plants have adapted to the stress of living in hot, dry conditions in many ways: some plants, such as rabbitbrush and arrow-leaved balsamroot, have pale-coloured leaves that reflect the sun and also have fine white hairs all over their surface that reduce windspeed across the leaves and reduce transpiration. Some plants, such as yellow bells, start growing before the snow has completely melted in spring and have completed their life cycle before the hottest and driest weather arrives. Yellow bells is one of many plants in the lily family found in grasslands; they survive through the summer drought and winter cold as an underground bulb. Annual plants such as small-flowered blue-eyed mary survive the drought as seeds. Some bunchgrasses are dormant through the summer months but begin growing again with fall moisture.

The long blades of bluebunch wheatgrass curve gracefully up and away from the centre of the plant and direct rainwater down into the centre of the plant towards the roots. The many long, fine roots fill the surface soils, capturing water before it can penetrate to the lower layers of the soil.

NUTRIENT CYCLING AND REQUIREMENTS

Nutrients are absorbed from the soil through the roots of the plant and taken by the xylem and phloem cells to the parts of the plant that need them.

Three nutrients are especially important: nitrogen, phosphorous, and potassium

Nitrogen is an important component in the proteins and genetic material of all organisms. It also cycles through the ecosystem. Nitrogen is released when organisms decompose and enters into the soil and the atmosphere. Some nitrogen is also produced by cyanobacteria and by lightning strikes. Plants take up nitrogen through their roots and it is passed to the consumers through the food chain.

In grasslands lichens with cyanobacteria and other free-living cyanobacteria in the cryptogamic crust play an important role in fixing nitrogen.

Phosphorus is an important component of the internal energy system of all organisms. In plants it is an essential part of the processes of photosynthesis, flowering, and root growth.

Potassium is an important component of the water circulation system in plants and of the nervous and circulatory systems of grazing animals.

Other important nutrients include: sulphur, iron, calcium and magnesium.