

THE CLEAR WATER MUSKETEERS

CHAMPLAIN COMPANY



Guide for **Mister**
Aramis' Musketeers

THE AQUATIC
ECOSYSTEM GRADE

Guide for Mister Aramis' Musketeers

Aquatic Ecosystem Grade

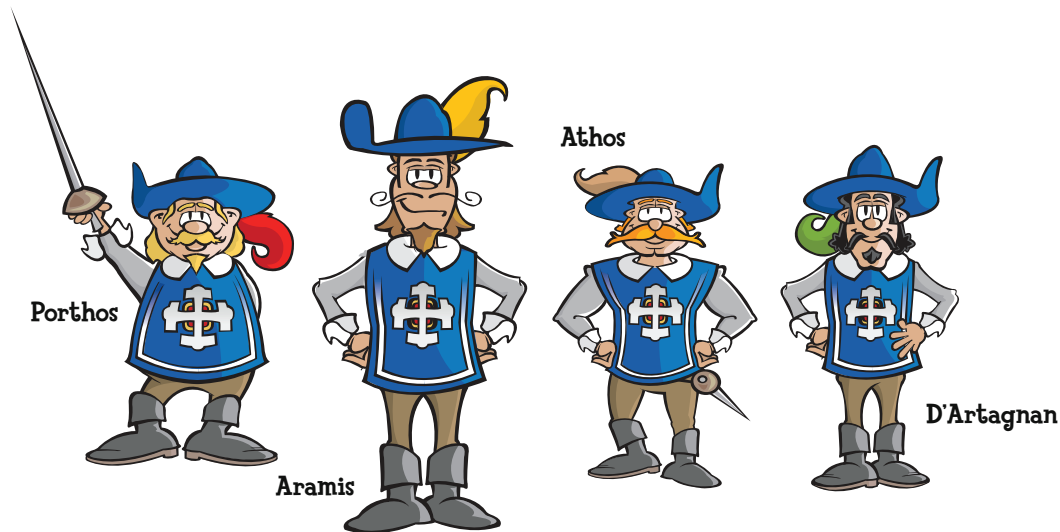
The Clear Water Musketeers are in charge of water protection in their community. As part of their training, Clear Water Musketeers must complete the aquatic ecosystem grade, represented by Mister Aramis. To accomplish a mission, Aramis would gather information just like a detective. He had many social acquaintances who would tell him various secrets. When he had a problem or puzzle to solve, he liked to go on nature walks to think. Aramis' Musketeers will follow his example to discover the secret relationships among organisms living in various aquatic environments.

There are three other grades in the Clear Water Musketeers program:

The Basin Grade: Mister Porthos' musketeers learn about the land through which the rivers flow.

The Water Usage Grade: Mister Athos' musketeers learn how various kinds of human activity affect the quality of water.

The Water Treatment Grade: Mister d'Artagnan's musketeers learn how to find solutions to reduce water pollution.



The four musketeers were featured in a story written by Alexandre Dumas in 1844: their names were **Aramis**, **Porthos**, **Athos** and **d'Artagnan**. They lived in the 17th century, from 1610 to 1670.

Name: _____

School: _____

Class: _____

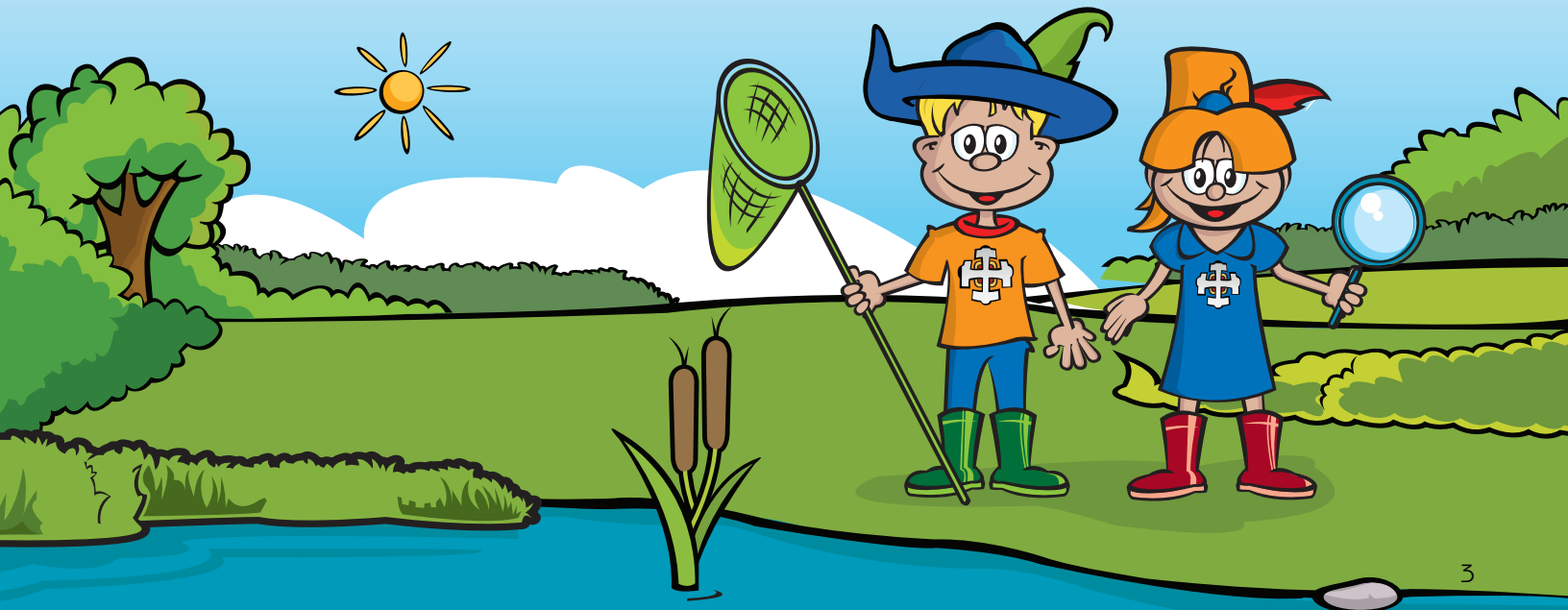
The Aquatic Ecosystem

To get a good idea of what makes up an ecosystem, think of an electric system. First there is a factory that produces electricity; then, a network of electric wires carries the energy to people's homes. Finally, there are electric devices that have to be plugged into the network to get the energy they need to work. These elements make up the electric system. In other words, a system is composed of a series of elements that are all connected to each other and that work together.

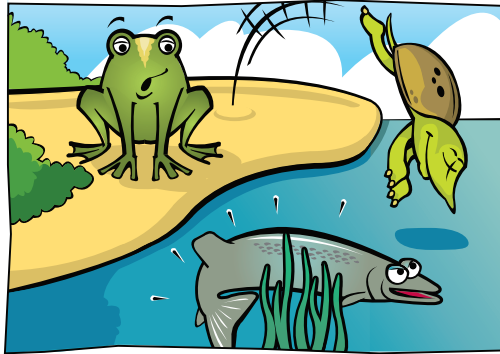
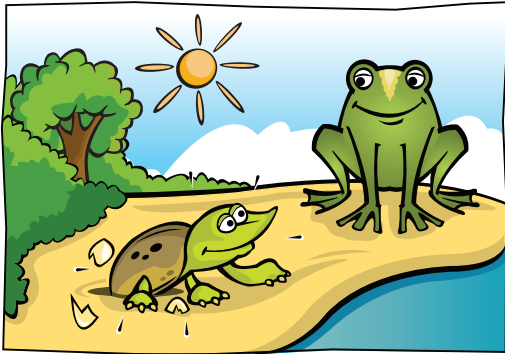
The ecosystem is a biological system that looks like an electric system. The factory that produces energy is the sun. The sun's energy fuels the biosphere, that is, the surface of the earth where organisms live. Plants receive this energy and use it to grow plant tissue. This energy then circulates through the food web: herbivores eat the plants, carnivores eat

other animals, and human beings eat a bit of everything. There are no wires in this system, but there are invisible ties connecting all living organisms. That is the secret of the ecosystem!

To understand the relationships among organisms living in the aquatic ecosystem, we need to find out how energy circulates and what the nutritional components are. In addition, organisms establish relationships with their living environment in order to define areas for feeding, shelter, travel, reproduction, raising their young and even recreational activities! Aqualine and Rivero will help you discover the secrets of aquatic ecosystems. You will also learn about the evolution of the Missisquoi Bay ecosystem by following the story of a young turtle named Shelley.



Shelley Discovers the Bay



The sun has just risen. Already, its hot rays are heating up the sandy beach. In the early morning stillness, cracking sounds can be heard. A little head with a pointed snout pokes up through the sand. Is it a tiny mole? No! It's Shelley Softshell, a little turtle full of life. A dozen of her brother and sister turtles soon follow. Their wrinkled eyes open wide as they discover a beautiful bay before them. Its clear water looks cool and refreshing! Without waiting for anyone else, Shelley takes off at a run and dives head first into the blue water of the Missisquoi Bay. She sees all kinds of strange animals, from tiny transparent organisms to large, long beasts that continually open and close their mouths. "Careful, Big Pike has seen you!" This warning comes from Pippa the green frog, a bay regular, who is hiding among the water lilies of the grass bed. The two quickly become friends and go off to discover a whole assortment of species of aquatic plants, invertebrates and fish, as well as shoreline birds, of which they need to be careful—especially the great blue heron, with its beautiful blue-grey feathers.

After spending a few years in the bay with her friend Pippa, Shelley feels the need to go on a trip. She has found out that several other turtles are going to

hibernate in the United States, and so she decides to go with them to broaden her horizons. Excited, Shelley says good-bye to Pippa, who cannot follow her, and swims frantically all the way to the Alburg-Swanton Bridge in Vermont. What a fabulous voyage! On the way, she

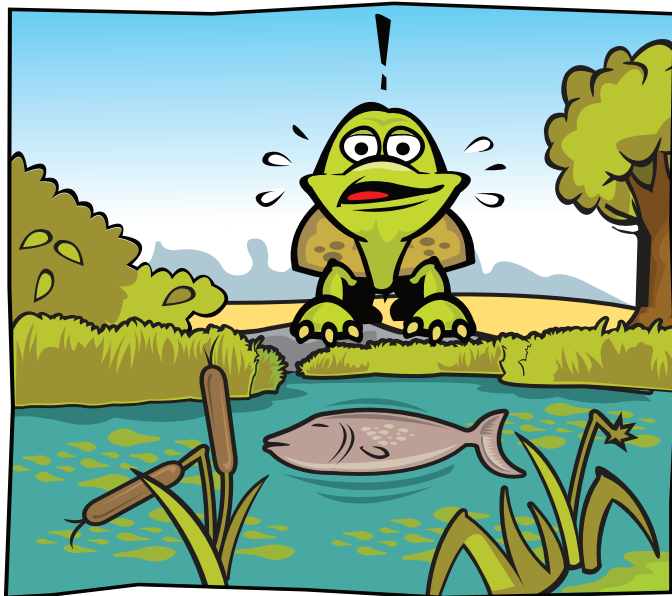
meets Sheldon, a male turtle who plays the trumpet to charm her. When they arrive at their destination, the two friends decide to form a music group while waiting for the great sleep of winter, under the ice, in the mushy sediments at the bottom of Lake Champlain. In the spring, all the turtles wake up and prepare to go back to the Missisquoi Bay. "No, no, stay with us!" plead the other members of the band. So Shelley and Sheldon remain in Vermont, tumbling through the water and playing music on the beaches, for several years.

Draw a group of musical turtles at the bottom of the water.



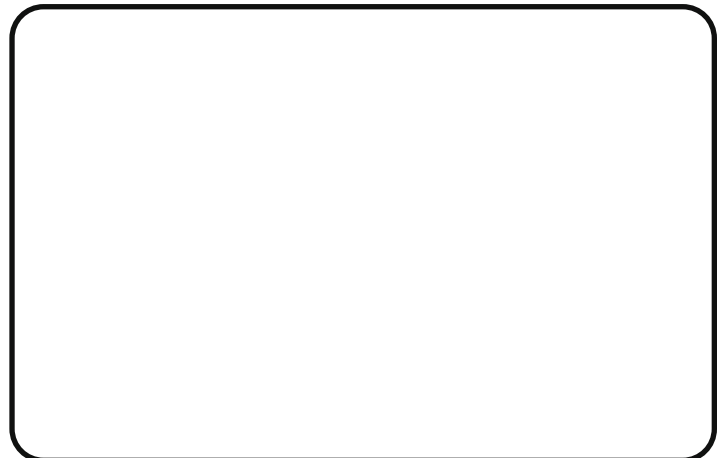
Shelley Returns to Quebec

But spring of the year 2006 is approaching, and Shelley and Sheldon are already ten years old. They miss their country. The two turtles poke their heads out of the water, stretch their necks, look towards Quebec, and suddenly have the same idea. "Friends! Let's do a musical tour of Quebec!" So they all head for Pike River. When they arrive in the Bay, Shelley is shocked that she cannot see anything properly, as if all the animals had become blurry. "Quick, dive!" She shouts to Sheldon. Vrooommm...! A Sea-Doo whizzes past and then rides off, bouncing over the water in all directions. "Could that have been Big Pike, who has grown and gone insane?" wonders Shelley, who does not understand what is going on. She realizes that her American friends have scattered, since they could not see each other any more. But Sheldon stuck close to her, and so the two make their way to the edge of the water. They paddle through the silt, which is thicker than it used to be and smells of recently rotted fish.



Near the mouth of Pike River, she meets an old friend. "Pippa, I'm back, and this is Sheldon! But the water is green and we saw fish that were sick. Can you tell us why?" It's not Pippa, but her daughter, Phebe, who looks just like her. Phebe explains sadly that the water in the Bay has deteriorated because of the contaminants coming from the rivers, the streams and even the houses all around. "It's no joke! And just wait, this summer there will probably be a sticky blue-green film covering the surface of the water again. Oh, it's awful!" "This has to stop," says Shelley, pushing Sheldon toward the shore. "Let's get out of here so that we can breathe." The beach is empty. In fact, there is not really a beach anymore. Just a low stone wall with a bit of vegetation. "Let's hide to protect ourselves and think!" suggests Sheldon, who can no longer take this depressing view. He sees people at the edge of the water, but no one is swimming like they used to. There are no more children laughing. What happened?

Draw Shelley and Sheldon talking with Phebe the frog at the edge of the water.



Shelley Takes Action

Shelley and Sheldon are lying in the sun on the stones at the foot of the low wall. Suddenly, there is movement in the bushes behind them. They see a boy and a girl with huge eyes that reflect the sun's rays. It's Aqualine and Rivero, observing them through binoculars. "Oh, what beautiful spiny softshell turtles! We shouldn't scare them!" warns Rivero. Surprised, Sheldon cries out with his trumpet beak: "Halt! Who goes there?" Hardly believing her ears, Aqualine responds. "We are Clear Water Musketeers and our mission is to take notes on the aquatic system." "Indeed!" replies Sheldon. "Why is it that in the last ten years, the Bay has become so inhospitable?" Aqualine and Rivero tell them about the effects of water pollution on the aquatic ecosystem. "All the creatures are suffering, even human beings! Our motto is All for water and water for all!" exclaims Rivero.

Shelley offers to help them. "We would like to live here and start a family. But things have to improve. Why don't we patrol the Missisquoi Bay for you, as well as Pike River and the streams and wetlands? We'll take note of the problems and then you can find solutions."

The American turtles have joined them but do not feel reassured. They climb a sunken tree trunk. "Well if you're going to lie there and sunbathe, why not play us something to cheer us up?" suggests Shelley. Phebe the frog comes jumping over and joins in with her pretty voice. The mussels at the bottom of the water tap the beat by snapping their



valves. And that is how Aqualine, Rivero, Shelley and Sheldon formed a team to protect the water in the Missisquoi Bay basin. The American turtles went home to form water protection teams for the Missisquoi and Rock rivers, too. With time and lots of work, the quality of the water is improving and the quality of life too.

All for water and water for all!

The Missisquoi Bay of Lake Champlain

The Missisquoi Bay forms an aquatic ecosystem that houses many living organisms, both plants and animals. On the banks are tall, stately trees that create shade and cool the air—silver maple, red ash and black willow. There are also smaller, bushy shrubs. Many produce berries on which a number of songbirds love to dine, including the soft-feathered cedar waxwing. On the banks, the cover of herba-

ceous plants is the ideal habitat for various amphibians and reptiles such as the leopard frog and the painted turtle. Many mammals also live on the shore, including raccoons, the red fox, voles and even moose!

In the shallows, rushes form tall grass beds, which are home to many kinds of insects. Swallows hunt them during the day, and bats, at dusk. The other plants of the grass beds, such as water lilies and eel-

grass, serve as hiding places not only for little fish and frogs, but also for the northern pike that lie in wait for them, and the great blue heron. The sediment at the bottom of the water is home to small organisms such as worms, insect larvae and mussels.

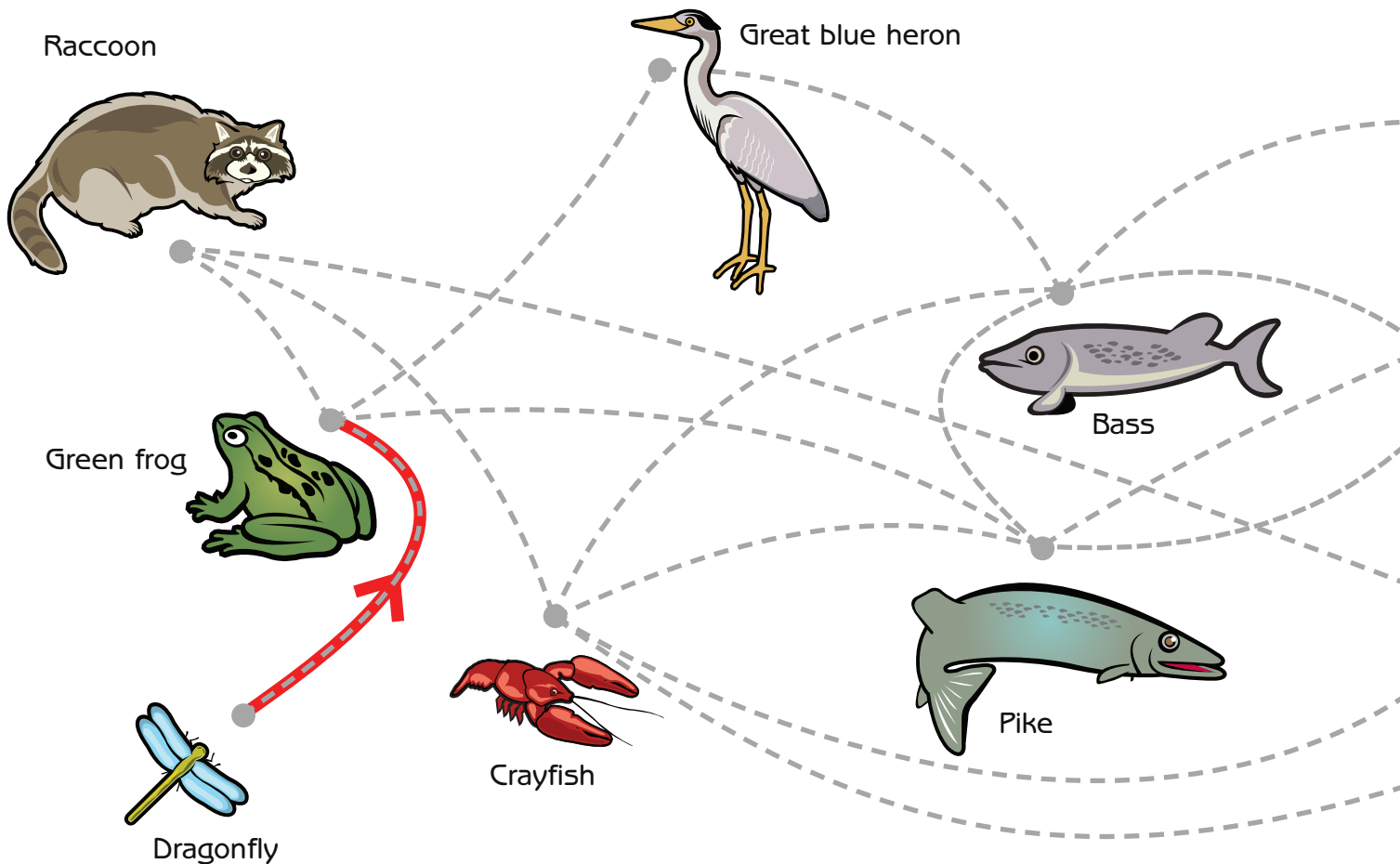
The water also contains tiny little organisms that form plankton. Phytoplankton includes microscopic plants and algae, while zooplankton is made up of tiny animals with funny names: copepods, rotifers, daphnia, artemia.



The Food Web

The Missisquoi Bay contains about thirty different species of fish. There are also many aquatic birds, especially during the migrations of snow geese and Canada geese in the spring and fall. There are about twenty species of aquatic plants, many insects in the grass beds, and invertebrates in the sediment. It is

impossible to illustrate all the relationships between these organisms in a single diagram of the food web, so we have to restrict ourselves to a few species. The dotted lines represent the links between predators and their prey. You will complete them by drawing arrows from the food to its consumers.



Grades 1 and 2

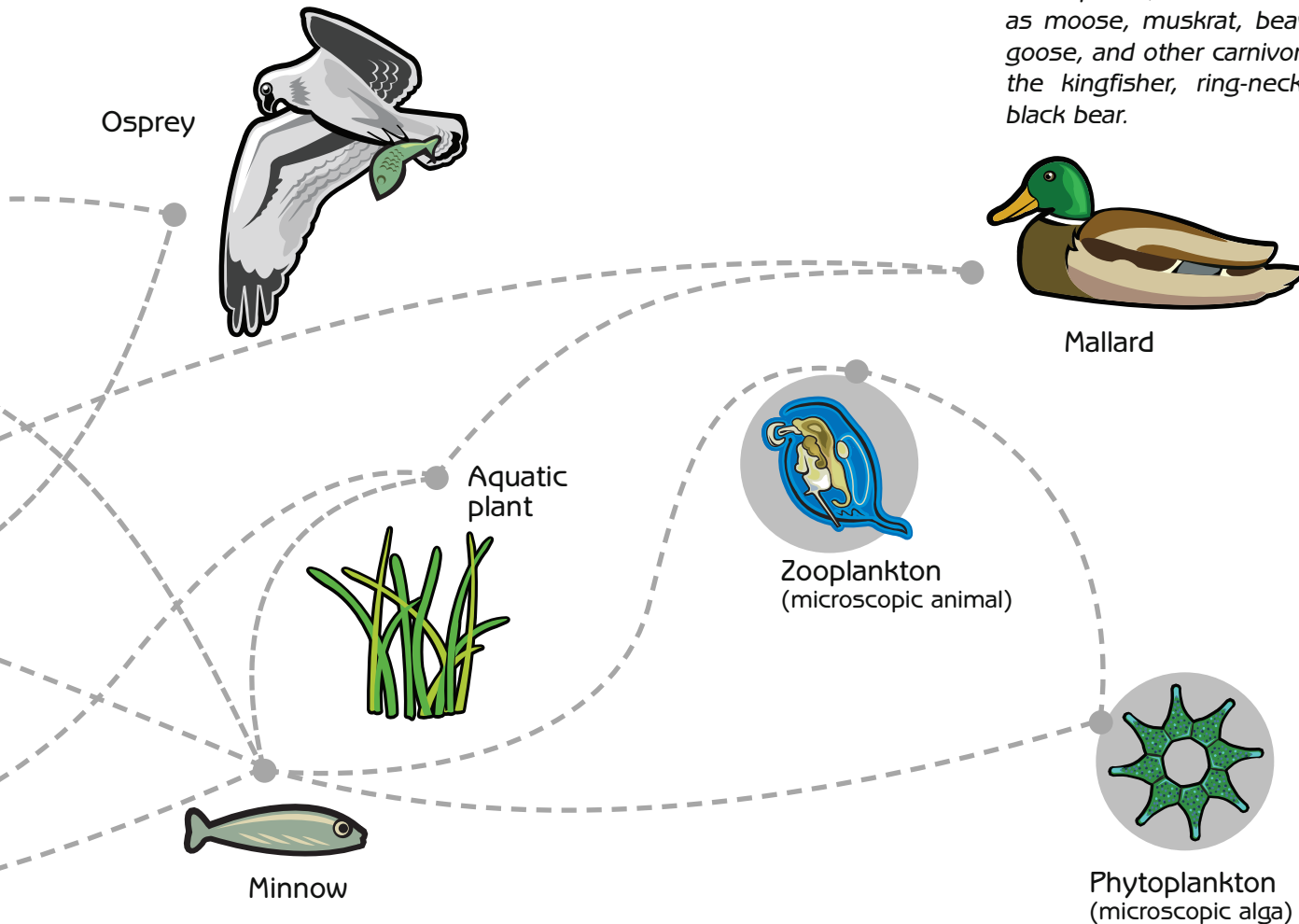
Fill in the dotted lines between the plants, the herbivores (animals that eat plants), and the carnivores (animals that eat other animals).

Grades 3 and 4

Draw green lines over the dotted lines between the herbivores and the plants and red lines between the carnivores and their prey. Add arrows going from the food to its consumers.

Grades 5 and 6

Add arrows going from the food to its consumers. Add other plant species to the drawing, such as aquatic plants, herbaceous plants and shrubs. Complete the network of arrows with other plants, other herbivores such as moose, muskrat, beaver, Canada goose, and other carnivores, such as the kingfisher, ring-neck duck and black bear.



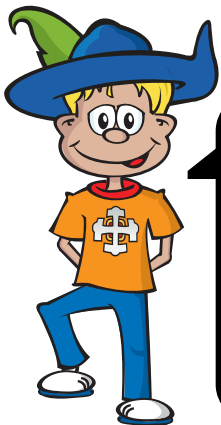
The Missisquoi Bay Ecosystem

The aquatic ecosystem of the Missisquoi Bay includes bacteria, plants and animals. Bacteria are needed to break down the remains of dead organisms such as leaves and animal waste. This activity is called biodegradation, and it is very beneficial to the ecosystem. But some bacteria can cause human beings to get sick. That's why you should never drink water directly from a lake or stream. Plankton is an important source of food for many species: insects, mollusks, crustaceans and small fish. Worms and insect larvae in the water or in the sediment at the bottom of the water are also excellent food, at the bottom of the food chain. Without them, there would be no life in the lakes and waterways.

When everything is going well, the ecosystem of the Missisquoi Bay is in equilibrium. There is an exchange of energy, water molecules, oxygen, carbon dioxide and nutrients in all components of the aquatic habitat. On the shore and in the water, the plants capture the sun's energy and use photosynthesis to transform the carbon, water and nutrients from the ground into plant tissue, so that they can grow.

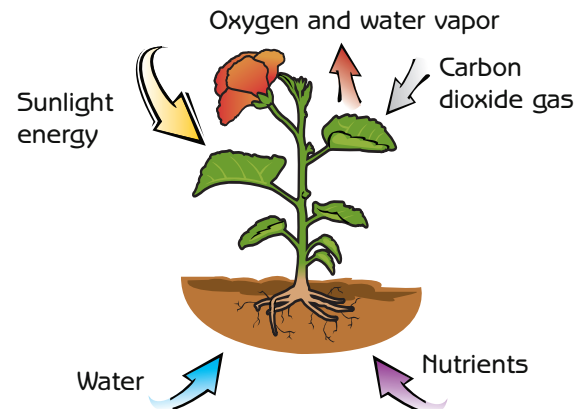
The roots of the plants living on the banks penetrate the ground and hold it in place. The dead leaves decompose on the ground thanks to the bacteria and mushrooms, which transform them into humus, the food of invertebrates such as worms, slugs and snails. These organisms liberate the nutrients into the ground, where they are captured by plant roots. These decomposers are also food for small mammals such as the shrew and star-nosed mole.

When something throws the system off, things go badly! If conditions in the Missisquoi Bay change too rapidly, the animals cannot survive. The food web is broken and energy does not circulate properly through the ecosystem. This can cause several species to disappear. If there is no more vegetation on the banks, all the shoreline animals will leave. Poor water quality will harm the fish and, consequently, all the animals that feed on them. The Missisquoi Bay will no longer be a good living environment for human beings either.



Photosynthesis forms the basis of the food chain. Leaves capture the sun's energy using chlorophyll, their green pigment, as well as carbon dioxide. The plant then transforms the carbon from this gas into plant tissue (organic matter) using the water and nutrients brought up from the ground by its roots.

Photosynthesis Diagram



The Pond: a Flower-filled Nursery

A pond is a small body of water bordered by lush vegetation. It is a rich living environment, ideal for raising one's young. Around the pond are several kinds of plant belts. The land belt of trees and shrubs provides shade and cool air to numerous animals, especially the raccoon, eastern cottontail, voles and moles, songbirds and the blue-spotted salamander. If the pond was created by a beaver dam, it will contain his favorite food, tree bark, from balsam poplars, birch, silver maple and speckled alder. Fruit-feeding birds delight in the shrubs (dogwood, arrow-wood, chokecherry and elderberry), while the wood duck and green-backed heron nest in the trees.

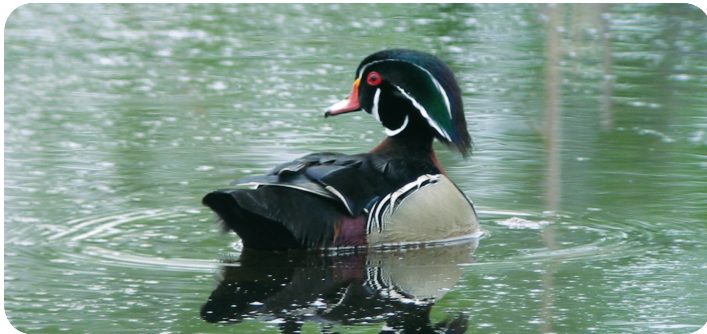


Photo: Jean-Guy Papineau

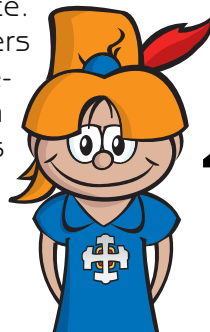
Wood duck

The rush belt includes tall herbaceous plants that love dangling their roots in the water: bulrushes, rushes, cattails, bur reeds, horsetails and wild rice. This beautiful green and yellow belt filters the waters and protects the banks against soil erosion. It creates a visual screen that shelters amphibians such as the leopard frog and the spring peeper, reptiles such as the painted turtle and common garter snake, as well as the muskrat, a rodent that likes

to eat aquatic plants. Damselflies and dragonflies flit and twirl about, joined by red-winged blackbirds and marsh wrens.

On the shoreline, in front of the rushes, is the aquatic plant belt, whose roots dig into the sediment. These grass beds hide many insect larvae (dragonflies, mosquitoes and ephemeras) and a host of frog and fish eggs. Aquatic plants are a delicacy to many of the ducks and their flowers also attract butterflies: the white flowers of the arrowhead, the blue of the pickerelweed, the pink of the flowering rush, the yellow of the water lilies, and the violet and yellow flowers of the blue flag iris, Quebec's floral emblem.

Larvae and eggs serve as food for the small fish and aquatic insects such as whirligig beetles, those little coleopters that twirl around on the water's surface. The water contains lots of plankton as well as invertebrates such as freshwater shrimp and snails, which are decomposers. All these little organisms living in the pond make up the food that helps fish to grow: minnows, yellow perch, pumpkinseed, brown bullhead and pike. Food is quite abundant and varied for the families of aquatic birds: blue-winged teal (seeds from aquatic plants), ring-necked duck (invertebrates and small crustaceans), and pied-billed grebe (snails, insects).



Dragonflies keep their wings open when they're at rest, while damselflies fold them up. Tree frogs have adhesive pads on the tips of their toes, but not tree frogs.

The River: a Whirlpool of Life

Going down the river, there is great biodiversity. At the start of its path, in the wooded zone, the river is narrow and its water clear and cold (10°C). The bottom is covered with clean stones, making excellent spawning grounds for fish to lay their eggs. This is the domain of brook trout and salamanders. Because the water flows very fast, there are no aquatic plants growing here, and insects cling to the stones. Some insect larvae are covered in coats of little wood pieces or stones to make them heavier and keep them stable. The rocks and wood debris in the river make good shelters for the aquatic animals. Beautiful songbirds gather at the edge of the swirling water, including the Northern waterthrush and the warbling vireo.

hide among the stones. This is the preferred area for animals and birds that fish: the river otter loves the crayfish, the common merganser goes diving, the spotted sandpiper searches the shoreline and the kingfisher builds his nest in a burrow! You can find painted turtles gathering to sunbathe on fallen branches close to the shore, and wood turtles hiding in the vegetation.

In the lower course, the current is weaker and the river takes wide turns, forming meanders. The water may overflow from the riverbed in the spring and fall, into the floodplain. When the banks are protected, there are tall black willow, ash, silver maples, alder and large ferns. Birds are still plentiful, especially the alder flycatcher, the Baltimore oriole and the common yellowthroat. The water is brownish and warm (20°C), and aquatic grass beds grow from its silty bottom, hiding insects, fish and wading birds. This is the domain of the northern pike and great blue heron. And watch out for the big snapping turtles hiding amid the vegetation! Approaching the river mouth, the water flows into a larger river or a lake, leading to other types of aquatic habitats.



Photo: CBVBM

Pike River in Bedford

In the middle course of the river, the water volume is greater, but the flow is slower. The water is warmer and not as clear, and the bottom is made up of sand and gravel. Algae cover some of the stones, and aquatic plants take root in the sand. Invertebrates swim among the plants and crayfish



In a meander, the strong current digs into the bank on the outside of the curve (concave), causing it to erode. On the opposite bank (convex), the current is slower, and materials accumulate: sand, gravel, wood, plants, and all kinds of debris.

The Marsh: a Mysterious Filter

The marsh is a type of wetland that is completely covered by herbaceous plants and some shrubs, but no trees. This wetland filters the water, improving the quality. The vegetation and water that accumulate over the soil are very mysterious. Only the animals find their way around them easily. On foot, you might sink into the waterlogged ground, and in a canoe, it's easy to get lost. That's why you should never go into a marsh alone.

The animals blend into their surroundings so well that it's easier to locate them by their call, which can sometimes be surprising. The bittern is a small wading bird that stretches its neck to hide among the rushes. It has a particular thumping call, going "glug, gu-glug," as if someone were emptying a large bottle of water. The common moorhen walks on leaves with its long toes. In the Missisquoi Bay area, the least bittern, a very small heron, clings to the stems of cattails. Aquatic birds take shelter in the tall grasses to nest peacefully. Some species like to dine on eelgrass, pondweed and duckweed floating on the water surface: Canada goose, wood duck, American black duck, mallard, teal, bluebill and coot. Others prefer to fish for insects, snails, amphibians and small fish: golden-eye, grebe, bittern, green-backed heron, black-crowned night heron, Virginia rail and snipe. Birds of prey, such as the osprey and Northern harrier, fly over the marsh.

Marshes are the kingdom of amphibians and reptiles: yellow spotted salamander, American toad, spring peeper, leopard frog, pickerel frog, green frog, bullfrog, snapping turtle, painted turtle, garter snake and Northern water snake. Mammals come



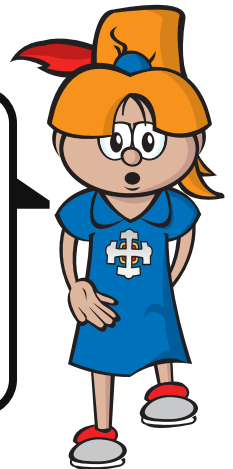
Photo: CBVBM

Bullfrog

here too. Moose can spend the entire day feasting on aquatic plants and may cross paths with the white-tailed deer, porcupine or even a black bear. Carnivores visit the marsh to hunt and fish: ermine, weasel, mink, otter and bobcat. They like to eat voles, shrews or jumping mice, as well as frogs, insects and fish.

Marshes can be found along rivers, lakes and even ponds. There are other types of wetlands as well. A swamp is a marsh with trees such as silver maple and ash. Peat bogs are swamps dominated by sphagnum, also called bog moss.

Did you know that peat bogs have carnivorous plants? The purple pitcher plant traps and drowns insects in its tube-shaped leaves, while the little pink sundew captures insects with its sticky hairs.



Glossary

Alga

Single-celled and sometimes microscopic primitive plant without roots, stem or leaves.

Amphibian

Cold-blooded vertebrate (animal with a spinal column) with permeable skin, living in water and on land, but whose larvae live in the water when they hatch. Examples are frogs and salamanders.

Bacterium

One-celled micro-organism.

Biodegradation

Natural decomposition of dead organic matter.

Biodiversity

Synonym of biological diversity, that is, the diversity of animal and plant species in an ecosystem.

Crustacean

Animal that lives in water, having two pairs of antenna and forked feet, such as shrimp and water fleas (daphnia).

Erosion

Wearing away of the soil, caused by water, wind and some human activities.

Grass bed

Colony of aquatic plants along the shoreline.

Hibernate

When an animal spends the winter in an inactive state, usually in a hiding place, such as a burrow.

Invertebrate

Animal without a spinal column.

Larva

Stage in the development of some animal species before they become an adult. For example, the caterpillar is the larval stage of the butterfly.

Mammal

Warm-blooded animal covered in hair and whose young suckle on the mother's milk, such the beaver or fox.

Mollusk

Invertebrate with a soft and non-segmented body, often protected by a shell, such as a snail.

Plankton

Collection of tiny plants and animals that drift in the water.

Predator

Animal that feeds on other animal species, called prey.

Reptile

Cold-blooded animal with a spinal column, lungs and scales, such as a snake or turtle

Sediment

Solid fragments of organic or inorganic material that come from the weathering of rock and accumulate on the bottom of a body of water.

Spawning ground

Place where the female fish lays the eggs that have been fertilized by the male.

Game Answer Key

Food

Phytoplankton
Zooplankton
Aquatic plant
Minnow
Mallard
Green frog
Dragonfly
Crayfish
Bass
Northern Pike

Consumer

Zooplankton, minnow
Minnow
Mallard, crayfish, minnow
Crayfish, bass, raccoon
Northern pike
Great blue heron, raccoon, northern pike
Green frog
Raccoon, northern pike, bass
Northern pike, osprey, great blue heron
Osprey

Your Mission as One of Mister Aramis' Musketeers

With the help of your teacher, parents or friends, explore your surroundings to find a wetland near your home. Don't forget your boots, binoculars, notepad and pencil. Draw a sketch of the secret elements of the wetland: trees, shrubs, aquatic plants and animals. List three species of plants and three species of animals that you see. Are there particular smells, surprising sounds, or animal tracks? If there is no wetland in your area, draw a pond from your imagination. Once you have completed your mission report, you will be ready to take the musketeer's oath and thus become one of Mister Aramis' Clear Water Musketeers. The following references may help you carry out your mission.

Books

What Are Wetlands?

Bobbie Kalman and Amanda Bishop, Crabtree Publishing Company, 2002

Ponds & Lakes

Anthony Wootton, Usborne Spotter's Guides, 2000

Rivers and Lakes

Chris Oxlade, Science Files Series, 2003

Web sites

Lake Champlain Basin Program, Kid's page

www.lcbp.org/kid.html

Canada's Aquatic Environments

www.aquatic.uoguelph.ca

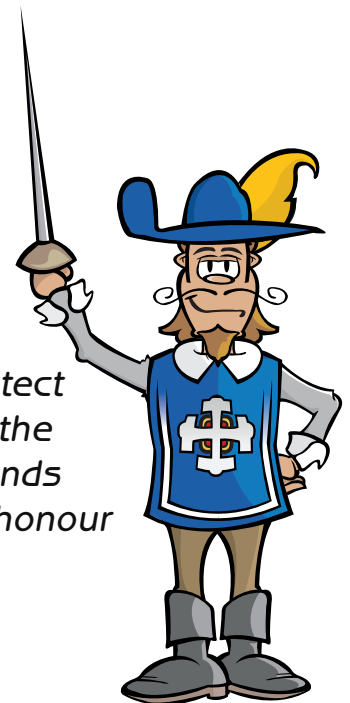
Canadian Waters, Big Blue Bus

www.dfo-mpo.gc.ca/canwaters-eau



The Musketeer's Oath

We are Mister Aramis' Clear Water Musketeers. We undertake to protect the ecosystems of the lakes and rivers, ponds and marshes, with honour and with pride.



Production

Corporation Bassin Versant Baie Missisquoi - 2007



Aramis the Musketeer served the king and queen of France. The Clear Water Musketeers work to protect the environment and nature. They must understand aquatic systems well in order to fulfill their mission as water protectors!



Production team

Research and writing: Chantal d'Auteuil

Story of Shelley the turtle: translated and adapted from a text by Joanie Lussier

Illustrations: Le Bipède

Graphic design: Ékorce Atelier créatif

Printing: K2 impressions

Translation: Eve Krakow

Blazon: adapted from a drawing by Élise Mercier-Coupal

Financial partners

Lake Champlain Basin Program, Education and Outreach Committee

Programme Pacte Rural de la MRC Brome-Missisquoi

Ministère de l'Éducation, du Loisir et du Sport

Ministère des Ressources naturelles et de la Faune

TransCanada

Développement durable,
Environnement
et Parcs

Québec



Pacte rural
MRC Brome-Missisquoi

This guide was designed in collaboration with the Direction régionale de l'analyse et de l'expertise de l'Estrie et de la Montérégie of the Ministère du Développement durable, de l'Environnement et des Parcs.