This Lake Alive!

An Interdisciplinary Handbook for Teaching and Learning about the Lake Champlain Basin

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Koluscap and the Water Monster

as told by Joseph Bruchac

Once there was a great drought. The rain stopped falling and the Earth became dry. Finally the streams themselves stopped flowing. There was a village of people who lived by the side of the stream, and life became very hard for them. They sent someone upstream to see why the stream had stopped. Before long, the man came back.

"There is a dam across the stream," he said. "It is holding back all the water. There are guards on the dam. They say their chief is keeping all the water for himself."

"Go and beg him for water," said the elders of the village. "Tell him we are dying without water to drink." So the messenger went back again. When he returned, he held a bark cup filled with mud.

"This is all the water their chief will allow us to have," he said.

Now the people were angry. They decided to fight. They sent a party of warriors to destroy the dam. But as soon as the warriors came to the dam, a great monster rose out of the water. His mouth was big enough to swallow a moose. His belly was huge and yellow. He grabbed the warriors and crushed them in his long fingers, which were like the roots of cedar trees. Only one warrior escaped to come back to the people and tell them what happened.

"We cannot fight a monster," the people said. They were not sure what to do. Then one of the old chiefs spoke. "We must pray to Gitchee Manitou," he said. "Perhaps he will pity us and send help." Then they burned tobacco and sent their prayers up to the Creator.

Their prayers were heard. The Gitchee Manitou looked down and saw the people were in great trouble. He decided to take pity and help them and he called Koluscap. "Go and help the people," Gitchee Manitou said.

Koluscap then went down to the Earth. He took the shape of a tall warrior, head and shoulders taller than any of the people. Half of his face was painted black and half was painted white. A great eagle perched on his right shoulder and by his side two wolves walked as his dogs, a black wolf and a white wolf. As soon as the people saw him they welcomed him. They thought surely he was someone sent by the Creator to help them.

"We cannot afford you anything to drink," they said. "All the water in the world is kept by the monster and his dam."

"Where is the monster?" Koluscap said, swinging his war club, which was made of the root of a birch tree.

"Up the dry stream bed," they said.

So Koluscap walked up the dry stream bed. As he walked he saw dried-up fish and turtles and other water animals. Soon he came to the dam, which stretched between two hills.

"I have come for water," he said to the guards on top of the dam.

"GIVE HIM NONE, GIVE HIM NONE!" said a big voice from the other side of the dam. So the guards did not give him water.

Again Koluscap asked and again the big voice answered. Four times he made his request, and on the fourth request, Koluscap was thrown a bark cup half full of filthy water.

Then Koluscap grew angry. He stomped his foot and the dam began to crack. He stomped his foot again and he began to grow taller and taller. Now Koluscap was taller than the dam, taller even than the monster who sat in the deep water. Koluscap's club was now bigger than a great pine tree. He struck the dam with his club and the dam burst open and the water flowed out. Then he reached down and grabbed the water monster. It tried to fight back, but Koluscap was too powerful. With one giant hand, Koluscap squeezed the water monster and its eyes bulged out and its back grew bent. He rubbed it with his other hand and it grew smaller.

"Now," Koluscap said, "no longer will you keep others from having water. Now you'll just be a bullfrog. But I will take pity on you and you can live in this water from now on." Then Koluscap threw the water monster back into the stream. To this day, even though he hides from everyone because Koluscap frightened him so much, you may still hear the bullfrog saying, "Give him none, Give him none."

The water flowed past the village. Some of the people were so happy to see the water that they jumped into the stream. They dove so deep and stayed in so long that they became fish and water creatures themselves. They still live in that river today, sharing the water, which no one person can ever own.

Used with permission.

The Ecology of the Lake Champlain Basin

Zebra Mussel Attack

by Stephanie Bushey, Grade 5, School Street School, Milton, Vermont

Hi. My name is Karen. My brother and I are going to the beach. Daddy is going to bring us. We begged him. It's a beautiful day so he said yes!

"Karen! Tommy! Come on! We're not staying there all day," Daddy yelled.

So we ran downstairs and went outside and got in the car.

On the way there, Tommy and I played copy cat. When we got there, Daddy said, "Oh man."

Karen said "What?"

"It's closed!" my dad said. He got out of the car and read this sign. Then he came back.

Karen said, "What is it?"

"Zebra mussels are everywhere on the beach," he said.

"What are they?" Tommy said.

On the way home, Daddy explained what they are. He didn't seem to even care what the mussels were doing.

So when we got home I said I was going to the library. I had heard about them before in school. I know that they cluster together and stick to things. And are shaped like a D. But nobody thought they would get this bad in Lake Champlain.

When I got there I got some books on zebra mussels. I sat down and started reading. I looked for the section on how to get rid of them. I found out there's an acid that gets rid of them in pipes. And some kind of chemical that you can put in the water. But it harms other animals. There's one thing they could do but it cost so much money. It's a certain thing you can put in the water and they will die. And it doesn't harm other animals.

So when I got home I explained to my parents about it. They said, "We should start a club and do fundraisers."

So they got a group of people together. So the club started having fundraisers and yard sales and car washes. We also put allowance money in. The club did so much work.

One night Karen, Tommy and their parents counted up all the money. They had 500 dollars. They needed 700 more. So Karen's mom said, "We should go to the state!"

So the next morning the whole club went to the state. They explained about their problem.

The state said, "Well, if you care this much for the lake, well then yes."

So they ended up doing the treatment. The next time Karen and Tommy went to the beach it wasn't closed.

THE END

P.S. You should have learned that zebra mussels are a problem and they're getting worse. So something needs to be done.

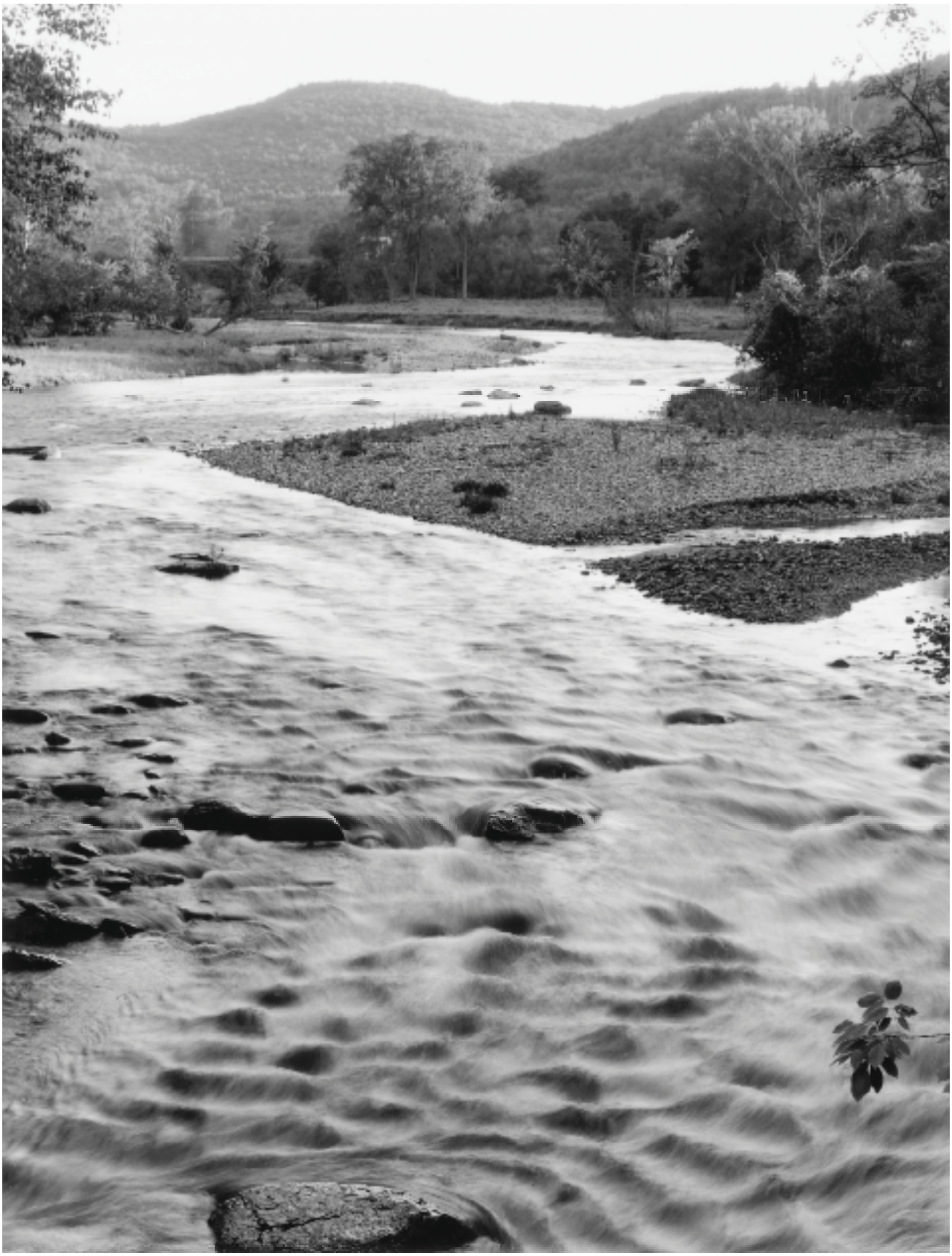
Introduction

The Lake Champlain Basin is truly a rich and wonderful resource. This chapter is designed to take you through the ecology of the basin one drop at a time, starting with "Water as a Universal" to "Water Naturally," then exploring issues of "Human Impact." From the bottom of Lake Champlain to the tops of the Green and Adirondack Mountains, there is an amazing variety of habitats containing numerous complex interrelationships that you can explore with your students.

The ecology of the basin is a huge topic. As Judy Elson and I began to write this chapter, we felt as if we were trying to unravel a ball of yarn. Where was the beginning of the story and how could we lay it out in relatively simple terms so it would be useful to science and non-science teachers? Tom Hudspeth and Bill Romond had some initial conversations with us that helped us begin to unravel the yarn. Tom advised us to "define water, say how it behaves in the natural world and then describe what happens when humans interact with it." This became the framework for the three sections in this chapter.

However you structure the ecology portion of your study, you will soon discover, if you haven't already, that using real data with kids and exploring the natural world with them is a free ticket to meaningful learning—and besides that it is really fun!

Tom Hudspeth, Bill Romond and Pat Straughan reviewed this chapter. Fred Magdoff and Nancy Bazilchuck wrote short articles.



The Ecology of the Lake Champlain Basin

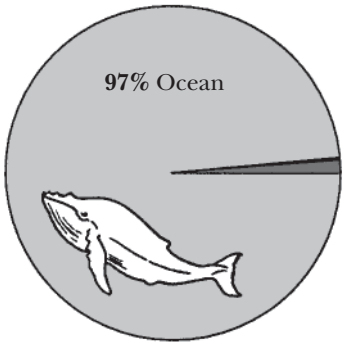
WATER AS A UNIVERSAL

Just look around you. Water is everywhere! It might be raining, or you might be having a glass of juice. Perhaps your town is covered with a blanket of snow, or you can see a sunset sparkle on a nearby lake or river. How does this water move? Where does our water come from? Contemplate the adventures of a water droplet!

A single droplet of water may evaporate from Lake Champlain, travel in a cloud over the Atlantic Ocean and precipitate as rain in a reservoir in France. The local town in France gets its drinking water from that reservoir. That same droplet is taken from the reservoir and sucked into a water pipe heading for the town. It is forced out of a faucet into a dog dish and slurped up by a French poodle, Pierre! What happens next? You can continue this story for as long as you like, but it is a story without an ending. The water droplet cycles around the earth forever and ever!

WATER *is* EVERYWHERE!

Welcome to the water planet! Water, this life-giving resource, covers about 70% of the earth's surface. Does all this water look, feel and smell the same? Absolutely not. Water takes many different forms on this planet:



0.003% Fresh water available to living things
(*streams, lakes, groundwater, soil moisture, water vapor*)

2.997% Fresh water unavailable to humans
(*glaciers, water too far below earth's surface*)

Water makes up part of every living thing on earth. It is part of many nonliving things, too. Your body may contain as much as 70% water. A loaf of bread contains as much as 35% water! Stop for a moment and look around you. Count how many things you can find that have water in them, need water to be alive, or used to have water in them. Water is everywhere!

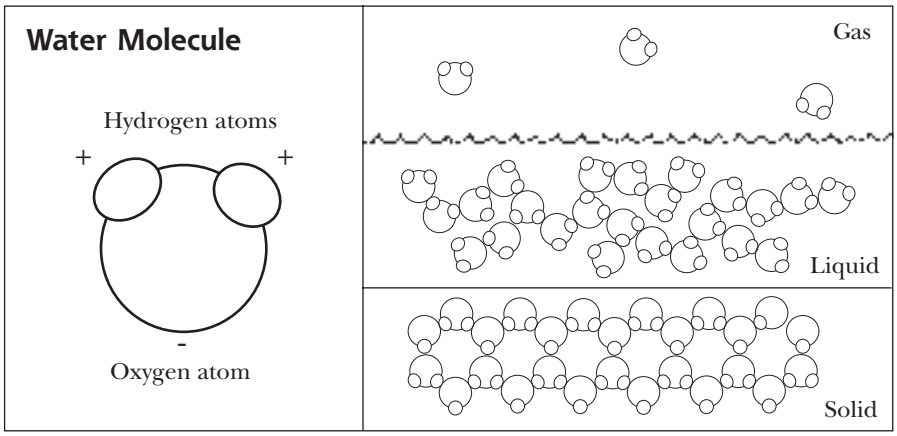
Many living things can use salt water to survive, but others, like humans, freshwater fish and most plants, need water with low amounts of salt (fresh water) to survive.

What is a hydrologist?
The prefix "hydro" means water. The suffix "logy" means to study. Put the two together and you've got a person who studies water—a hydrologist.

WATER *has* MANY FORMS!

Water's Molecular Structure
The covalent bonds of each water molecule create a weak negative charge near the oxygen atom and a weak positive charge near the hydrogen atoms. Because opposite charges attract, the hydrogen and oxygen atoms of one molecule are attracted to those of others. This structure gives water its intriguing properties.

Water in all its forms—as a puddle, as part of a plant or absorbed in a paper towel—behaves like no other substance. A water molecule is formed when two atoms of the gas called hydrogen join one atom of the gas oxygen. Covalent bonds join the atoms within each molecule of water. A covalent bond simply means that atoms share electrons. Together, these two gases make a molecule called water—also known as H_2O. A water molecule has a strong pull, or attraction for other molecules. This attraction is why water mixes so well with other substances—including pollutants!



Water has a few other intriguing properties.

- Water can transform from a solid to a liquid to a gas.
- Some aquatic insects can walk on the tense skin of the water's surface.
- Many substances dissolve completely in water. Water is called a universal solvent!
- Water becomes less dense when it becomes a solid (ice).

Walking on Water!
When water cools, the molecules get closer together and become heavier and sink. As water approaches 32˚F, however, its molecular structure changes. The molecules expand, become less dense (lighter), and form ice. In a lake, the ice floats on top of the water below because the ice is now lighter than the water. Ice forms on the surface instead of sinking to the bottom. This property makes it possible for you to go skating in the winter!

Water even evaporates from the leaves of plants. This is called transpiration.

THE WATER CYCLE!

Water circulates around the earth as the main component of the "hydrologic," or water cycle. Some parts of the world have more water than others. Although water may gush from your faucet, we can't assume there's an endless supply. Why? Go to the faucet and slurp down a handful of water. That gulp may have been the same water the dinosaurs used, and the same water that your grandchildren will use. Water is a precious and limited resource.

When water comes in contact with dry air, it evaporates from lakes and other bodies of water to form water vapor. This vapor can remain a gas, contributing to humidity in the atmosphere, or it can cool and condense to form water droplets. Moisture is carried into the basin in air masses from other regions. As the air cools, it holds less water and the excess moisture falls as rain, snow or fog. This is called precipitation. Precipitation falls on the land and returns to the lake as surface runoff. It can also infiltrate the soil and be taken up by plants or become groundwater. Groundwater is water stored under the earth's surface in underground reservoirs or aquifers. As water moves into the soil (infiltration) and through the soil (percolation), it can be purified.

WATER NATURALLY

While hiking near the top of Camel's Hump in Vermont, I came upon a small trickle of water flowing along the land. At first, I couldn't see it, I could only hear it faintly babbling. I decided to follow this small trickle of flowing water. As I moved down the mountain, this trickle was joined by other trickles to form a mountain stream. I looked at my map—this stream had a name! Brush Brook. I decided to follow it. As I moved down the mountain, the brook got larger and louder. I passed a waterfall with the water cascading over huge rocks and a swimming hole below. At one point I had to cross the brook by jumping from rock to rock. I reached the bottom of the mountain and decided to follow the brook a little further. The brook eventually flowed into the Huntington River. I realized that Brush Brook together with many other streams and brooks form this larger, slow-moving river. I pulled out my map. The Huntington River meanders through the valleys of Vermont and eventually flows into the Winooski River. And the Winooski River, a larger, slow-moving river, empties into Lake Champlain. Lake Champlain flows via the Richelieu River into the Saint Lawrence River and eventually into the Atlantic Ocean.

GO *with the* FLOW!

We live in a watershed. If we could walk around the whole Lake Champlain Basin and attach a string to all the highest points as we went, the string would mark the outline of the watershed. All the water that fell within the string would end up in Lake Champlain. Any water that fell outside the string would contribute to another watershed such as the Connecticut River Basin.

A watershed is all the land that contributes water to a lake, a pond, a river or a wetland. Another term for a watershed is a drainage basin. The Lake Champlain Basin drains about 8,234 square miles of land. 56% of this land is part of Vermont, 37% of this land is part of New York and 7% of this land is part of Quebec. The Lake Champlain Basin is made up of a series of smaller watersheds or sub-basins.

When water falls from the sky and onto an area of land, it seeks the lowest point and may eventually end up in the bottom of its watershed, which in our area is Lake Champlain. For example, let's say a drop of rain falls into

Gravity is the force of attraction between matter in proportion to its mass. Gravity is the force that holds us on the ground and holds the Moon in orbit around the Earth.

The Italian Galileo Galilei (1564–1642) conducted experiments to show that gravity produces a steady acceleration, and that gravity makes all free-falling objects drop at the same constant acceleration.

Upper Ausable Lake in St. Huberts, New York. If that drop of water stays in liquid form, it will flow down to the Lower Ausable Lake, then into the Ausable River, and eventually will flow into Lake Champlain at the mouth of the Ausable River in Port Kent, New York. The force of gravity causes the water to find the lowest point!

How does Lake Champlain compare with other lakes of the world? Locate these three lake regions on a world map.

• Lake Baikal in Russia contains the world's largest volume of fresh water. It is also the world's deepest body of fresh water, measuring 5,315 feet (700 kilometers). The lake is home to approximately 1,700 species of plants and animals, 1,200 of which are not found anywhere else on earth.

• Lake Hozgol in Mongolia is perhaps the second oldest lake in the world and is still in pristine condition. This lake has never been commercially fished or the surrounding area logged. The lake is clear enough to see fish 30 feet below the surface.

• The Great Lakes are made up of five interconnected lakes that contain at least 20% of the world's fresh water. Approximately 26 million people drink this water. About 40% of U.S. industry and 50% of Canada's industry is in the Great Lakes watershed.

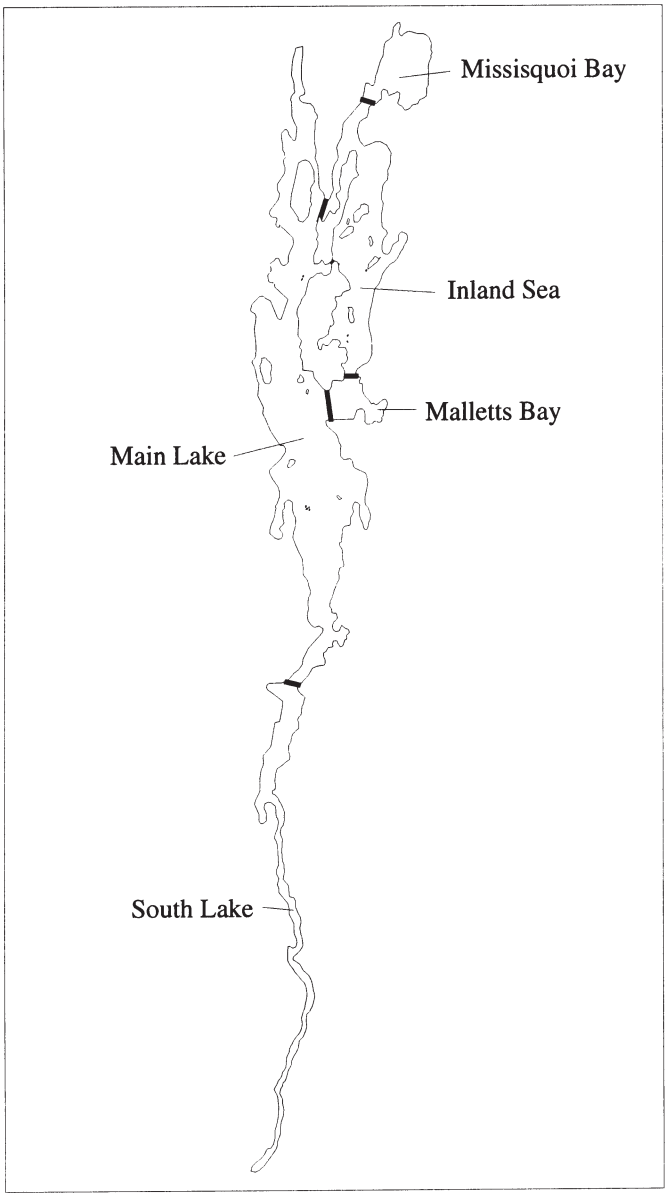
GEOGRAPHY *of* LAKE CHAMPLAIN

Lake Champlain is one of the largest freshwater lakes in North America. We are fortunate to have such a beautiful and valuable resource in our backyard. It is 120 miles long, starting near Whitehall, New York, and flows north to Ash Island, Quebec, where it drains into the Richelieu River. It is a narrow lake, only 12 miles across at its widest part, and it has over 70 islands. The average depth of the lake is 64 feet, but some parts are 400 feet deep. Lake Champlain is bordered by mountains on both sides—the Adirondacks on the west and the Green Mountains on the east.

Only 10% of the water that reaches Lake Champlain falls into the lake directly; the other 90% of the water flows through the watershed first.

Due to the shape and size of Lake Champlain, it is divided into five distinct areas or lake segments. Each segment has different physical and chemical characteristics:

- **Missisquoi Bay** is very shallow with warm water. Water flow in and out of the bay is very slow.
- **South Lake** is a very narrow and shallow section of the lake and acts much like a river.
- **Main Lake** holds 81% of all the water in the lake. This includes some of the deepest and coldest water in the entire lake.
- **Mallett's Bay** is the smallest of the five segments. Bordered by causeways on the north and west, this section of the lake has very poor water circulation.
- **The Inland Sea** has water flowing south from Missisquoi Bay and north from Mallett's Bay. From here the water flows past the many islands in the Inland Sea through the Gut and Alburg Passage.



Most of the water that flows into Lake Champlain comes from 12 major rivers. Five of these rivers are on the Vermont side. They are from north to south: the Missisquoi, the Lamoille, the Winooski, the LaPlatte, Otter Creek, and the Poultney/Metawee River. On the New York side the lake is fed by the Great Chazy, the Saranac, the Ausable, the Boquet and Lake George. Rivers and streams that flow into a larger body of water are called tributaries.

"River take me along
In your sunshine sing me your song
Ever movin' and wanderin' and free,
You rollin' old river
You changin' old river
Let's you and me river
Flow down to the sea."
Bill Staines

RIVERS *and* STREAMS

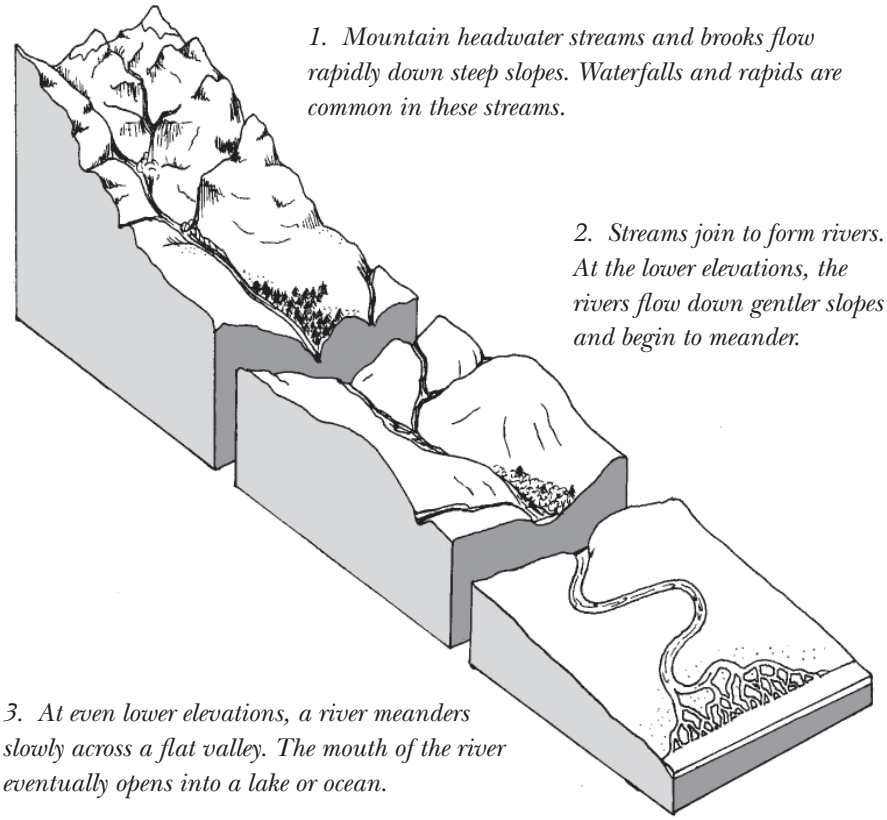
Streams and rivers are home to many plants and animals. Along the edges of the stream, you may discover riparian vegetation such as willows, alders, ferns, liverworts and water plantain. Otters, muskrat, moose and maybe a black bear might come to feed and drink along the shore. While exploring a river, you may discover a mayfly nymph, crayfish or the various forms of algae. All these forms of life make up the ecology of rivers and streams.

The Lake Champlain Basin can be viewed as a network of rivers, brooks and streams. Every river is part of a larger system, which includes all of the other rivers, streams and brooks that contribute to it. Rivers generally go through three phases as they flow downward from the mountain tops, as shown below.

Rivers and streams, although very similar, also have marked differences. The table on the following page shows how the two environments can be different from one another.

Riparian refers to the area near a stream and can refer to plants, animals or soils that are connected to the stream or riverside.

These fast- or slow-moving and meandering bodies of water we call rivers, brooks and streams are also known as lotic waters. Lotic means "washed." On the other hand, lentic waters are the calm waters such as ponds, lakes, swamps, marshes and bogs. Lenis means "calm."



1. Mountain headwater streams and brooks flow rapidly down steep slopes. Waterfalls and rapids are common in these streams.

2. Streams join to form rivers. At the lower elevations, the rivers flow down gentler slopes and begin to meander.

3. At even lower elevations, a river meanders slowly across a flat valley. The mouth of the river eventually opens into a lake or ocean.

STREAM ENVIRONMENT	RIVER ENVIRONMENT
• *Cooler water throughout the stream*	• *Warmer water, can even see some thermal stratification like in a lake*
• *Good amounts of dissolved oxygen in the water*	• *Good amounts of dissolved oxygen*
• *Normally clear water*	• *Water can be turbid or cloudy, murky*
• *Narrow channel*	• *Broad meandering channel*
• *Shallow*	• *Shallow to deep*
• *Gravel or rock bottom*	• *Muddy, silty, sandy or clay bottom*
• *Swiftly flows in v-shaped valleys in a series of riffles, pools and runs*	• *Swiftly or slowly flows or meanders in u-shaped valleys*
• *Fully shaded by stream bank vegetation*	• *Only shaded by stream bank vegetation along the edges of the river. The middle of the river is unshaded.*
• *Water level may fluctuate greatly*	• *Water level is more stable*

Rivers and streams tend to be rich environments with a diversity of life. They frequently contain a lot of dissolved oxygen due to the constant movement of water. There may also be a large supply of nutrients for many different organisms. Nutrients enter the streams and rivers in many different ways:

- by plant matter falling into the water from overhanging trees and shrubs,
- by dead plants and animals washing downstream, settling into a pool and decomposing,
- from phytoplankton (small aquatic plants) drifting in the sunny upper levels of the river or stream,
- from flooding—when large amounts of water are washed into the rivers and streams (nitrates),
- by being attached to eroding soil particles (phosphorus).

LIVING THINGS DEPEND *on* CLEAN RIVERS *and* STREAMS

Many species depend on varying levels of oxygen and nutrients to survive in streams and rivers. For example, a stonefly nymph prefers to live in a stream with good water quality—high in oxygen, just the right amount of nutrients and a fairly fast flow rate, or velocity. A midge larva, on the other hand, can tolerate poor water quality—lower levels of oxygen, many nutrients, and a slow water velocity. Scientists study these macroinvertebrates to determine the water quality in streams and rivers. If a scientist finds only those species that tolerate poor water quality then there may be a pollution problem.

damselfly nymph

Artwork by Jodi McQuillen, Grade 6, South Burlington

Macroinvertebrates are invertebrates you can see with the naked eye.

A larva is the immature stage of development in animals that go through complete metamorphosis. Larvae usually look very different from the adult. A nymph is the immature stage of development in animals that go through incomplete metamorphosis. Nymphs look very similar to the adult.

LAKE CHAMPLAIN *through the* SEASONS— A YEAR *in the* LIFE *of a* LAKE

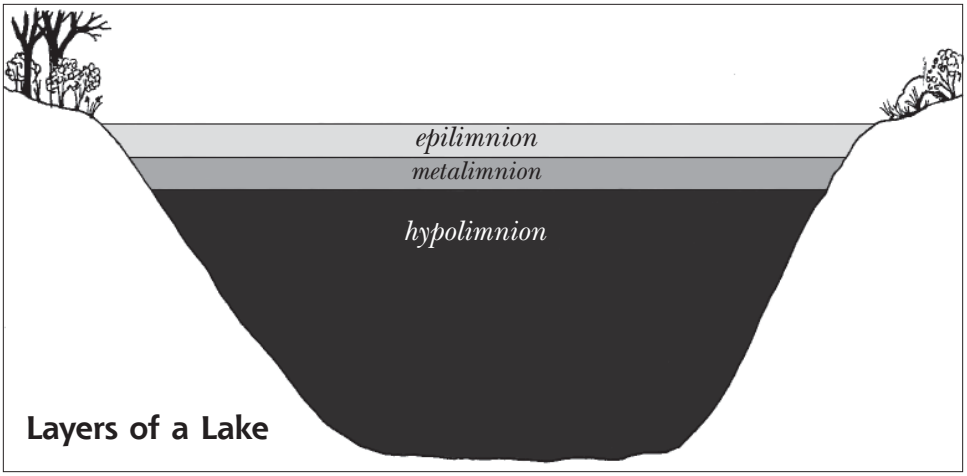
Nature controls the many changes in Lake Champlain. The changing seasons bring variations in temperature, winds, and forms and amount of precipitation. These factors all affect the movement and amount of water in the lake.

The water in a lake is always changing. Although the water in Lake Champlain naturally flows from south to north, there are many other factors that control the movement of water within the lake.

The water in the lake has different temperatures at different times of the year. Spring graciously brings warmer weather, and the sun heats the surface of the lake while the deeper parts of the lake stay cool. This layering of the lake is called lake stratification.

Imagine the lake as being a huge cake. The warmer surface water of the lake is less dense than the cold water. Therefore, the warmer water floats on top of the cold water, forming the top layer of the cake known as the epilimnion. Below this layer, there is a thinner layer called the metalimnion (the icing between the two cake layers) which separates the warm water on top from the cold water below. The bottom layer of the cake is called the hypolimnion. This water is very cold and still.

When the water moves, so do all the things suspended in the water, such as microscopic plants and animals. The movement of the water re-supplies parts of the lake with nutrients and oxygen for aquatic species. This helps to balance the system and keep the lake healthy.



Layers of a Lake

SPRING

Spring brings warmer temperatures. The warm weather begins to melt the snow on land. Every spring the water level of the lake rises due to the melting snow and the spring rains. These changes cause the water level to be highest during the spring and early summer. Stones, silt and other debris (logs, solid waste, organic matter, chemicals and manure, to name a few) are washed into the lake by this new rush of water. The height of the lake can vary about six feet during this time of year.

The record low water level was 92.4 feet above mean sea level (m.s.l.) in 1908, and the record high was 101.89 feet above m.s.l. at Rouses Point in 1993!

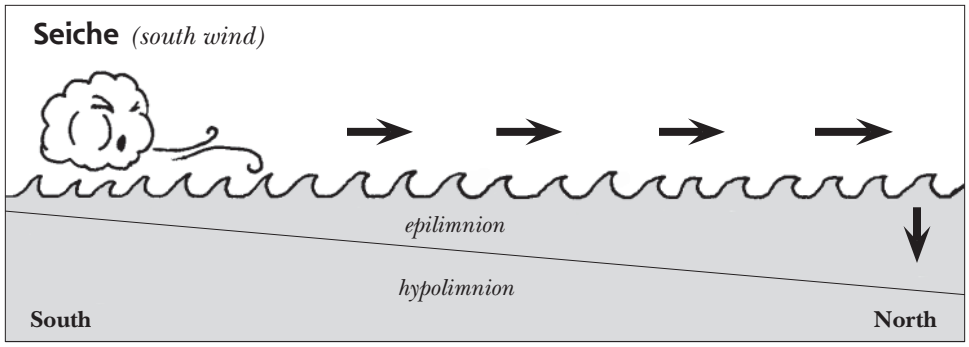
The changes in water level can be seen as good or bad, depending on whether you are a person or a fish! Many fish depend on the changing water levels to survive. Annual flooding in the spring replenishes and nourishes the wetlands, which provide fish spawning habitat. But when the lake floods, there can be stormy, high winds and shoreline erosion. Flooding often occurs where development along the shoreline has damaged soil, altered wetlands or destroyed vegetation—all things that nature provided to protect shorelines from natural flooding. Excessive erosion causes the water to become murky with silts and sands, making it hard for some aquatic species to survive.

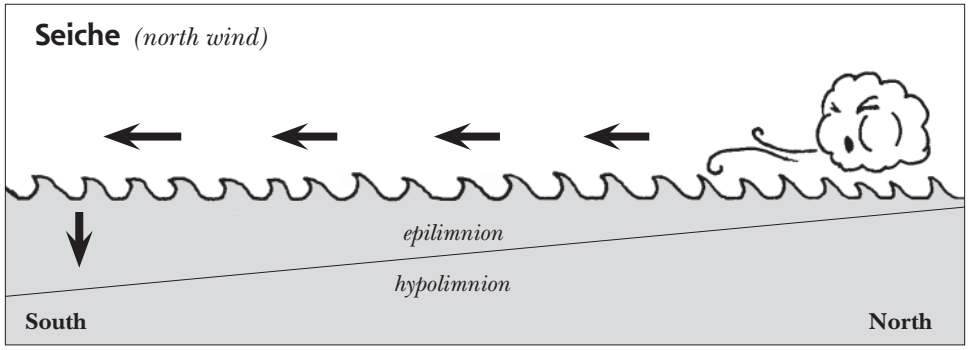
SUMMER

As spring slowly gives way to summer, the lake's layers become more defined. Changing wind speeds and directions control an internal wave called a seiche. This wave is continually active from early spring to late fall. For example, a strong north wind may blow for a few days pushing some of the warm surface water (epilimnion) down to the southern part of the lake. At the same time, this wind action pushes the colder, deep water to the north end of the lake. When the wind stops, there is no longer any force keeping the water piled up on the southern section of the lake, and it moves back north. Natural momentum allows the water to oscillate back and forth, forming the internal seiche or wave. This sloshing motion can cause mixing of the water and sands and silts.

The epilimnion in the Main Lake during the summer is typically about 33 feet deep.

Create an internal seiche in your next bowl of soup. Create a steady wind in your "lake soup" by blowing on its surface in the same direction. When you stop blowing, watch what happens. This is the same action that takes place in the lake; the only difference is that the wave is about 124 miles long!





The reason plants need so much water is because they transpire just like people perspire or sweat. Plants use 300–500 pounds of water to make 1 pound of dry leaves or stems.

Because it rains more in the summer, you'd think that the lake level would rise. In fact, lake levels are lower in the summer. Because it is warmer, more water evaporates from the surface of the lake. Also, plants are growing on the land and they consume a lot of the water that would have drained into the lake. As the soils dry out in the summer, they hold more water after a rainstorm. Because more water is retained by the soil, less water is available from the rain to enter the groundwater or surface water.

What's that big cloud hanging over the surface of the lake? Lake fog! Late in the fall, you can almost always see fog lingering over the lake. Fog forms from contrasting temperatures. The lake water is warmer than the air just above its surface. The warm air rising from the lake immediately condenses as it hits the cooler air temperature and forms a misty cloud lingering over the lake.

FALL

The surface waters cool in late fall, making them more dense or heavy than the water below the surface. The cooler water sinks to the bottom and flushes the warmer water below up to the surface. This is known as lake turnover. Lake turnover also occurs in late winter and early spring. As the air temperature remains cooler, the lake holds the warmth from the summer. Therefore, the air temperatures near the lake stay warmer later in the season. This helps some of the local farmers extend their growing season later into the fall.

The fall is a very active time for wildlife. Birds are passing through on their way south for the winter, and year-round residents are preparing for the long winter. The Lake Champlain Basin is part of the Atlantic Flyway. This is a route that migratory birds follow as they move back and forth between their winter and summer habitats. In the fall, some of the basin's birds move south along the Atlantic coast and winter in the southern United States or continue on to Central America. At the same time, the basin is welcoming birds from farther north in Canada. These birds overwinter in the basin where it is warmer and where there's more food.

Dead Creek Wildlife Management Area in Addison, Vermont, used to be a brief feeding spot for migrating Canada and snow geese as they honked and flapped their way up north to Canada. In 1954, 44 Canada geese were released at Dead Creek. Ever since that time, a small flock of geese breeds there every year. Biologists estimate that each year over 300 geese hatch and over 4,000 geese stop for a migratory snack at Dead Creek Wildlife Management Area!

WINTER

During the winter, the temperature of the lake averages 39˚F. The surface waters may or may not freeze depending on the harshness of the winter. The whole lake does not freeze every winter. However, the bays do freeze most winters. As the long winter comes to a close, the surface ice begins to melt. This melted ice is colder and more dense than the water below, so it sinks to the bottom, forcing the water that was below the ice all winter to the surface. The lake water has "turned over" for the second time in one year.

What happens to all the animals during the winter months? It depends on the species. For example, some fish, such as the bass, spend their winters at the bottom of lakes in a dormant state. In other words, they take long naps hiding under rocks. Some fish, such as bullheads, actually bury themselves in the mud at the bottom of the lake and remain dormant all winter. Other fish, such as the pike, perch, walleye, smelt and lake trout, remain active in the winter and spend time swimming in deeper, warmer water. These are the fish that the ice-fishing folks catch on those blustery days. Amphibians and reptiles burrow in the mud at the bottom of the lake and hibernate. Their heart rate slows down and their body temperature is very cold, and they breathe through their skin. Aquatic insects also borrow down into the mud and lie dormant. Some aquatic insects overwinter as eggs laid in the mud.

The leopard frog can be frozen in ice and still survive the winter as long as it doesn't freeze all the way through!

THE LAKE CHAMPLAIN BASIN *as an* ECOSYSTEM

Ecosystems are communities of organisms that interact with each other and their nonliving environment. The Lake Champlain Basin is an ecosystem. When we look at the basin as a whole, we are looking at all living things on land and in water. Human beings are part of this ecosystem. The Lake Champlain Basin ecosystem is made up of a variety of habitats including woods, rivers and streams, open meadows, wetlands and lake waters.

The sun provides the fuel for this ecosystem. The sun's energy warms the earth, water and air, causing wind currents, and activates the hydrologic cycle. The light energy from the sun also fuels photosynthesis.

Photosynthesis is the process of green plants turning water, light and carbon dioxide into oxygen and glucose. The oxygen is released to the atmosphere and the glucose is used by the plants to grow.

Photosynthesis

$12H_2O + 6CO_2$ + chlorophyll *(acted on by sunlight)* leads to $6O_2 + C_6H_{12}O_6$ (glucose)

AN AQUATIC FOOD CHAIN

Plants grow by using the sun's energy to make many different types of chemicals. In water, small aquatic plants, including algae and other types of phytoplankton, are consumed by tiny floating animals or zooplankton. Next in the chain are larger organisms that feed on these tiny animals, including small crustaceans and forage fish. Larger fish and other animals are the next link in the chain, and they are eaten by birds, mammals (including humans), reptiles and amphibians. The step that completes the cycle is decomposition. When plants and animals die, decomposers, organisms that eat dead plant and animal matter, break down the material into basic components. These elements can then be cycled back through the food chain.

There are approximately 487 vertebrate species of fish and wildlife in the basin.

Important organisms such as fungi, bacteria and worms are the decomposers that feed on the dead animal and plant materials.

Each link in the food chain represents the transfer of energy through the ecosystem. Since each species is usually part of more than one food chain, the food chains in an ecosystem are interconnected. These connected food chains form a food web. Pictures of food chains and food webs show how the energy that creates life moves from one trophic level to another. These pictures also show how harmful pollutants can be passed along through an ecosystem.

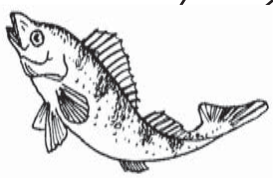
What will happen to this food web if one of the species' population declines due to poor water quality? Will anything else be affected by this change in the web?

Food Web

cormorant

great blue heron

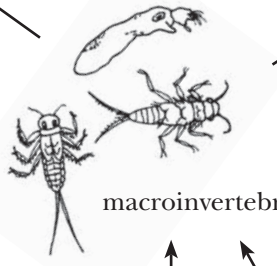
raccoon



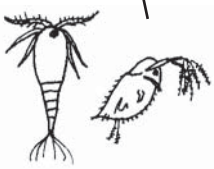
perch

frog

crayfish



macroinvertebrates



zooplankton

snail

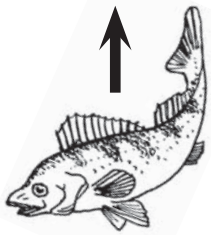
algae

zebra mussel

detritus

Food Chain

cormorant



perch

macroinvertebrates

algae

Habitat Highlight

Wetland habitats are wonderful places to visit and they are especially fun if you are a curious person. Awaken your five senses while exploring the wonders of the wetlands. Wetlands are full of many plants and animals.

The characteristics of a wetland help us to understand why so many species depend on wetland habitats for their survival. For example, if you are a fish, the calm and nutrient-rich waters of the wetlands are a perfect place to spawn and raise your young. Birds love wetlands because of all the delicious bugs for eating and the trees and tall grasses for nesting. Turtles can find lots to eat in a wetland, as well as fallen logs protruding from the calm water for sunning and mud for burrowing into during the winter months. Unique plants such as cattails have a special design that allows them to get oxygen to their roots. Roots of plants that don't have this design will die if the soil becomes too wet, because the soil below the surface of wetlands does not contain oxygen.

What is a wetland? A wetland is an area of land covered all or part of the year with water. The U.S. Fish and Wildlife Service more specifically defines wetlands as "lands where saturation with water is the dominant factor determining the nature of the soil and what grows on its surface." There are many kinds of wetlands including: swamp, marsh, bog, open water and wet meadow.

WHY ARE WETLANDS IMPORTANT *to the* LAKE CHAMPLAIN BASIN?

• The Lake Champlain Basin wetland habitats provide: nesting sites, food, shelter and protection for wetland species such as migratory birds (ducks, geese, gulls and songbirds), beaver, moose, insects, amphibians, silver maples, cattails, water lilies and tall grasses to name a few!

• Wetlands help to improve water quality by acting as large filters. As water travels through a wetland, the soils of the wetland filter out sediments, pollution and excess nutrients.

• Wetlands are full of plants with strong roots that help to stabilize the soil and prevent erosion.

• Wetlands are like huge sponges that soak up lots of water. During the flood seasons, wetlands help to absorb the excess water that enters the basin. This can help protect the basin from damaging

floods. During drier times of the year, wetlands slowly release the water back into the water table.

• Some wetlands in the Lake Champlain Basin are Wildlife Management Areas, which provide wonderful recreational activities and educational opportunities including fishing, canoeing and bird-watching.

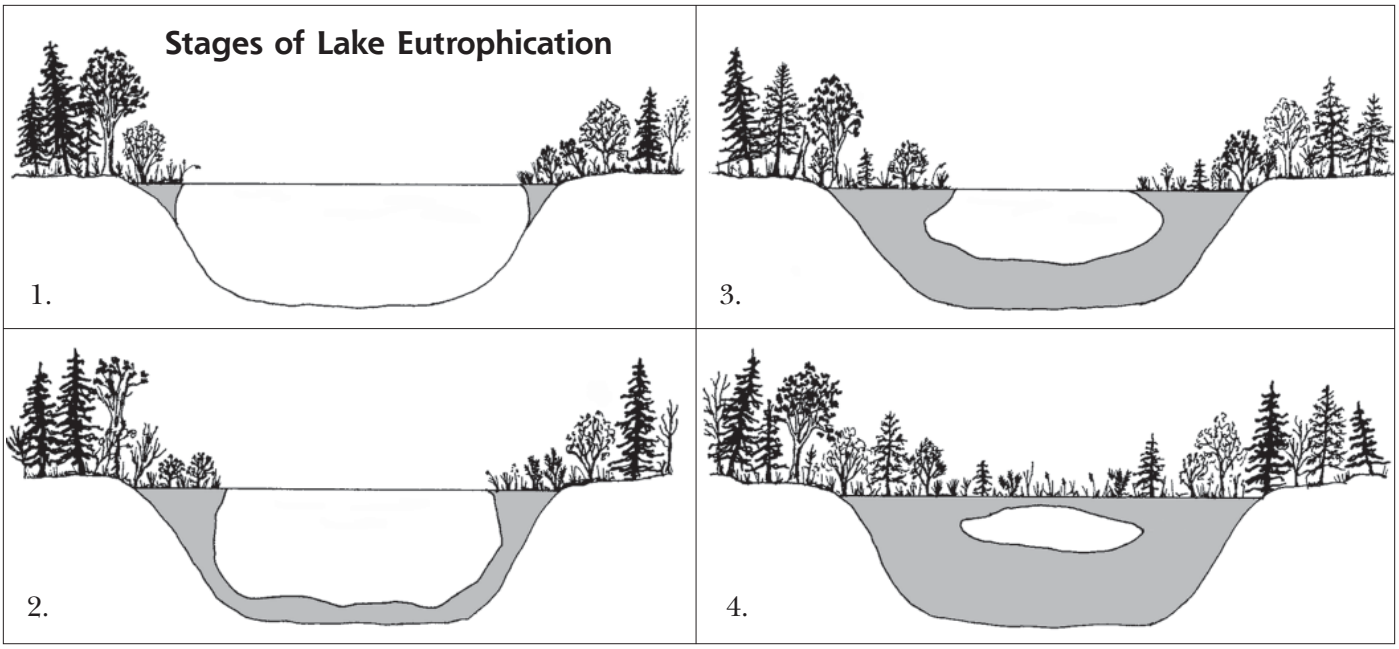
Due to increased land development pressures, introduction of non-native aquatic species, and pollution, wetlands are in danger. The State of New York regulates wetlands under its Freshwater Act passed in 1975. The State of Vermont passed a Wetland Act in 1986. Both New York and Vermont follow the national guideline that states there should be "no net loss" of wetlands. The Lake Champlain Basin has approximately 300,000 acres of wetlands.

And now for some good news! The Lake Champlain Wetlands Restoration Project began in 1993 to provide funding and technical support to willing landowners who want to restore wetlands on their property. The project hopes to restore 100 to 525 acres of wetlands.

Wetlands are exciting places and lots of fun to explore. If you visit one, remember you are a guest in the home of many other species. Be polite and you'll be invited back!

A LAKE GROWS UP!

All lakes go through a slow, natural aging process called eutrophication. Over very long periods of time, perhaps hundreds to thousands of years, all lakes eventually fill with plant matter and debris and become a marsh or a bog and then fill in completely and become land. This will eventually become the fate of Lake Champlain. Although this is many thousands of years away, it is important to understand how human activity is linked to an increasing rate of eutrophication, which affects the quality of our water today.

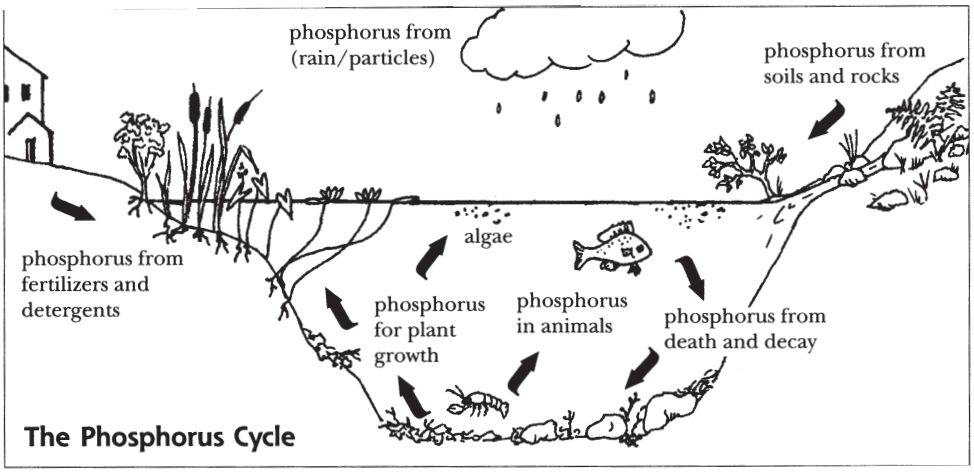


The rate of eutrophication depends on the amount of nutrients that enter the lake. What are nutrients? Nutrients are elements that sustain the lives of every living thing. Among humans, healthy eaters choose certain foods that are particularly rich in specific nutrients. You can eat broccoli for Vitamin C, milk for calcium, and potatoes for potassium. In order to maintain life in a lake, nutrients also must be present. Some of the common nutrients found in the lake are: potassium, magnesium, iron, calcium, nitrogen and phosphorus.

When a nutrient, or any other essential need such as light or oxygen, is lacking it is known as the limiting factor because it inhibits the growth of plants.

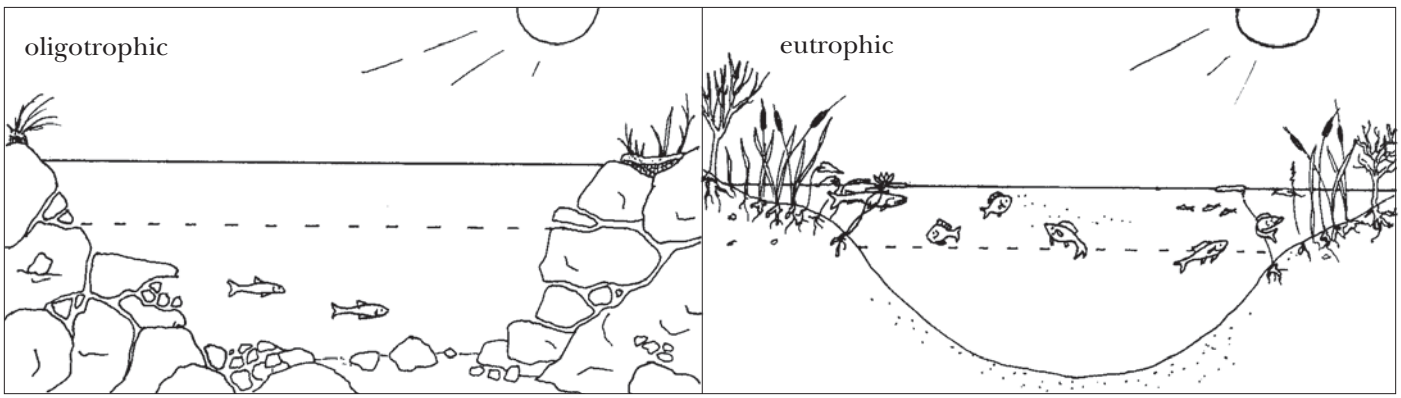
Most lakes are naturally low in nutrients, which leads to little plant and algae growth. This keeps the water clear. Lakes at this stage in their lives are called oligotrophic, meaning poorly nourished. Lakes that have medium levels of nutrients and plant growth are called mesotrophic. Lakes that contain high nutrient levels that cause excessive amounts of plant growth are called eutrophic. Overall, Lake Champlain is categorized as mesotrophic to eutrophic.

Sometimes, one or two nutrients are present in relatively small amounts compared to what plants need. This limits the plants' ability to grow. Phosphorus, which naturally cycles through lakes, is one of these "limiting nutrients." Aquatic plants and algae use what phosphorus is available to survive and grow. In Lake Champlain, as in other freshwater ecosystems, phosphorus is usually the nutrient that limits plant growth.



The Phosphorus Cycle

If a lake stays low in phosphorus, the natural aging takes place slowly. However, many human activities add more phosphorus than would normally be present. When excess phosphorus enters a lake, there is an "explosion" or bloom of fast-growing plants, and the lake is termed eutrophic. A eutrophic lake becomes rich with aquatic vegetation, including algae. After the aquatic plants die, bacteria, fungi and worms feed on the plants and decompose them, consuming a lot of the water's oxygen in the process. When the oxygen level becomes low it can be life-threatening to other species in the lake such as fish, which require a certain level of oxygen in the water to live.



Eutrophic comes from a Greek word meaning "well-nourished."

The bays and shallow areas of the lake tend to be eutrophic in the summer because there is less water exchange and the water is warmer; the phosphorus becomes concentrated and trapped. The South Lake, St. Albans Bay and Missisquoi Bay are considered eutrophic during the summer months. Within these bays there are 30 pounds of phosphorus for every one billion pounds of water. However, because of a relatively small watershed that feeds Mallett's Bay, it has the lowest phosphorus level for the entire lake, measuring 11 pounds of phosphorus for every one billion pounds of water.

Some lakes around the world as well as parts of Lake Champlain have become eutrophic—they are loaded with excess nutrients, choked with plant growth and appear green and thick like pea soup! These excess amounts of nutrients speed up the natural aging process by adding organic matter to the lake. Where do these excess nutrients come from? Human activities within the Lake Champlain Basin are responsible for increasing the nutrient inputs to the lake. Routine human activities such as flushing the toilet, gardening or washing the car can impact the health of the lake.

Phosphorus also can enter the water naturally through the process of erosion. Next time you're out riding your bike or on a drive with your family, look for bare land where there is little or no vegetation growing. Nothing is holding this soil in place. It can easily be moved by wind and water. Look along road sides and stream banks. Phosphorus attaches to the sediment along the banks of tributaries and the lake. As the banks erode, the sediment flows into the water carrying the phosphorus with it. One way to help decrease this input of phosphorus is to stabilize the stream and lake banks by planting vegetation. The roots of the plants will hold the soil in place, not allowing it to flow into the water.

Eutrophication, accelerated by human activity, is a serious problem in the Lake Champlain Basin. However, there are things that we can all do to minimize the harms. One of the most important things is to understand the connections and impact between human activity and water quality.

HUMAN IMPACT

Imagine for a moment what the basin would be like today without the influences of humans—no malls, roads, houses, boats or farms. What would that be like? Close your eyes and imagine this 8,000 plus square miles of land and water without any human influences. WOW!! Now, back to reality... we do have malls, roads, houses, boats and farms and many other things. In order to keep the basin healthy, we must learn how our daily actions affect the natural cycles within the basin and seek to maintain the natural balance of the ecosystem.

We share this land with other species including plants, mammals, fish, birds, reptiles, amphibians and insects. In general, all living things impact each other's lives by simply existing. Consider your own neighbors. When you mow your lawn, the noise affects your human neighbors as well as the lawn habitat and the animals that live there. A mosquito trying to survive and reproduce affects the lives of humans and other animals by extracting blood from their bodies, causing them to itch, roll in mud, swat their tails or grab for a bottle of bug repellent! Impacts such as these are all part of the natural life cycle of species on the planet earth. We are all connected. The action of one will affect the life of another.

How do we use the land and water within the basin, what effects do these land and water use practices have on the basin and why should we care about keeping the basin clean?

LIVING *in the* BASIN

How do you use land and water in the Lake Champlain Basin? In general, there are six major ways in which humans have an impact:

- recreation
- forestry
- agriculture
- transportation
- manufacturing
- developed land

Let's take a closer look at each of these categories.

RECREATION

• It's a beautiful summer day and you're out enjoying the mountains. A peaceful climb up Mt. Marcy in the Adirondacks provides a fabulous view of the Adirondacks.

• Strap on those roller blades and head for the Burlington bike path. You pass a biker. You get a good pace going and cruise the path all day long.

• What a day for a ride on the lake. The boat is full of gas, and you're off for a day of high speed fun and swimming on the Main Lake.

• Winter vacation! Ice-fishing season at last! Finally, you can ice fish all day!

The basin is a valuable recreational resource for residents and welcomed guests. It is rich in scenic beauty and a large source of income to the area. Despite these benefits, some aspects of recreation pose a threat to the health of the basin. Let's take a look at the lake itself in relation to these issues.

In 1990, $2.2 billion was spent by tourists within the basin.

Today the lake is mainly used for recreation. Access points are becoming crowded and marinas are filling up. Boat traffic on the lake can be very congested and conflicts arise between sailboats and motorboats. The more boats there are on the water, the more fuel and engine oil enter the lake. The list can go on and on. Some people believe we have reached a limit in terms of how much activity the lake can take. Recreation needs to be managed in order to preserve this precious resource.

In recreation management, the amount of use a recreation area can sustain without deterioration of its quality is called carrying capacity.

FORESTRY

"My grandfather tells wonderful stories about the early logging days in the Adirondacks…how big the trees were back then, the two-person cross-cut saws slicing through bark and wood— back and forth, back and forth, and the horses used for skidding the logs out of the woods."

"Our family has some land that is designated as a tree tarm. This means that we actively manage our woods. We have to follow some specific guidelines to be 'tree farmers,' but I'm glad we do. It helps to save our woods and make some money when we do harvest the trees and sell them to be made into furniture or paper."

• "My mom and I were traveling down Interstate 87 the other day. We got behind this logging truck. Huge logs stacked on top of one another. My mom asked me where I thought the trees were from. Then she asked me what I thought they would be turned into."

Today, forests cover 62% of the basin's surface area. In any given year, only

1% of this forested land is subject to harvest. Most of the forestland in the basin lies within the Adirondack Forest Preserve and is not subject to harvest. Therefore, forestry practices do not pose a large threat to the basin's health. However, poorly planned logging operations can cause major soil erosion, which leads to sediment and nutrient runoff into local streams and rivers.

AGRICULTURE

- *"We've got a hundred head of Jerseys. My family has been farming this land since the early 1900s."*
- *"We grow organic crops for the local community. Although the growing season is short, we love working the land and providing food for our neighbors."*
- *"Llamas are a unique agricultural enterprise. We raise them as breeding stock as well as selling their hair to be made into commercial products such as sweaters, blankets and scarves."*

Agriculture is an important way in which land is used and has been an important aspect of our history and culture. There are presently 3,100 farms in the U.S. portion of the basin, 2,080 of which are dairy farms. Farmers play a valuable role in our lives. Farmers provide us with the food and products we use every day. Think of how much milk you drink in a week, in a year—and thank the farmer! Farmers also provide food and agricultural resources for people and animals that live outside of the basin. Maple syrup produced within the basin is sold all over the United States. The milk from some of the basin's dairy cows is also sold in other parts of the country.

At the same time, agricultural practices impact the health of the basin. Any activity on the land, such as plowing, grazing, irrigation or pest management can potentially affect the quality of the water through runoff and infiltration.

The major threat to water quality from agriculture is the nutrient phosphorus. Manure and fertilizers are sources of phosphorus. When these phosphorus-rich products are put onto the land, they are either absorbed into the soil and plant root systems or they run off into a nearby stream or infiltrate down into the ground water. If the phosphorus reaches the surface water, the plants in the water use this nutrient to grow—and grow and grow. If too much phosphorus enters a body of water, an algal bloom will occur. This can affect the other plants and animals in and around the body of water.

By the 1850s, farming and logging had caused 70–75% of Vermont forest land to be cut down and converted to agricultural land.

Agriculture uses about 25% of the land within the basin.

The ins-and-outs of a cow
It is estimated that in a day one cow produces 75 pounds of wet manure, gives over 60 pounds of milk and consumes 25 gallons of water.

Vanishing Farms!
People wonder about the future of agriculture. On the average, Vermont loses 69 dairy farms each year. At this rate, how many years will it take until there are no farms left?

Soil and You

by Fred Magdoff

WHAT *is* SOIL?

When you are walking in your backyard or garden or in a forest or alongside a stream, you are walking on soil. From this soil comes the nutrients and water that plants need to grow. Most of the nutrients that you need also come from the soil. Where does the calcium come from that helps make your bones strong? From milk? From vegetables? Well, yes. But how did it get into the milk? First plants grow and calcium enters the roots and moves up to the leaves and grain. Then a cow eats the hay and corn and uses some of the calcium to make milk. So the calcium inside you came from soil!!! So did the phosphorus and magnesium and nitrogen. The cotton shirt or socks you wear, the hamburger you ate last week, the cereal and orange juice you had for breakfast this morning all came from plants that needed soil.

There are many different kinds of soils, which scientists classify according to their properties. Some soils are deeper than others; some are more fertile than others. Soils may contain different minerals and have very different colors. Some soils are always wet, while some never contain enough water to grow plants.

Soils also play an important role in the environment. Soils store water during a rainstorm so that it doesn't run off into streams and rivers and cause flooding. The soil water is then used by plants or may percolate down to groundwater. Soils also serve as a filter for pollutants. Many people in the Lake Champlain Basin live outside of cities and big villages. The water from the kitchen sink and the bathroom go into a big septic tank buried near the house and then out to a trench or mound septic disposal field. As the wastewater enters the soil and flows downward, the soil filters out many bacteria and viruses and helps reduce the other pollutants as well.

HOW *is* SOIL MADE?

Soils can be formed in many different ways. The slow breakdown of bedrock or rocks ground up and pushed for hundreds of miles by glaciers can make soil. Rivers carry sands and clays down from mountains; the sands are deposited in the delta and the clays are pushed farther out into the lake. When lake levels drop, these sediments become soil. As plants start to grow (and then die) on the sediments, their remains become part of the soil, as well as the remains of insects, earthworms and larger animals that feed on the plants. This organic matter makes the soil more fertile. That's why many people put compost, manure or grass clippings in their gardens.

In the Champlain Valley there are many soils that were formed from materials that were once underwater. Do you know that the level of the lake was once about 500 feet above the current level? We have some soils that are very sandy—mainly old lake beaches and river deltas—as well as some that are very clayey—from parts of the old lake bed. But there are also rocky soils formed from glacial rocks and

sandy loams alongside many rivers. The soils in the valley are pretty young—for soil, that is!—being only some thousands of years old. And because they are so young they contain many minerals that help keep the soil fertile.

WE *are the* CARETAKERS *of the* SOIL

There are many threats to our soil. Erosion by water and wind can be a major problem and cause loss of the fertile topsoil. Pollutants can contaminate soil, like when there is an accident and oil spills onto the side of a road. Also, new developments sometimes pave over large areas of soil for parking lots or buildings.

There are many ways to take care of the soil. Farmers are now trying to use crop rotations and other practices to reduce soil loss. Construction crews use straw or hay mulch to cover bare soil to decrease erosion. Loggers are being encouraged to select some trees in a forest to be harvested at one time—instead of taking all the trees at once—and this helps to protect soil from damage. Some states and private organizations are helping to keep soil from being paved over by purchasing land and then forbidding development in the future.

YOU can help protect soil by staying on trails when hiking in the mountains, helping to compost wastes and then putting the compost on your lawn or garden. And you can also be careful with wastes like paint or gas—don't pour them onto soil or down the drains where they will get into the water or soil. Soil is an important life-giving resource that helps us all—plants, animals and people—grow and stay healthy.

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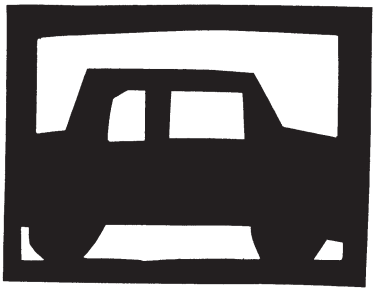


TRANSPORTATION

• *"We live in Vermont and my mom works in Plattsburgh. Five days a week she uses the Grand Isle Ferry to get to work and back again. The ride is peaceful. During the winter she sits inside and reads the paper. During the summer she hangs out on the deck, soaks up the sun and feels the cool lake breeze."*

• *"My family lives in rural New York. If we want to go shopping, I mean really shopping, we have to travel by car to Plattsburgh. There's no public bus or train, and it's way too far to ride our bikes!"*

• *"Have you ever driven on Route 7 south from Burlington between 4:00 and 6:00 p.m.? It's bumper to bumper traffic. There's been talk lately about running a train that would travel from Rutland to Burlington. If people commuting into Burlington took a train each day, think of all the fuel we'd save and traffic jams we'd avoid!"*

Historically, the lake and its rivers served as the main transportation route for all the people who settled here. Canoes, bateaux, sailing ships and steam boats were used to travel from one place to another. Towards the end of the 1900s the railroad system replaced these ships as the major form of transportation. Although there are still trains, the system isn't as popular as it once was. Other forms of transportation, such as cars, motorcycles and airplanes, have replaced the rail system.

Ferries still provide an essential form of transportation from one side of the lake to the other. In 1995, 863,000 cars used the three ferry crossings run by the Lake Champlain Transportation Company. The Grand Isle-Plattsburgh ferry, which operates year-round, carried 679,000 cars in 1995.

Due to the fact that the basin is mostly a rural region, public transportation is either inconvenient or not available. In today's fast-paced society, we need to be there NOW. It is quicker to jump in a plane or a car. The more urban areas, such as Burlington and Plattsburgh, provide public bus transportation within the city limits. This helps to cut down on traffic, save fuel and decrease the air pollution from the exhaust of all the cars.

MANUFACTURING

• *"I was at a science fair last week and International Paper Company had a display on making paper and how much water they use to make the paper. They were giving out pads of paper that were made at the plant in Ticonderoga."*

• *"Our class toured the Teddy Bear Factory this year. They showed us how they make the bears and the materials needed for stuffing and fluffing. Some of the materials they use are recycled."*

There are various forms of industry all over the basin. These industries may be located on the shores of the lake, such as International Paper in Ticonderoga, New York, or located near a tributary, such as IBM in Essex, Vermont. These industries provide people with products and help to bring people and jobs to the area.

These industries also use water during phases of their manufacturing processes. There are presently 28 industries that discharge treated water within the basin. This is called industrial effluent. It is important to make sure that the effluent is free of materials that may pollute the water. There are regulations designed to stop hazardous industrial effluent from entering the lake and its tributaries.

DEVELOPED LAND

• *"My parents just sold off my grandfather's farm. They told me a new housing development was going to be built there, and they're going to name the whole place after my grandfather!"*

• *"My mother is really upset about the Walmart that's going up in town. She said that there will be too much traffic on our road and we'll lose some of the scenic beauty."*

• *"I was at the mall yesterday when it started to rain really heavily. All this junk from the parking lot was in this little river and it all went down a storm drain."*

Developed land includes land used for residential home sites, roads, malls, construction sites, commercial developments, towns, cities and schools. Developed land makes up 3% of the basin's surface area. The common feature of most developed land is that the soil gets covered up by a hard surface. Water that falls onto these surfaces no longer filters through the soil. Water runs off these hard surfaces into a storm drain or directly into a body of water. The water can carry with it anything on the surface such as motor oil, pet feces, road salt or pesticides.

We may feel pretty comfortable now, but what will happen if all of these activities continue without being managed? Consider the following scenarios:

• *It's a beautiful summer day and you're out trying to enjoy the mountains of the basin. You arrive at the trail head of Mt. Marcy and there is no place to park. There must be at least 2,000 people hiking the trail. You park half a mile away and finally reach the trail. As you hike along, you notice a lot of trash. You've passed 20 other hikers in the last 30 minutes! You reach the top of Mt. Marcy to find a crowd of people.*

• *Strap on those roller blades early in the morning and head for the Burlington bike path. You've learned that this is the best time to use the bike path. The middle of the day is a safety nightmare. You have to dodge strollers, bikers, walkers, bladers and runners. You're constantly slowing down or stopping to get out of someone's way...*

• *What a beautiful day for a ride on the lake. You arrive at the public access boat landing at 10:00 a.m. to find a waiting line to put the boat in the water. You finally motor off onto the lake at 2:00 p.m.*

The Pine Street Barge Canal

by Nancy Bazilchuk

Lake Champlain's early history as a transportation corridor inadvertently became a twentieth century problem at the Pine Street Barge Canal Superfund site, a hazardous waste site on the shores of Lake Champlain.

In the early 1800s, engineers dug a large canal in a wetlands area of Burlington to allow barges from the Adirondacks to bring lumber to sawmills on Pine Street. A big square area called a turning basin allowed boats to turn around and head out into Lake Champlain again.

But once boats were no longer used to move timber, the canal fell into disuse. By 1908, when the Burlington Gas Works moved its operation to Pine Street, the canal took on another job; it became a convenient place to put wastes from the gas works, and that's when the trouble began.

The gas works took coal and cooked it in a kind of pressure cooker to produce something called water gas, which was piped throughout Burlington for lighting, cooking and heating.

Making the gas left sticky coal tar, essentially the same substance that paving companies use as asphalt. Some years the gas works was able to sell the coal tar for just that purpose. But even though coal tar is commonly used, it is not safe when sitting next to Lake Champlain, which supplies drinking water to about 166,000 people, including everyone in Burlington.

People do not agree on how the coal tar got into the barge canal. Those who ran the gas works said the Lake Champlain floodwaters spread the coal tar from tanks where it was stored during the last years of the plant's operation. But it is likely that in the early years, some of the coal tar was simply dumped in the canal. In any case, chemicals in the tar found their way into the groundwater.

By the time Green Mountain Power Company closed the gas works in 1966, an estimated 600,000 cubic yards of soil had been contaminated by the coal tar wastes. That's enough soil to fill a football field more than 100 feet deep.

The green of wetland vegetation hid the barge canal's woes until 1978, when the state decided that it would route a road through the wetland next to the canal. The road, called the Southern Connector, was seen by transportation experts as a way to ease congestion on roads like U.S. Route 7, and speed cars into Burlington's downtown. When engineers began drilling into the soil to see what was there, they found the sticky coal tar in everything—in some places as deep as forty feet.

Still, state officials weren't discouraged. They thought they could clean up the barge canal and build the road. But at the same time, the U.S. Congress enacted a new law that was supposed to help states clean up big hazardous waste sites like the barge canal. Some Burlingtonians, thinking that the new "Superfund" law would help pay for the cleanup, lobbied Vermont's senior senator, Robert Stafford, to have the Environmental Protection Agency (EPA) include the Pine Street site as one of the national sites needing cleanup.

Those Burlingtonians got their wish. But the complexity of the Pine Street site, combined with difficulties implementing the Superfund law, tied the problem up in red tape.

In November, 1992, 12 years after the Pine Street Barge Canal got named as a Superfund site, federal officials released a cleanup plan. But the plan didn't seem like a solution at all. Because there was so much contaminated soil, the EPA wanted to build a landfill right on top of the contaminated wetland. The landfill would have cost $50 million, and it would have been as big as the University Mall in South Burlington—a 25-foot-high, 23-acre structure that would have been larger than any other building in the city.

And because the landfill was going to be built on the squishy peat soils of the wetland, environmentalists were afraid that the weight of the landfill would squeeze all of the coal tar out of the peat and right into Lake Champlain, contaminating the lake. And even if the coal tar stayed in the peat, residents who lived near Pine Street were afraid that digging it up to pile in the landfill would release toxic vapors from the tar. Environmental groups, businesses and residents who read about the plan thought that it was crazy.
The EPA was going to protect a wetland by building a landfill on top of it, possibly poisoning Lake Champlain or the neighborhood near to the barge canal? It just didn't make sense.

In fact, Vermonters were so outraged they flooded the EPA office in Boston with letters, phone calls and faxes. So the federal agency changed its mind and decided to let Vermonters study the barge canal site some more to come up with a more sensible plan. Out of this activism, the Pine Street Barge Canal Coordinating Committee was formed. This committee hopes to have a cleanup plan in place by 1997.

THE EFFECTS *of* POLLUTION *on* LAND AND WATER

Everything we do on the land affects the health of the basin in either a positive or negative way. Whether we are washing our car in the driveway or helping to pick up trash along the roadside, our actions have an effect on the basin.

Next time it rains in your area, think about where the water goes. What is the rainwater picking up as it travels toward a stream, lake, pond or puddle? Our land-use practices have a large impact on the quality of water throughout the Lake Champlain Basin.

Pollutants from land use are categorized in two large groups, point and non-point sources of pollution. Point sources of pollution enter the lake or a stream directly from one place, such as a pipe. This kind of pollution is easier to track and measure because researchers know exactly where the water is coming from and where it flows out into the lake or stream. Point sources of pollution usually are connected to industries and wastewater treatment facilities, which may include the outflow of chemical and industrial wastes.

On the other hand, nonpoint sources of pollution are a bit different. These are the pollutants that enter the lake and tributaries from dispersed sources on the land and in the air. They normally enter the water in surges of snowmelt or rainfall runoff. As the water travels over the ground, it picks up pollutants and carries them to a nearby stream or lake.

For the purposes of our discussion, pollutants in the Lake Champlain Basin can be placed into four categories:

- organic materials,
- inorganic materials,
- toxic pollution,
- thermal pollution.

Organic materials come from the decomposition of living organisms and their by-products. They enter the lake through both point and nonpoint sources. Materials such as grass clippings, manure, banana peels, urine and newspapers are examples of organic materials. Decomposing organic materials are great for the soil. However, in the water, decomposing organic materials can cause some problems.

OPPORTUNITIES FOR ACTION, a publication of the Lake Champlain Basin Program, says that 29% of the phosphorus entering Lake Champlain is from point sources. In 1992, the State of Vermont enacted statute 10 V.S.A. Sec. 1266a, which established a basin-wide phosphorus limit from point sources at 0.8 milligrams/liter. This regulation applies to point source discharges greater than 200,000 gallons/day. Research indicates that in order to maintain a balanced level of phosphorus in the lake, phosphorus inputs into the lake must be reduced by 200 metric tons/year.

Turbidity is the measure of how clear the water is. The more turbid the water, the more solids there are floating around making the water murky. We can test the turbidity of the water with a simple device called a Secchi disk.

When these solids settle to the bottom of the lake or stream, they fill in the cracks where small aquatic organisms live. This makes the habitat unsuitable for some aquatic species, such as stonefly nymphs, mayfly nymphs and caddis fly larvae.

The Monsanto Corporation introduced PCB fluids in 1929. PCBs were manufactured and unchecked for about 40 years. PCBs have excellent electrical and temperature-insulating abilities. They were used in transformers, x-ray machines, refrigerators, microwave ovens, paints and various other products. The whistle was blown on the use of PCBs in 1968 when 2,000 Japanese were poisoned after eating food cooked in PCB- contaminated rice oil. PCBs have been found to cause cancer and many other biological problems in animals.

In the water, these organic materials are broken down by microorganisms. This process requires oxygen. If there are lots of organic materials in the lake, thus lots of decomposition taking place, more oxygen is used, and the water will become low in oxygen. Some aquatic species do not tolerate low oxygen levels and will die or leave the area.

Inorganic materials include suspended and dissolved solids such as road salt and sand, minerals in the soil eroding from stream banks, and soil from construction sites, plowed croplands and dirt roads. When these inorganic pollutants enter the water, they may float around or settle to the bottom. Excess solids in the water can cause the gills of aquatic species to clog, making breathing difficult. Suspended solids also block light from reaching aquatic plants and interfere with photosynthesis. These solids are considered non-point sources of pollution.

Toxic pollutants are organic and inorganic chemical compounds that can poison living things. Sources of toxic pollutants can come from industrial sources and airborne contaminants as well as from our own homes. Issues relating to pollution from toxins in Lake Champlain, however, are centered around polychlorinated biphenyls (PCBs) and mercury. Most toxins are found in sediment. Therefore, the first species to ingest these toxins are the ones that live in the sediment and consume the particles such as midges and worms. A dragonfly nymph might consume several midges that are contaminated with toxins. The toxic material will accumulate in the dragonfly nymph. If a fish consumes numerous dragonfly nymphs that are all contaminated with toxins,that fish has all of those accumulated toxins in its body. Someone who catches 20 fish loaded with toxins and eats the fish then has all the toxins in his or her body.

When a toxin enters an ecosystem, its concentration sometimes increases as it moves up the food chain. This is called biomagnification. Although humans are susceptible to toxins in food, they are less vulnerable because of their ability to vary their diet. If, however, a person eats too many fish that are contaminated, there is a risk of a health problem.

Thermal pollution is a by-product of using water to cool something down. Some industries utilize water as a coolant; the water is heated in the process. Thermal pollution is considered waste heat. Although it is not considered to be a major problem in Lake Champlain, warmed water will affect the life of aquatic species.

THE IMPORTANCE *of* GOOD STEWARDSHIP

The best way to make sure that the lake and its tributaries are pollution-free is to take action, get involved! You can become part of a water testing program in your local area, conduct land-use surveys and monitor your own water use.

By testing the quality of water in a stream, you can learn important information. You may discover it has a lot of phosphorus in it. Now you're not only a scientist, you are a detective. What is causing the phosphorus to be high? Monitoring the water over a period of time, several times a year for five years, can tell you whether the water is healthy or polluted. You may see variations in your tests from season to season. Now that you've become involved, you have the responsibility to communicate your test results to the community. Many laws and regulations are changed in response to the results of citizen monitoring programs.

There are lots of different things to test for and techniques for testing them. The table below outlines the tests and their purposes. Most of these tests require some equipment that your school can purchase or make.

"People who live in the communities along the river need to get involved in the river's future."

Wayne Laroche, one of the organizers of the Missisquoi River Basin Association

TESTING FOR WATER QUALITY

TEST	PURPOSE OF THE TEST
Dissolved Oxygen	*To determine the amount of dissolved oxygen in the water. Aquatic species need a certain amount of oxygen to survive.*
pH	*To determine how acidic the water is. Extreme low or high pH values create unsuitable living environments for aquatic species.*
Temperature	*To determine the temperature of the water. Warm water holds less oxygen.*
Turbidity	*To measure the clarity of the water. Murky waters can clog fish gills, block light and absorb the sun's heat.*
Total Dissolved Phosphorus	*To determine the amount of phosphorus in the water. Excess amounts of phosphorus can cause algal blooms and cultural eutrophication of the water.*
Benthic Macroinvertebrates *(bottom-dwelling invertebrates such as mayfly nymphs, leeches and snails)*	*To determine the species present in a certain body of water. Aquatic species have various tolerance levels for polluted waters.*

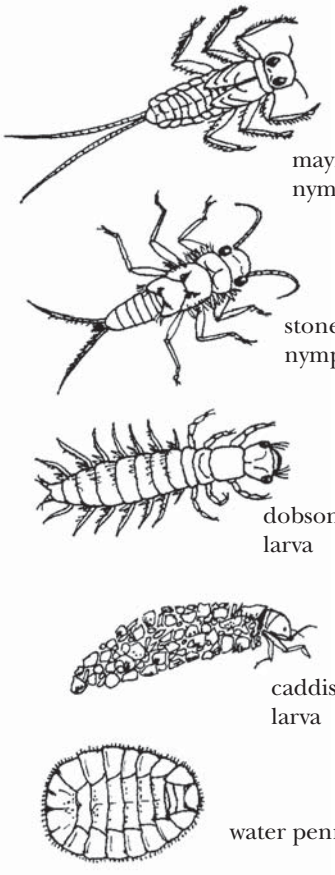
Aquatic Storytellers

The lakes, ponds, streams and even the puddles of the basin are full of very small aquatic species that can help tell us about the quality of our water. These species are called benthic macroinvertebrates.

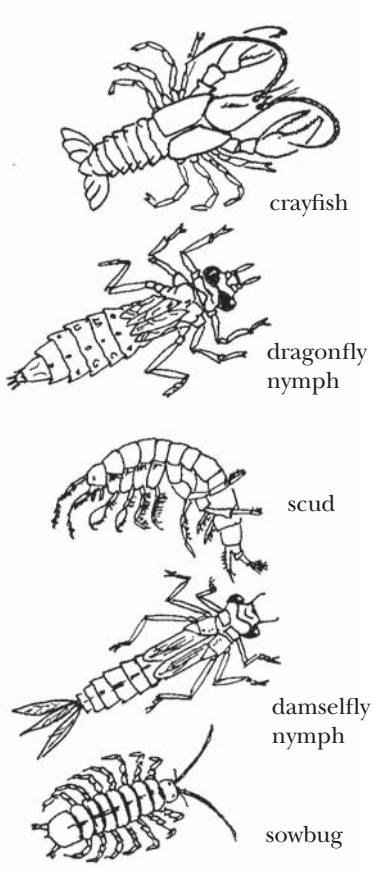
Benthic means bottom-dwelling. Macroinvertebrates are invertebrates you can see with the unaided eye. Most macroinvertebrates are aquatic insects such as the water penny or the aquatic stage of insects such as a dragonfly nymph.

Macroinvertebrates have different tolerances for polluted water. By sampling a stream for macroinvertebrates, you can determine the quality of the water by simply identifying the collected species. All you'll need is a net or kitchen strainer, a bucket, a small cup for rinsing, a macroinvertebrate guide and good observation skills. Some of these macroinvertebrates are small and most of them are well camouflaged. Because they are so tiny they can be easily hurt. Find creative ways to observe them without touching them. Magnifying glasses or "bug boxes" that hold water and have a magnified lid work well.

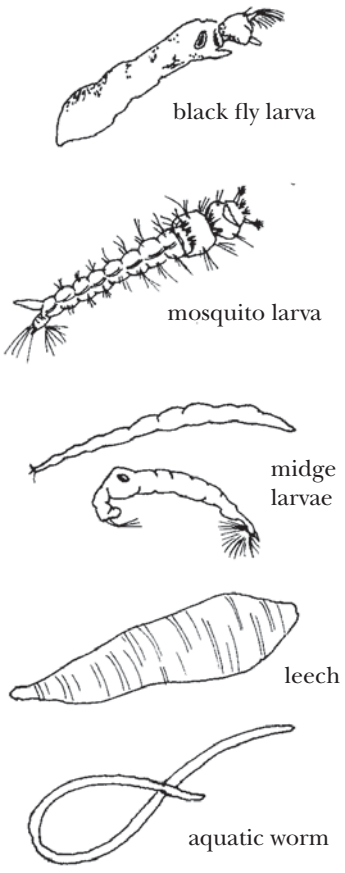
Good water quality



Range of water quality conditions



Poor water quality



YOU CAN MAKE *a* DIFFERENCE!

People have been concerned about the health of Lake Champlain for a long time. In 1905, a U.S. Geological Survey was conducted and recommendations were made to improve water quality. The report clearly outlined the many problems facing the lake and deemed the water of Lake Champlain "unfit for domestic consumption," but little was done to design a comprehensive plan.

Many individuals over time became involved in water monitoring and lobbying politicians on specific issues. Over the years, Native Americans have protested and voiced their opposition to many land use practices that affect the quality of the water. The Lake Champlain Committee, formed in 1963, is a citizen's action group that has worked for many years on both sides of the lake.

In 1990, the Lake Champlain Basin Program (LCBP) was established to coordinate the activities of the Lake Champlain Special Designation Act. The Lake Champlain Special Designation Act, supported by Senators Leahy and Jeffords from Vermont and Senators Moynihan and D'Amato from New York, was to bring together people to create a comprehensive plan for protecting the future of the Lake Champlain Basin. A draft plan was released in October 1994 and adopted in the fall of 1996.

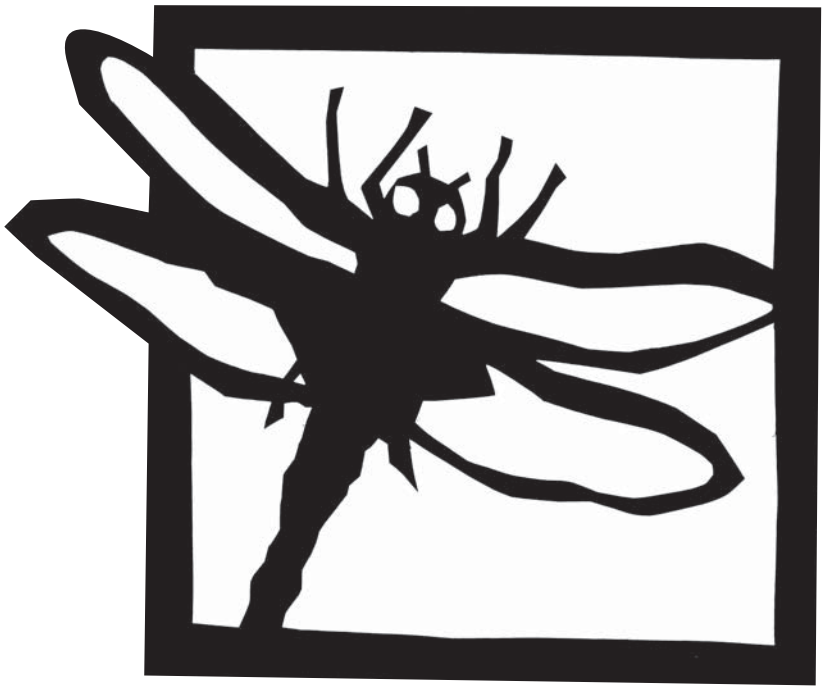
How can you insure that the Lake Champlain Basin we call home will continue to be a beautiful and useful resource in the future for all species? You have to take action! Many people in the basin participate in action projects. So can you!

You may not be a senator or serve on a big committee, but you can still work to help the Lake Champlain Basin. Ask yourself, what can I do to help keep the basin healthy? There are lots of simple yet critical action steps that we can all practice to make a difference. The following list offers just a few ideas. Meet with your family and friends to brainstorm some other ways you can make a difference and then put them into practice every day. We share this earth with many living things and are the caretakers of the earth for future generations. We all must do our part.

The plan, adopted in 1996, was under development for five years. It provides recommendations for a wide variety of management actions, including water quality, fish and wildlife, recreation and cultural resources. The three main priorities in the plan include: reducing phosphorus levels, reducing and preventing pollution from toxic substances, and controlling nuisance nonnative aquatic species.

Governor George Pataki of New York said, "This comprehensive plan demonstrates that New York and Vermont, along with our federal partners, can work together to protect and enhance a valuable resource that is cherished by families and communities in both states."

- Turn off the water while brushing your teeth.
- Test the water in your local community's ponds, streams and rivers.
- Ride your bike instead of traveling in the car.
- Car pool or take public transportation whenever possible.
- Write a letter to your local newspaper.
- Write a letter to your senator.
- Use environmentally-sound products to clean your home.
- Keep cars and boats in good working condition.
- Start a compost pile.
- Plant trees and shoreline vegetation to reduce soil erosion.
- Avoid using toxic materials.
- Dispose of toxic materials correctly—know about hazardous waste pick-up days in your community.
- Share your new knowledge about the basin with family and friends—you can be the teacher!
- Participate in a community clean-up day.
- Don't use too much fertilizer on your lawn.



The Ecology of the Lake Champlain Basin

Activities

There is an endless supply of wonderful educational activities relating to ecology and water. This section of the book provides you with a few favorite activities as well as a resource listing to find more. The key element, however, is to get the students out into the environment—take a close-up look at a mayfly nymph, plant willows along an eroded stream bank or simply take a walk in the woods.

In order to appreciate the beauty and richness of the Lake Champlain Basin, you and your students must take the time to be in the environment. As soon as your students have become more aware of the basin and begin to appreciate its resources, they are ready to take action. Foster their desire to be stewards of the basin by providing opportunities to complete community projects near your school or local body of water.

Above all, have fun and be prepared for exciting learning opportunities in and out of the classroom!

Water as a Universal

QUESTIONS

- Where is water?
- Where does water come from?
- What does water look like?

KEY RESOURCES

- Water Science *by Deborah Seed*
- Project WET—*Western Regional Environmental Education Council*
- Pond and Brook *by Michael Caduto*
- At the Water's Edge *by Alan Cvancara*
- Water *by Graham Peacock*

Word Bank

absorb
aquifer
atom
attraction
charge
covalent bonds
displace
droplet
electron
evaporate
freshwater
gas
gravity
groundwater
humidity
hydrogen
hydrologic cycle
hydrologist
ice
infiltration
lake
molecule
negative (charge)
percolation
positive (charge)
precipitation
ocean
oxygen
river
saltwater
solvent
transpiration
vapor

Activity: Poetic Possibilities

TEACHER NOTES *and* INFO

Learning about Lake Champlain can provide wonderful opportunities for writing poetry. Whole classes, small groups, or individuals can start by brainstorming a list of "water words" on the board, on an overhead or as a web on poster paper. A variety of activities may then be developed using this list, again either in small groups or as individual assignments.

STUDENT ACTIVITY

Brainstorm with your class some water words. Here is a sample from Sue Hardin's sixth-grade science class:

Water Words

rain snow ice lake flow cold aquatic dew condensation water scuba submarine river sewer moisture H_2O frost fog fish swim sink wet fluid boil dive drown bubble aquarium gurgle skating sparkles boat vapor Jacuzzi showers pool wet dog wetland swamp squirting juice spring splash spit saliva ice cream sleet wavey gulf precipitation spray squirt pacific pond marine waterbed brook water gun slippery sea sparkle canoeing hail skiing Atlantic hose falls overcast drops lobster damselfly tap dragonfly chlorine hydrophobia blizzard whale pleasure frog estuary well skipping stones stream shark trickling ice fishing snorkeling seal benthic shell algae clam depth habitat thunderstorm ocean l'eau foamy gushing

Poetic Possibility 1

Write a poem using at least five words from the list.

Poetic Possibility 2

Write a five-line poem in which the first word of each line begins with the letters of the word water.

Poetic Possibility 3
Write similies and metaphors for water or wetlands.

Poetic Possibility 4
Write poetic or punning definitions beginning with "Water is...."

"Water is a brook moving rapidly."

Poetic Possibility 5
Compose a wetland haiku (seventeen syllables, arranged in three lines of five, seven, five).

Sun peaks through the clouds.
The wetlands serve their purpose,
Soaking up the storm.
Samantha Price, Grade 6, South Burlington

The goose flies southward,
Comes to rest in a wetland.
Home away from home.
Kevin Stevenson, Grade 6, South Burlington

Poetic Possibility 6
Write a "shape" poem in which the words become graphic illustrations of their meaning, then mount them on construction paper cut to an appropriate shape. The shape poems provide a neat opportunity to play with words and to learn about computer fonts and typestyles as well:

WWWWATER LOVES TO WWWAVE

A brook rushes
down
the mountain,
Tripping
over
stones.

Credit: *Activity from Susan Hardin, sixth-grade teacher at Frederick Tuttle Middle School, South Burlington, Vermont. Used with permission.*

Activity: Water Diary

TEACHER NOTES *and* INFO

This is a way for students to gather information about how much water people use in simple daily tasks.

STUDENT ACTIVITY

This activity can go for a week or longer. The "Water Diary" on which the students record their daily water use should be checked daily and can be recorded on a master class chart. If you want to extend this activity throughout the year and record seasonal changes in water use, you will need to set up another recording system.

Before handing out the worksheet, invite students to predict how much water is used for the tasks listed.

STUDENT HANDOUT - "How Much Water Do I Use?"

You will need:

- a diary for each student with a chart to help calculate water use. See "How Much Water Do I Use?"

Other Ideas

• When the activity is completed, have a small group of students calculate the total for each student in each category. Then calculate the total class use for each category. You will then have one figure for each activity, e.g. the class uses 175 gallons of water for their pets. Students can then each make a bar graph, or together they can make a large bar graph to display in the room.

Taking It Home

Brainstorm ways to conserve water for certain activities. Graph how much water you can save by changing water- use habits. Discuss with the class how they would like to share this information with their families and what action plan they might develop to conserve water.

Name: _____

How Much Water Do I Use?

DIRECTIONS: Use this chart to figure out how much water you used in one day.

PURPOSE	AMOUNT
Bath	40 gallons
Shower	30 gallons
Brushing teeth	1 gallon
Flushing toilet	5 gallons
Drink	1/2 gallon (food and drink)
Washing hands and face	2 gallons
Washing dishes	10 gallons (by hand), 15 gallons (by machine)
Watering lawn	240 gallons in 30 minutes
Washing clothes	30 gallons
Watering houseplant	1/16 gallon per plant
Pet waterbowl	1/4 gallon

DIRECTIONS: We all use water in different ways every day. We might drink it, wash with it or even water plants with it. Think about the things you do that use water. Record the amount of water you use in one day.

In the morning

I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.

In the morning I used _____ gallons of water.

At school

I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.

At school I used _____ gallons of water.

After school and in the evening

I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.
I used water to: _____. I used about this much water _____.

After school and in the evening I used _____ gallons of water.

DATE OF RECORDING: _____ I USED THIS MUCH WATER ON THIS DAY: _____

Activity: The Drop Goes On!

TEACHER NOTES *and* INFO

The following activity is a fun and creative way to teach about the never-ending process of the water cycle.

Find a large piece of rope and tie both ends together. The rope should be large enough for each child in your whole class to hold onto with both hands while standing in a circle. The one knot will signify the drop of water.

Note: *If you or a student or parent "knows the ropes," splice the rope and make a slip knot that sits on the loop and can be transferred from one student to another.*

You will need:
- a large rope

STUDENT ACTIVITY

Explain to your students that, together, they are going to tell a story about the life of a water droplet. The knot in the rope symbolizes a drop of water.

The first person to start is the person holding the knot. That person can have that drop of water do whatever he or she wants, as long as it ties in somehow with the water cycle. Encourage students to use the vocabulary they are learning, e.g. evaporate, precipitate, etc.

Example: *"The drop of water came out of the sky, it precipitated, and landed on the back of a frog."*

The speaker then hands the knot to the next person. The next person must take the drop of water from the frog's back and continue the story. Continue until everyone has had a turn. How much longer could the story go on? Forever! There is no end to the water cycle. Encourage your students to be creative: travel around the world, hook up with celebrities; the drop goes on!

Activity: Believe It or Not

The following three activities explore the qualities of water and can be set up as stations around your classroom. Directions for each experiment are on individual cards that can be handed out to pairs of students. Students will need to predict, test, observe and record their thoughts and results. The activities are from PROJECT SEASONS by Deborah Parrella. You can find more activities to explore the nature of water in this book.

You will need:
- several quarts of water
- clear plastic cups
- several plastic forks
- paper clips
- sewing needles
- magnifying glass

TEACHER NOTES *and* INFO

Step 1

The paper clip and needle are able to float because of the surface tension of the water. The water molecules at the surface are strongly attracted to one another and they form an elastic skin. If you can place these items horizontally on the surface, without breaking through this elastic skin, they will float. This is how some insects can walk on the surface of water!

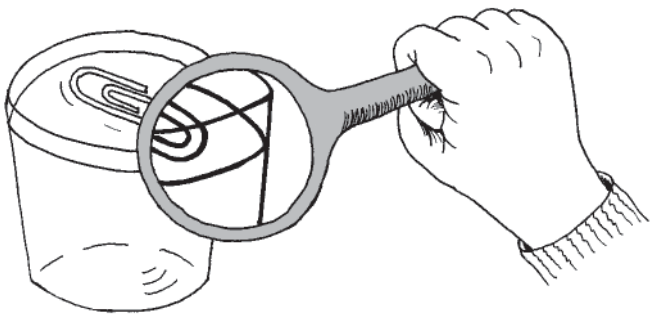
Step 2

If you look closely at the water surface around and beneath the paper clip or needle, it appears dimpled. The water's skin appears to stretch and can suspend these light objects.

STUDENT DIRECTIONS *for* Believe It or Not

1. Fill a cup with water. Try to float a paper clip or sewing needle on the surface of the water. Use a fork to help place it gently. Why can the paper clip and needle float in the water, if placed correctly?

2. Once the paper clip or needle is floating, observe the water beneath it with a magnifying glass. What does the surface of the water look like?



Activity: Rising to the Top

You will need:
- several quarts of water
- plastic cups
- variety of paper samples such as stationary, newsprint, sketch paper and paper towel
- scissors
- ruler
- pencil
- magnifying glass

TEACHER NOTES *and* INFO

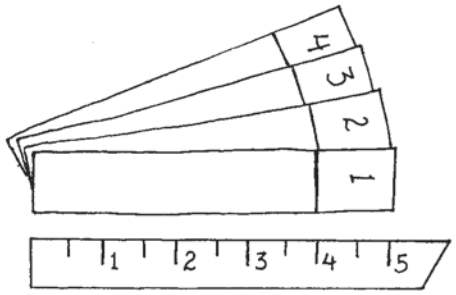
If you look closely at paper, you will see that it is made up of fibers. In between the fibers are air spaces. The water is attracted to these spaces and pulls itself into them, moving up the strip. The paper with the largest air spaces should provide the most surface area for the water. It is the most porous and water should move through it the fastest.

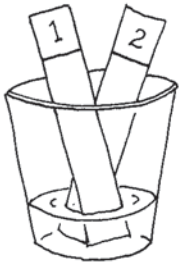
STUDENT DIRECTIONS *for* Rising to the Top

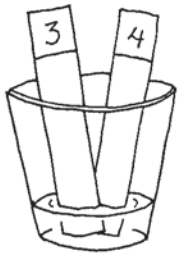
1. Gather four different kinds of paper to test in this activity. Using a ruler, pencil and scissors, cut the paper into strips one-inch wide by five inches long. Put a line across each of the strips at the four-inch mark. Number the strips one to four above this line. These are your "racing strips."

2. Fill two identical cups with one inch of water. You will place your racing strips into the cups at the same time, and the water will race to the finish line. Now it's time to place your bets. On which sheet will the water cross the line first? second? third? last? How long do you think it will take? Make your predictions. Then, on your mark, get set, flow!

3. What were the results? Can you explain how and why the water moves faster on some paper and slower on others? Use a magnifying glass to look for clues.







Activity: Sink or Float

You will need:
- dish basin full of water
- a collection of objects to use in the experiment (see list on Student Directions for possible ideas)

TEACHER NOTES *and* INFO

The wooden block, crayon, lemon, walnut in the shell, pencil and twist tie, all float because they weigh less than the water that is pushing upwards beneath them. The metal jar lid may or may not float depending on how it is placed in the water. The cotton ball floats then sinks as it absorbs water. The plastic comb may sink or float, depending on what kind of plastic it is made of. The golf ball sinks.

STUDENT DIRECTIONS *for* Sink or Float

1. Begin by guessing which of the items on the following list will sink and which will float. Record your guess in the proper column.

2. Now test your guess by experimenting with each item in the basin of water. Record the actual result.

3. Look around the room and find at least two more objects to guess, test and record your results. Why do some objects sink and some float?

OBJECT	SINK *or* FLOAT?	RESULTS
Wooden block		
Crayon		
Lemon		
Walnut in the shell		
Metal jar lid		
Pencil		
Golf ball		
Plastic comb		
Cotton ball		
Twist tie		

Water Naturally

QUESTIONS

- What is a watershed?
- How many different types of habitats are in the basin?
- How much land makes up the Lake Champlain Basin?
- How does water travel within the basin?
- How is a river different from a stream?
- What happens to lakes and ponds in the winter?
- What types of species live in the basin and how are they connected?
- How do lakes and ponds change over time?

KEY RESOURCES

- Interactive Lake Ecology *by Mark Denencour*
- Project Seasons *by Deborah Parrella*
- Pond Life, a Golden Guide *by George K. Reid*
- Opportunities for Action—*Lake Champlain Basin Program*
- Pond and River, an Eyewitness Book *by Steve Parker*
- NatureScope: "Wading into Wetlands" —*National Wildlife Federation*
- Aquatic Project Wild—*Western Regional Environmental Education Council*
- WOW! The Wonders of Wetlands *by Britt Eckhart Slattery*
- Water: A Natural History *by Alice Outwater*

Word Bank

algae
Atlantic flyway
decomposition
density
dissolved oxygen
dormant
ecology
ecosystems
epilimnion
erosion
eutrophication
food chain
food web
gravity
habitat
hypolimnion
larva
lentic water
lotic water
macroinvertebrate
metalimnion
nutrient
nymph
oligotrophic
phosphorus
photosynthesis
phytoplankton
riparian
seiche
stratification
sub-basin
tributary
watershed
wetland
Wetland Restoration Project
Wildlife Management Area
zooplankton

Activity: Where Are You in the Watershed?

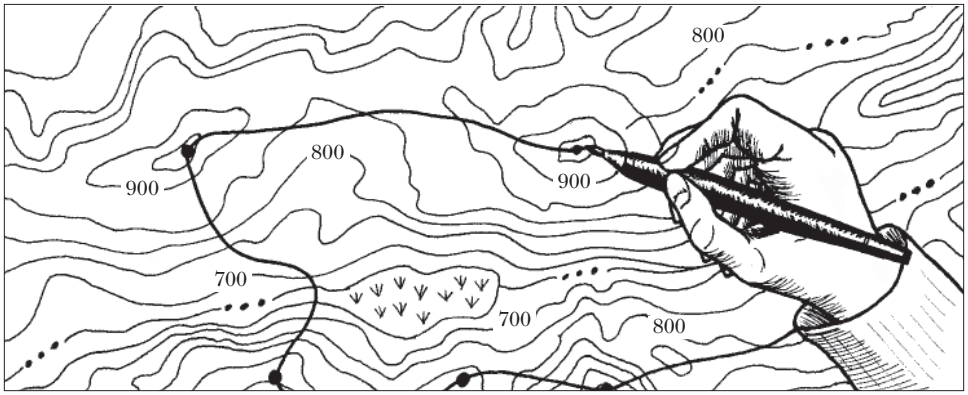
You will need:
- a topographic map for your region that shows the area from your town to the lake
- reproducible copies of topographic maps. National Wetland Inventory maps are available from the Vermont Wetlands Office. These maps are based on topographic maps and are in black and white so that you can reproduce them. Students can directly mark copies or use mylar with overhead markers.
- mylar (optional)
- overhead markers (optional)
- markers
- one large map of the basin would be helpful

TEACHER NOTES *and* INFO

This activity gives students a chance to become familiar with topographic maps and learn how to recognize wetlands, watersheds and other features on these maps. Students will be able to identify where they are in the watershed.

STUDENT ACTIVITY

1. Get a USGS topographic map of your area and have the students find locations of interest—their homes, the school, the roads they travel. Explain that a contour line joins all points of the same elevation (height above sea level), that some of the contour lines have numbers on them and this is the elevation in feet or meters, and that contour lines that are close together indicate a steep area. Find some hilltops and valleys.
2. Have the students find the wetlands in your area. Are they associated with rivers, streams, lakes or ponds. If not, why are the wetlands where they are? Where are the wetlands located (elevationally) relative to other features?
3. Choose one wetland area and mark all the highest points around the wetland with an X or a large dot. Connect the points with a line to delineate the wetland's watershed (see below). Discuss how any land use activity in the watershed can affect the wetland: soil, fertilizer, pesticides and other pollutants can wash downhill into the wetland with surface runoff.
4. Use the topographical map to try to "travel" by water to the lake. Locate the nearest tributary and figure out what route to take to the lake. Students should be able to delineate what sub-basin they are in by outlining the area from their home to the lake.



Credit: *Activity adapted with permission from DISCOVER WETLANDS, by Brian Lynn, Washington Department of Ecology, 1988.*

Activity: Layering Activity

You will need
for each group:
- some food coloring
- 2 glasses half full of really hot water
- 2 glasses half full of ice-cold water

Other Ideas
• Give students the materials and invite them to design an experiment that will demonstrate whether cold water acts differently than hot water and how they act together. Students will need to make a hypothesis, design a procedure then record what happens. Help them design questions that their experiment will answer.

TEACHER NOTES *and* INFO
Just as warm air rises above cool air, making the second floor of a building warmer than the first, warm water rises above cool water, making the top of the lake warmer than the bottom. Warm water is lighter or less dense than cold water. Discuss with students how this phenomenon affects the lake.

Every winter as the cold wind blows over the lake, it chills the surface water, which sinks. The warmer water below rises, gets cooled by the cold air, then sinks, too. This happens again in the spring as the water warms. The continual up-down movement of water is called "overturn." In this way, food and oxygen are constantly being turned over in the water.

STUDENT ACTIVITY
1. Add food coloring to the glasses of hot water. Slowly pour some of the water into a glass of cold water. What happens to the hot, colored water? Does it float on top of cold water or sink? Is it lighter or heavier than cold water?
2. Do the experiment again, pouring cold water over hot water. What happens?

Activity: Junk in a Jar

You will need
for each group:
- pond water
- at least 3 same-sized jars
- detergent or other materials with phosphate
- an eyedropper, measuring cup or tool

Note: *The good news is that detergents with phosphates are banned in New York and Vermont. The bad news is that phosphate may be hard to find for this activity. You can use plant food or fish fertilizer.*

TEACHER NOTES *and* INFO
This activity demonstrates what phosphorus that goes down the drain can do to our water. Phosphorus is an essential element for all plants and animals but it causes problems in surface waters when present in excessive amounts. In some places it is used widely in detergents.

STUDENT ACTIVITY
Organize students in small groups. Ask students to predict how excess phosphorus might affect pond water. Will it clean it? Change it? Harm it?
1. Collect enough pond water to fill each jar with an equal amount of water.
2. Using the eyedropper, add different amounts of the phosphate material to all but one jar. Leave this one jar alone as a control sample. Label each jar with the amount of detergent you put in. Put all the jars in a sunny windowsill and watch what happens to them over the next two weeks.

Activity: Exploring Wetlands

TEACHER NOTES and INFO

The most important part of teaching about wetlands is to visit a wetland. This often means getting wet and mucky; it sometimes means a ruined pair of sneakers and some dirty jeans but it's a mighty wonder. The following material is actually a series of activities about learning and visiting a wetland. As a humanities teacher who has added the study of the natural world of Lake Champlain in the past five years, wetlands were my door to the world of science and to the extraordinary pull the natural world has for children.

STUDENT ACTIVITIES

1. Preconceptions about Wetlands
2. Guided Imagery
3. Wetlands Metaphor
4. The Visit
5. Winding Down
6. Mudpoem

Activity:
Preconceptions about Wetlands

TEACHER NOTES *and* INFO

Since many students and their parents have negative attitudes about wetlands, it is helpful to explore these attitudes before your visit.

STUDENT ACTIVITY

Ask your students what they think of when they think of wetlands. Have them write their impressions in their thinkbooks.

"When I think of a swamp I think of mud, plants, gross animals like frogs and snakes. It's slimy, wet and ugly."

thinkbook entry, Grade 5, Milton

"When I think of a swamp it's not the best place to be. Sometimes it's neat to explore to see what lives there. But not for very long. It smells, it's wet and it's murky."

thinkbook entry, Grade 5, Milton

Note: *The word "swamp" is loaded and you may choose to use "wetlands."*

Taking It Home

Ask your students to ask their parents what they think of wetlands. Make up some questions with your students and ask them to copy them over and take them home to interview their parents. **Examples:** "What's the first word that comes to mind when I say swamp?" *green slime* "Do you know anything about swamps?" *mosquito-infested, frogs live there, lily pads*

Activity: Guided Imagery

TEACHER NOTES *and* INFO

Students should be seated quietly in a darkened room while you lead them through an imaginary walk through the wetlands.

STUDENT ACTIVITY

*Shut your eyes and picture yourself in a very quiet place. It is warm and breezy and you can feel the wetness around you. There are trees and grasses and as you listen you can hear the sounds of birds. As you begin to walk you are aware of how soft and springy the earth is under your feet. You stop again and this time you can hear the CROAK of a bullfrog. It stops as you get nearer. You can hear the Zzzzz of mosquitoes and the ground is getting extremely moist under your feet. You're into some muck now and your feet are almost stuck as you pull them up to take your next step. (*Make mud-walking noise.*) Next you get to a small little hill and decide to sit there and watch all the birds and bugs fly by....*

Activity: Wetlands Metaphor

TEACHER NOTES *and* INFO

This activity helps teach the unique characteristics and functions of wetlands. Begin by introducing wetlands to your class. Since the metaphor activity helps teach this material, this can be brief. Students should be familiar with the benefits of a wetland on the right hand side of the chart that follows.

Prepare a "Mystery Metaphor Container" (a pillowcase or box), filled with the following objects: sponge, small pillow, soap, eggbeater or mixer, small doll cradle or pictures of nursery items, picture of zoo, toy animal, sieve or strainer, paper coffee filter, antacid tablets, small box of cereal or crackers, package of wild rice. Use magazine pictures to represent anything that you

You will need:

- "Mystery Metaphor Container" with items listed on next page

can't locate. The following chart will help you but students always come up with other ways to explain their objects:

SPONGE: absorbs excess water caused by runoff; floodbuster; retains moisture for a time even if standing water dries up (A sponge stays wet even after it has absorbed a spill.)
PILLOW or BED: is a resting place for migratory birds
EGGBEATER: mixes nutrients and oxygen into the water
CRADLE: provides a nursery that shelters, protects and feeds young wildlife
STRAINER: strains silt, debris, etc., from water (keeps water supply clean)
COFFEE FILTER: filters smaller impurities from water (excess nutrients, toxins)
ANTACID: neutralizes toxic substances
CEREAL, RICE or PICTURE OF A GARDEN: provides nutrient-rich foods for wildlife and humans
SOAP: helps clean the environment as a whole
PICTURE OF ZOO or TOY ANIMAL: habitat for diversity of wildlife
PICTURE OF RESORT or SUITCASE: resting place for migrating waterfowl

STUDENT ACTIVITY

Divide the class into small groups. Ask each student to choose an object from the container. The group needs to find a metaphor for each object. **Example:** "A sponge is like a wetland because it absorbs moisture."

Encourage students to make any connections that help them understand the benefits of wetlands. There is not one right answer. Give groups some time to discuss and then have each student show his or her object and state its metaphor.

Review by asking the class these questions:

- Why are wetlands important?
- How do they help Lake Champlain?

Formalize with a short essay assignment or "Five Facts about Wetlands."

Activity: The Visit

PREPARATION *for your* VISIT

Because of bird migrations some natural areas are closed at certain times of the year. Arrange the visit several weeks ahead. Some areas are designated hunting areas so this is a question of safety as well as courtesy. The area will be posted if it is restricted. Find out whether the wetland that you want to visit is privately owned or managed by a state or federal agency. Contact the person responsible.

Two weeks ahead, talk to the students about what they are going to need:
- "high waders" or a pair of old sneakers
- old clothes
- dry socks/pants to change into back at school
- warm jacket
- sometimes hats and mittens!
- sometimes bug repellent!
- chaperones!

Allow time for working out the logistics, e.g. "My brother has a pair of boots you can borrow."

You will need:
- 12 clipboards
- pencils
- copies of the scavenger hunt (see p. 471)

I usually carry everything to the site in a big canvas bag.

TEACHER NOTES *and* INFO

When we visit the wetlands, we do two activities on site, the "Scavenger Hunt" and "Observing Water Creatures," described on p. 471 and 475. For the past four years, I have had a naturalist come with me so that we could split the class in half, each run one of the two activities, and then switch groups. Nine to eleven students is a maximum number for each activity. When Mary Dupont and I take a group together, she has taken a third group and run a workshop on dissecting cattails.

It is important to prepare the students for what will be happening and what they will be asked to do. I explain the schedule and show them the scavenger hunt. You don't want to have to explain much on site; at that point you turn them over to Mother Nature and let her do the instructing.

I tell the students that the beavers are inside the lodge with pencils, clipboards and worksheets writing their observations on Milton fifth-graders.

STUDENT ACTIVITY
Hand out copies of the scavenger hunt, pencils and clipboards on site. Most of the walk is led in quiet; we try to stay still and see some birds and we sneak up on the beavers although they are always too smart for us.

At some point, when we have done our "work," we take time for some fun and exploration. If there is a safe place for them to explore the muck, I highly recommend letting them. The value of the exploring, observing, speculating and questioning always equals or surpasses the worth of the formal observation. When we've finished we walk to meet the other group, so the students can switch teachers and activities.

STUDENT HANDOUT - "Scavenger Hunt"

Activity: Winding Down

You will need:
- "Picture Page" (see p. 470)
- large, white drawing paper
- colored pencils
- glue
- scissors

TEACHER NOTES *and* INFO
I have enjoyed scheduling the wetlands expedition mid-day so that we have some time in the classroom the same afternoon. We are exhausted and happy, the room is a mess and stinks of muddy socks and wet boots. The students change into dry clothes and have a snack and we sit around for a while and rave and laugh about how dirty and happy we are. The principal comes in and shakes his head, but leaves smiling.

We then settle down to a drawing/writing activity, which provides a welcome calm and a chance for students to tell their stories of their visit to the wetlands.

STUDENT ACTIVITY
Each student gets a page with wetland "pictures" on it and a large piece of white drawing paper. The task for students is to write stories of their trips

using the pictures and their words. They may write the whole story on one page, or cut the paper into four to six sections and make a small book. Students always create variations to these possibilities and some artists choose to make all their own illustrations but use the "Picture Page" for ideas. We settle down to a peaceful time of drawing, writing, cutting and pasting.
Instruct your students to either plan the story first or choose the pictures first. In any case, they should color the pictures before gluing them on.

- Color the pictures.
- Plan the page.
- Write the story.
- Glue pictures.
- Illustrate background. Students can trim, color frames or illustrate by coloring in skies or grasses.

> *"It was COLD today at the wetlands and it was fun. We got to see a BEAVER home and a lot of other things and my friend Jason got tons of muck on him. We saw a lot of DUCKS."*
>
> *thinkbook entry, Grade 5, Milton*

Other Ideas

• One year, in addition to the above, each student chose one picture from an extra "picture page," and used it to illustrate one blank index card. Final "pages" were laminated and mounted into a book that we sent to Judy Elson, the naturalist who came on our wetlands walk, to say, "Thank you!"

Activity: Mudpoem

TEACHER NOTES *and* INFO

After your visit to the wetlands, record the sensations of your visit by writing a poem!

STUDENT ACTIVITY

Ask students to brainstorm a list of the different sounds that they did hear or might have heard in the wetland. Individuals or groups of students can write their own creative versions of what a wetland sounds like, using any of the ideas on the board. As students read these aloud, the efforts become a group poem. Write the completed poem on the overhead. Read the poem while they make the sounds to accompany it. Practice a few times and produce a final tape for the classroom archive.

Possible sounds:

- frogs
- crickets
- birds
- bubbles
- mud
- dripping water
- lapping waves
- beavers slapping their tails on water
- beavers gnawing on trees
- mosquitoes
- a bear stuck in the mud
- bees
- a duck landing on water
- a heron silently watching for food
- a fish flopping over on water

Picture Page


cloudy

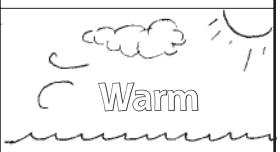

cattails

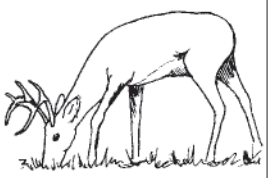

rushes

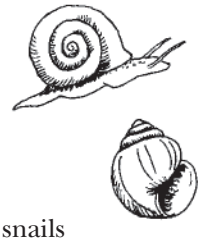

animal tracks


dragonfly


mosquito




deer


snails


muskrat or beaver lodge


raccoon

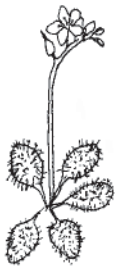

geese


ducks


freshwater marsh

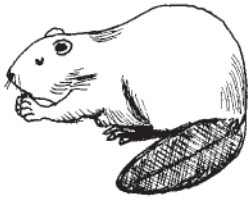

great blue heron


pitcher plant


sundew

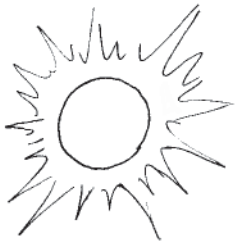

muskrat


frog


beaver


bog

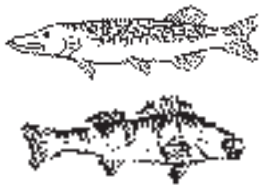

hawk


sunny


trees


grasses


mussels


fish


freshwater swamp

Credit: *Adapted with permission from NatureScope: "Wading into Wetlands" by the National Wildlife Federation.*

Name: _____

Scavenger Hunt

Work in groups to find, but not take, these things.
Try to identify anything that you can. Draw pictures and describe:

ANIMALS

with wings: with a tail: with a tongue: with three colors:

The most interesting thing about animals I saw:

PLANTS

with a flower: with shiny leaves: that float: with roots:

The most interesting thing about plants I saw:

Find something...

dead: tiny: slimy: weird:

Find evidence of...

a home: a sponge: moving water: still water: decay:

Check off the animal signs that you see.
Identify them if you can and write down any others not on the list.

_____ tracks
_____ droppings
_____ nests
_____ lodges
_____ chewings
_____ burrows
_____ bones
_____ feathers
_____ other: _____
_____ other: _____

You are a guest in someone's home. Be a good one!

Rubies Pearls

Activity: Silhouettes

YOU WILL NEED:

- wet-on-wet watercolors
- watercolor paper—heavy drawing paper is best
- brushes or small sponges
- ice trays to hold water for painting
- newspaper to cover desk or tables
- colored or silver foil paper

STUDENT ACTIVITY

Class 1

1. Wet the colors in the kit—really stir and have a juicy, wet surface.

2. Wet the paper that you are going to paint on with clear water. Use a brush or small sponge and lots of water. Work fast. Cover the paper so it's wet like your skin after you come out of a bath or the lake.

3. Taking your brush, soak up two watercolors from your kit. Brush across the wet paper. Watch the paint sprawl, bleed, blend and mix.
Do this three or four times—each time soak the brush with two colors to create color blends. You may use two different colors each time or the same ones over and over. I wouldn't use brown or black.

Class 2

The next day, draw seaweed, shells, grasses and growth on the bottom of the lake. Color in totally with black markers. Blacken sand and bottom of lake also.

Class 3

Add small fish with colored foil paper. If you want a school of fish, fold the paper, then cut it, so all your fish are a uniform size. Make the contour of the fish a simple shape.

Human Impact

QUESTIONS

- How do humans use the Lake Champlain Basin?
- What are some positive human uses of the basin?
- What are some negative human uses of the basin?
- What role does soil play in the basin?
- How can I help keep the basin healthy?

KEY RESOURCES

- Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates —*Cornell Cooperative Extension*
- The Magic School Bus at the Waterworks *by Joanna Cole*
- Field Manual for Water Quality Monitoring *by Mark Mitchell and William Stapp*
- Testing the Waters: Chemical and Physical Vital Signs of a River *by Sharon Behar*
- Water: A Natural History *by Alice Outwater*

Word Bank

agriculture
benthic macroinvertebrates
carrying capacity
coal tar
developed land
effluent
Environmental Protection Agency (EPA)
erosion
exotics
forestry
Lake Champlain Basin Program
Lake Champlain Committee
Lake Champlain Designation Act
macroinvertebrates
manufacturing
nonpoint (pollution)
PCBs (*polychlorinated byphenyls*)
phosphorus
Pine Street Barge Canal
point (pollution)
pollutant
recreation
runoff
soil
stewardship
superfund site
thermal pollution
toxic
transportation
urban
water quality
zebra mussel

Little Ice Shanty:

The Lake Champlain Ice Fisherman

by Shelley Posen, December 1984

I am an old ice fisherman, On Lake Champlain I dwell;
At hooking ice fish, perch and smelt, There's none can me excel.

Little ice shanty, Ice shanty dear to me,
In winter out on Lake Champlain, That's where I long to be.

I take my shanty on the ice, When first it forms a skin,
I choose my spot most carefully, Before I do begin.
I bank the outsides up with snow, To keep inside the heat,
Then I take my Swedish auger in, And drill two holes so neat.

I rise from bed at crack of dawn, And stay out all the day,
My shanty keeps me nice and warm, Ice fishing on the bay.

For bait I use a piece of smelt, I skin off by the tail,
But if for perch I drop my line, It's perch eyes will not fail.
And when an ice fish takes my bait and tugs upon my line,
I weave my fish sticks back and forth, And land him double time.

My shanty keeps me from the wind; my gas stove keeps me warm,
A little drop of rye or rum, Don't do me any harm.
By night my bucket's full of fish, To be carried home and dressed,
We eat five pounds at suppertime, And in water freeze the rest.

Let those that want to tip-up fish, Outside do as they please,
Give me my shanty any time—, Why should I fish and freeze?
Let heave cracks thunder under foot, Let white-outs make me blink,
I'll ice fish on Lake Champlain, 'Til I have to swim or sink

And when I die and go to heaven, Where all ice fishers go,
I'm sure I'll find ice shanties there, Just like I had below.

Little ice shanty, Ice shanty dear to me,
In winter out on Lake Champlain—
Fish with me only on the ice,
That's where I long to be.

Dr. Sheldon I. Posen, folklorist and creator of the exhibit and book, "You Hear the Ice Talking," composed this song to the tune of "The Stern Old Bachelor" to describe ice fishing on Lake Champlain. Sung by Stan Ransom. Used with permission.

Activity:
Observing Water Creatures

TEACHER NOTES *and* INFO

A note on teaching observation skills from Judy Elson:

Wetlands (or the grassy edges of a pond or lake) are truly magical places to explore with students of all ages. Before arriving at our observation spot, I like to brainstorm with the students the kinds of behavior that will ensure a successful visit. Eventually we cover everything—respect, quiet, slow movements..."take only pictures, leave only footprints." If you have done some work in class on wetlands or water environments, review what a wetland is and observe the basic characteristics of wetlands, such as moist soil and wetland plants.

The staff at Vermont Institute of Natural Science recites this poem as they put a creature back in the water:

Swim away, stride away, crawl away, hop.
You are free to go
I'm not going to stop
You from living your life
You deserve to be free
Thanks for sharing this time with me!

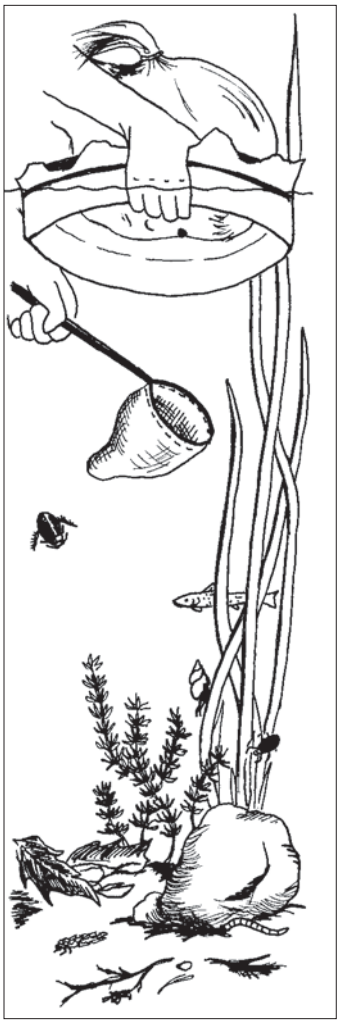
The main objectives of our trip are:
- to strengthen students' observation skills,
- to enlighten their curiosity about an unknown area,
- to have fun.

We definitely accomplish all three. We also learn the names of some of the plants, the life cycle of some aquatic insects and we solidify the connection of humans to the creatures and habitats of the wetland and the water's edge.

Review with your class the observation skills and procedures they will be using at the water's edge. Hand out "Taking a Closer Look" for each student to have at the site. Students should review this sheet before their visit and have a copy on site.

STUDENT HANDOUT - "Taking a Closer Look"

You will need
for each group:
- a pad of paper and pencil
- a nature guide to ponds (optional)
- a small hand-dip net, a flat-bottomed net, or a kitchen sieve
- 2 or 3 clear containers half full of pond water
- a spoon
- trowels
- bucket
- a waterscope
- a magnifying glass
- flat-bottomed container with high sides to view creatures (use white enamel or clear glass with white paper underneath it)



Taking A Closer Look

Tips for finding critters!

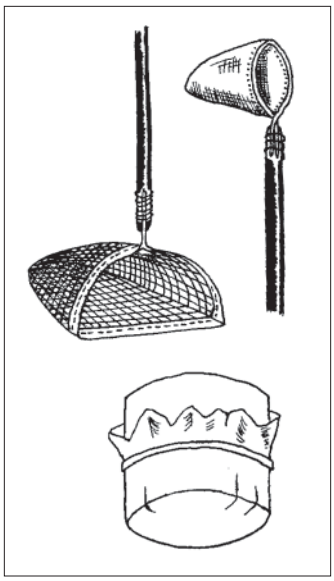
1. As you approach the water's edge, watch for tracks of animals in the mud or sand. Sketch the tracks on your pad of paper so you can look them up in your nature guide.

2. Look for insects such as water striders and dark whirligig beetles on the surface of slow-moving water, or for mosquito larvae under the water's surface. Catch a few insects with your dip net, and place them in a container of pond water. Some of these insects move fast so a viewer that can contain the insect, such as a magnifying insect bottle, is best. Use your nature guidebook to identify them.

3. Many insects hide near or on water plants. Sweep the dip net through the water close to plants and look under leaves. The slime beneath waterlily pads contains microscopic plants and animals that snails and insects eat. Look under rocks and small pieces of wood as well. How do the creatures attach themselves to things? Keep an eye out for dragonfly nymphs crawling about on the plants or stones, transparent freshwater shrimp that look like sow bugs, and dark brown leeches.

4. The bottom mud contains a surprising number of creatures. Use a spoon to dig up some mud and place it in a sieve. Wash the mud away with some pond water, then use the magnifying glass to look for aquatic worms.

5. Stand in the water and look at things with your microscope. Use the flat-bottomed net to catch minnows, large beetles or crayfish. Put them in a container of pond water, identify them, then return them to the pond.



Making Your Own Tools

• A **hand-dip net** is good for collecting small insects and organisms on top of the water and among plants. Bend a coat hanger into a ring three inches in diameter. Sew a nylon stocking or piece of cheesecloth onto the ring. Fasten the ring to a stick or pole with wire. (A butterfly net works well too.)

• A **flat-bottomed net** is useful for collecting fish, minnows or beetles. Bend a coat hanger into a D-shaped frame about a foot wide. Sew a net bag made from cheesecloth onto the rim. Fasten the ring to a broom handle with wire.

• A **waterscope** is an ideal way to view tiny animals and plants without getting wet! Cut off the bottom of a plastic pail or ice-cream container. Cut a piece of plastic wrap to cover the bottom. Attach the wrap with large elastics. Use your waterscope on a sunny day in clear, still water.

Credit: *Adapted with permission from WATER SCIENCE by Deborah Seed.*

Activity: Go With the Flow

TEACHER NOTES *and* INFO

This activity introduces the concept of a watershed and the way that nonpoint source pollution flows within a watershed. Arrange students into small groups.

STUDENT ACTIVITY

1. Explain to the group that they will be designing their own watershed with the materials provided: aluminum foil (land), plastic cups or scrunched up newspaper (molds for the mountains) and the tray (bedrock). Place two or three plastic cups upside down on the tray. Have the groups mold aluminum foil over the cups to create the mountains, valleys and rivers.

2. When the watersheds are complete, invite the groups to discuss the types of land use that take place in their watershed: agriculture, industry, urban development, roads, recreation areas, to name a few! What effect do these land-use practices have on the water quality in your watersheds?

3. Ask the groups to sprinkle some pollution (the dry drink mix)over the land-use areas that they think may affect the water quality. Invite the group to make some predictions about what will happen when it rains on all this pollution.

4. Give the groups watering cans or spritzers to simulate a rainstorm in their watersheds. Where did the water travel? What happened to the color of the water after traveling though the land-use areas? Does this happen in real watersheds? What are some local sources of nonpoint source pollution in our local watershed? How can we decrease the amount of nonpoint source pollution reaching our water supply?

"A watershed is like a giant funnel. So the mountains on all sides are like the side of the funnel. The water goes from the streams and rivers into Lake Champlain then it keeps going into the Atlantic Ocean. And some of the water goes underground and we need it for drinking water."

thinkbook entry, grade 5, Milton

You will need:

- aluminum foil
- plastic cups or newspapers
- packets of unsweetened dry drink mix (grape or cherry)
- lunch trays or large platters/plates (lasagna pans are good)
- watering cans or plastic jugs with pin holes

Activity:
A Question of Development

TEACHER NOTES *and* INFO

After students learn about the importance of wetlands, this experience will help them formulate their opinions about the pros and cons of development on the lake. It sets up an "us vs. them" mode for you and your students.

There are numerous role play scenarios in different sources such as PROJECT WILD and AQUATIC WILD.

STUDENT ACTIVITY

Explain the activity:

> *"Now you are all going to have a chance to be creatures of the wetlands. Imagine that you are a living thing in the wetlands on the Milton shore near the Sandbar [or other wetland]. You can be a very small creature or the largest living thing that might live in or near a wetland…a moose…a bear…? You may also choose to be a person…maybe you are a canoeist or hiker or bird-watcher who likes to walk through the wetlands in big, tall boots! Choose a creature that lives in or benefits from the presence of wetlands."*

Begin with:

> *"I am a developer and I want to build a 65-slip marina on these wetlands. Construction will mean draining the land and bringing in fill on which to put structures. It will mean the destruction of this habitat as you know it, but, of course, change is good. Don't tell me you have problems with this great plan!"*

As a closing for this activity, ask the students to write a position paper about what they think is the right thing to do. They can write them as a [fifth-grade student in Milton, Vermont], or speak as the characters they were during the role play. Students may choose to read their position papers orally when they have finished.

I maintain a strong position for building the marina and allow them turns in speaking out against construction. If needed, have a cattail for a microphone and ask them to pass it to each other and allow turns to speak. I prefer to do without this, however, so the crowd can build itself into a (well-orchestrated) frenzy.

In the second half of the activity, we switch positions: I am the lone opponent of the building of the marina and they are the local board of directors or selectpeople. I continue to press them with reasons why it shouldn't be built; they have an opportunity to explain to me why it must be built.

Activity: Basin Bumpers

TEACHER NOTES *and* INFO

This activity will give your students a chance to review all the problems that face Lake Champlain, consider solutions and speak out about a problem that they would like to solve.

STUDENT ACTIVITY

Brainstorm with your students all the problems that face Lake Champlain. Ask students to list the problems on the left-hand side of a worksheet. After you have completed the list, discuss and list solutions to each problem on the right-hand side.

Ask each student to choose one issue that he or she would like to design a bumper sticker for. Students can use space on the worksheet for a rough draft. Make final bumper stickers on oak tag, laminate them and display them in the school.

Your class may choose to have a contest and find a way to make real bumper stickers with the winning one!

You will need:

- worksheet
- oak tag pieces pre-cut to the size of a bumper sticker

Taking It Home

Ask your students to take home the list of problems that you have generated in class. Do families have any to add to the list? Ask students with their families to rank the problems in order of importance. What problems are the hardest to solve? What problems are the most serious and should be given priority? It would be interesting to have students share results in class and figure out a way to process and publicize the results.

Activity: Soil on the Run

You will need:
- old paint roller trays or 9" x 13" baking pans
- soil
- 2–4 bricks
- watering cans
- buckets filled with compost
- a variety of mulch materials such as dried leaves, grass clippings, straw, Popsicle sticks, twigs and toothpicks
- selection of quick-germinating seeds such as grass, wheat, buckwheat or bean

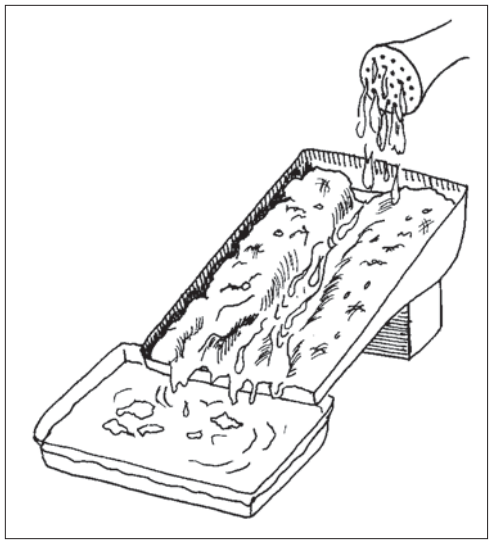
Other Ideas

• Try this activity outdoors on a sloping plot of lawn. Remove sod from several plots and test various options: mulch, terracing, adding organic matter, etc.

• Make splash sticks to show how raindrops can loosen and move soil. Have small groups of students make their own splash sticks by attaching paper to three-foot lengths of lumber with thumbtacks. Explain that they will be holding these sticks vertically over bare soil with the paper touching the ground and using a watering can to simulate rain. How high will the raindrops carry bits of soil? Ask them to record and initial their predictions along one edge

TEACHER NOTES *and* INFO

Students will learn about soil erosion and how to control it. Arrange your students in small groups.



STUDENT ACTIVITY

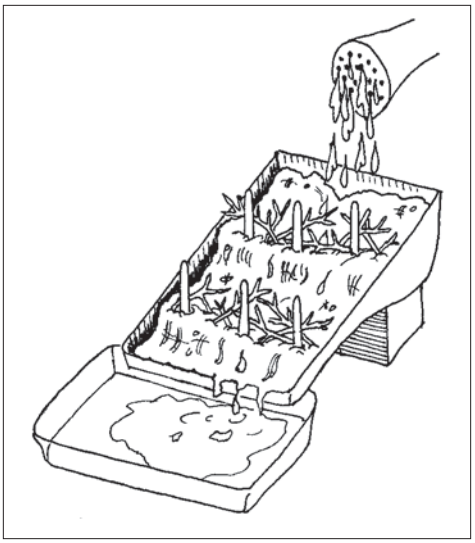
1. Gather the students together for a demonstration. Explain that you are a New England hill farmer and you just finished harvesting and tilling your fields. Show the students a tray full of soil that is propped up on one side, creating a slope. Place a collecting basin beneath the tray that runs the width of the tray. Tell the students it has been a rainy fall and another storm is brewing. Ask them what will happen to the soil in this field during a rainstorm. Record their predictions. Then, using a watering can (held one foot above the tray), let it "rain" for one to two minutes.

2. Have the students examine the soil in the tray and observe the runoff collected in the basin. Pour it into a clear jar for closer inspection. (They should see gullies formed in the tray, and perhaps large areas where the soil was washed away. The water in the collecting basin will be muddy and full of sediment.) Have them test the soil at various depths to see how much water was actually absorbed. Discuss the results and what this means with regard to soil and plant health.

3. Explain to the students that soil erosion is a serious problem facing humans throughout the world. Every year three billion tons of topsoil are lost, and it is the topsoil that is responsible for soil fertility. Remind them it takes a hundred or more years to make an inch of new topsoil. Challenge the students to reduce the amount of erosion that occurs on sloping farm fields.

4. Divide the students into small groups and give each group two trays to be filled with soil. Tell them they will need to research and discuss options for controlling erosion in these fields. Possible options include mulch covers, contour plowing, cover cropping, terracing, and adding organic materials to the soil to improve water absorption.

5. Provide materials for students to use on their fields including compost, various forms of mulch, twigs, Popsicle sticks and toothpicks (for creating terraces, water bars and roots), and seeds. Decide with the students a time limit for research and preparations. It can vary greatly depending on the students' desires to experiment with cover crops and planting patterns.



6. On the final day of the activity, set up trays and have students present their methods for erosion control. Have all groups pour the same amount of water from a set height onto the sloping fields. Examine the runoff of each field, noting clarity, color and amount collected. Which methods were most effective at controlling erosion?

Other Ideas (continued):

of the paper. Then, by pouring water from a predetermined height (knee-high, waist-high, shoulder-high) onto the bare ground, test their predictions. Note any dirt spots and measure their height. Try the experiment on soil covered with vegetation, with mulch, etc. Compare results. Discuss the effect of splash erosion. Look for examples in the schoolyard.

• Go on an erosion walk around the schoolyard to identify where erosion is occurring. Have the students suggest solutions to these problems and try to implement their ideas.

• Study the Dust Bowl era and how the health of the soil affected people's lives. CHILDREN OF THE DUST BOWL by Jerry Stanley gives insight into this tragic era in American history.

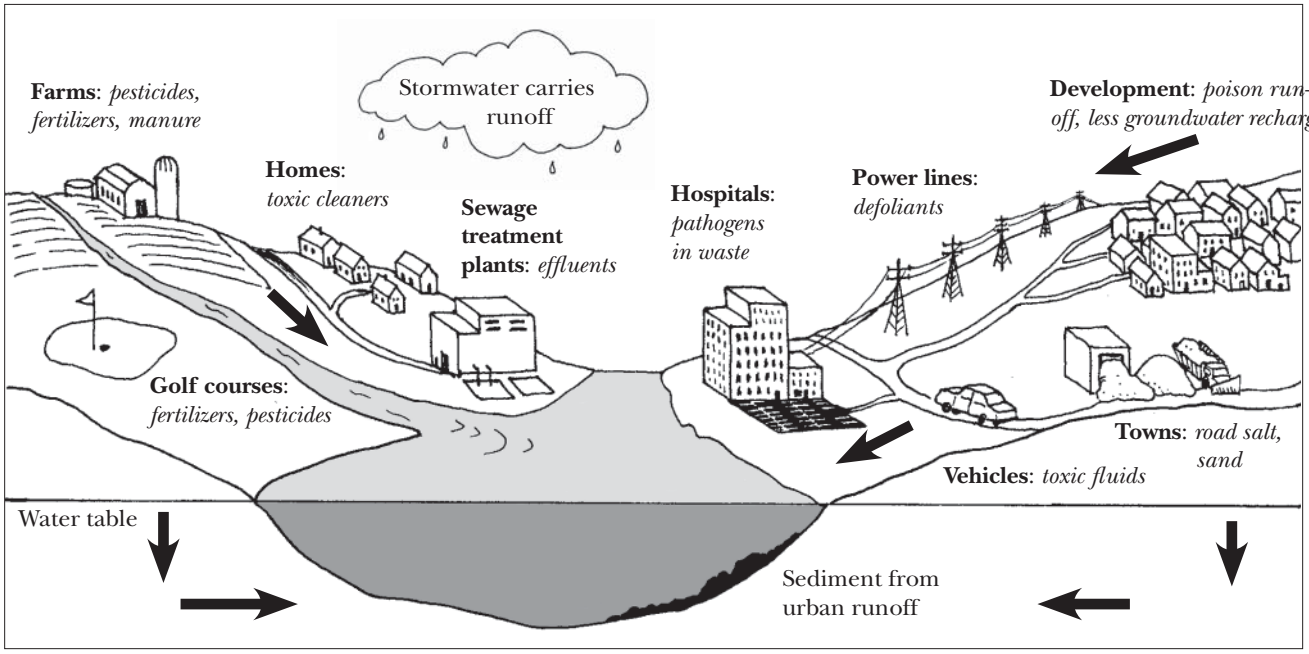
Taking It Home

TEACHER NOTES *and* INFO: After students have gained some familiarity with pollution issues, send home the handout: "Pollution Sources in a Watershed." This structured interview will help generate awareness of where sources of pollution actually exist. Students will bring back some interesting information. **Example**: One student's father worked on a town road crew and there had been a concerted effort to decrease the amount of salt they put on the roads in the wintertime. This makes students think about the impact of specific jobs and learn about human impact in a more real way.

STUDENT ACTIVITY: Explain the questions on the worksheet and send it home. It's good to give a few days for this type of assignment.

STUDENT HANDOUT: "Pollution Sources in a Watershed"

Pollution Sources in a Watershed



These questions should be completed with a member of your family.

A. Name three things that cause pollution in Lake Champlain.

1. _____

2. _____

3. _____

B. Can you find something in the picture that you recognize?

Example: Specify where there is a hospital. Name the hospital. _____

_____

C. Are there any sources of pollution that a member of your family is involved in because of their job? Does he or she know whether things are being done to find a solution to the problem? Use reverse side for answers.

Signature of family partner _____