GLACIERS & THE CHAMPLAIN WATERSHED

Map by Jean Boisseau, 1643.

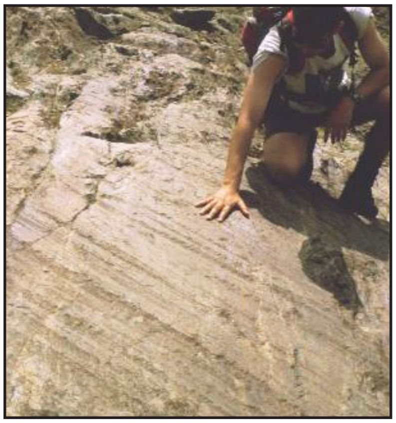
100,000 Years of Winter

Mike Winslow, Lake Champlain Committee

The article below is excerpted from the Lake Champlain Committee's (LCC) natural history book which will be available in 2009. LCC is a membership-supported non profit organization that has worked since 1963 to protect the lake's environmental integrity and recreational resources. LCC's natural history book explores the geological, physical, and biological forces at work in Lake Champlain from bedrock to climate to plankton. It will help people discover and understand the lake's rich and diverse resources and inspire them to value and care for it.

To order a copy, please contact LCC at 106 Main St., STE 200, Burlington, VT 05401, 802 658-1414, lcc@lakechamplaincommittee.org. Cover price: $18.95. Discounts available for schools.

By the beginning of March, I usually get a sense that winter has gone on long enough. At least by then the days are getting longer, but the slush and mud and ice have lost the allure they offered during the season's first storms. Watching melt-filled gutters and raging streams on those first warm days of spring makes me wonder what the land would have looked like after more than 100,000 years of winter, the approximate life-span of the last glaciers to blanket the Champlain Valley.



Striations from a glacier passing over and abrading this rock.

Without the Laurentide glaciers that covered northern North America, Lake Champlain would not exist. At their maximum extent 18,000 years ago glacial ice over the Champlain Valley was over a mile and a half thick; its weight compressed the land beneath it like a sponge. The ice flowed laterally over the landscape as the glacier thickened to the north, following the paths of least resistance through valleys including the Champlain Valley. Along the way rocks and boulders dragged beneath the ice sheet acted like sandpaper rubbed against the land. Tracks of the ice sheet are still visible on the landscape in scratches on bedrock outcrops and patterns of deposited boulders transported far from their northern origin. The glacial scouring, coupled with an influx of freshwater when it melted, has bequeathed us the lake we enjoy now.

Lake Champlain was not the first water body to occupy the post-glacial Champlain Valley. About 18,000 years ago the glaciers reached their southernmost extent, depositing debris on present day Long Island and Cape Cod, and then began to retreat. Mountains previously covered by ice became visible. Chunks of ice were left in depressions about the landscape that would melt and become kettle ponds. For a long period the remaining glacier prevented any northward flow of water, forcing drainage south to the Atlantic via the Hudson River. This was Lake Vermont. At first, the southern terminus of this lake probably sat near Albany, NY, but later drainage occurred near Fort Ann, NY, 500 feet higher than the present water level. A 40-story building on the today's lake shore would have been underwater.

Geologist Steven Wright says:

"Lake Vermont was not a clean lake, but instead contained muddy water. Some of the mud washed off the recently deglaciated and poorly vegetated mountains bordering the lake, but a lot of mud was also pumped into the lake from streams flowing off the melting glacier, especially those streams flowing in tunnels within the ice, near its base. These high-pressure streams were like fire hoses at the front of the glacier spewing cold, dirty water into the lake."

By about 12,000 years ago, the glacier had retreated far enough north to allow water to escape via the St. Lawrence estuary. According to Wright:

"Lake Vermont ended catastrophically when the glacial ice dam that was preventing its water from flowing north failed. … The failure of the dam allowed a huge volume of fresh water (hundreds of cubic kilometers) to roar out into the Atlantic Ocean through the Gulf of St. Lawrence. In the Burlington area the water level fell almost 100 m (~300 ft) within a matter of hours or days at most exposing huge areas that were formally under the muddy water of Lake Vermont."

However, the land had been depressed so much that it was actually below sea-level, and the ocean soon advanced. For the next 2,000 years the brackish water of the Champlain Sea covered the valley. This water body was intermediate in depth between Lake Vermont and present day Lake Champlain. A 40-story building on today's lake shore would have stuck above the surface, but a 25-story building would not. The saltwater brought with it a distinctive biota including whales and seals left only in bones, and sea lamprey and rainbow smelt which have since adapted to a freshwater existence.

At its greatest extent, the Champlain Sea covered the areas around Montreal and the Ottawa River Valley in addition to the Champlain Valley. Over time, the earth that had been depressed by the glaciers rebounded, and the sea shrank. Cut off from the Atlantic, eventually, the salt sea became diluted until fresh. The area covered by the Champlain Sea shrunk to the size of the Lake Champlain we know today.

Though Lake Champlain seems such an integral part of our landscape, it too has changed and will continue to change. Many low areas, once underwater, have since been mantled with sediment eroded from the surrounding mountains. Lowlands of the Champlain Valley slowly transitioned from water to wetland to dry land. The process continues today exemplified by the river deltas forming at the mouth of the lake's largest rivers or in the southern part of the lake where lazy sloughs fill with vegetation. Older deltas from the Winooski River can be found as far inland as Hinesburg Vermont. A continuing challenge for lake lovers is distinguishing manageable changes from inevitable ones.

Snow to Ice

LCMM, adapted from Jason Project

Grade Level
K-8

Content Areas
Science

VT Grade Expectations
VT S 12: Students demonstrate their understanding of the States of Matter by…
- Identifying , describing and comparing the properties of selected solids, liquids and gases.

VT S 14: Students demonstrate their understanding of Physical Change by…
- Predicting the effect of heating and cooling on the physical state and the mass of a substance.

NY Standards
NY Science Standard 4: Physical Setting Key Idea 3:
- Observe and describe properties of materials using appropriate tools.
- Describe chemical and physical changes, including changes in states of matter.

Duration
1 Week

Learning Goals
Students will observe the compaction of marshmallows and compare it to the formation of glacier ice.

Description
1. Discuss how many of the lakes in North America were formed by glaciers. The activity will demonstrate how individual snow flakes form into glacial ice.
2. Fill a jar to within 8 cm of the top with loosely paked marshmallows.
3. Cut out a cardboard circle that just fits into the mouth of the jar. Place the circle on top of the marshmallows in the jar.
4. Place weights on top of the cardboard.
5. Place a strip of tape vertically from top to bottom on the outside of the jar.
6. After the experimental materials are set up, have students speculate on what kind and how fast changes will occur.
7. Leave the jar standing for one week, checking each school day for any change. On the tape, mark and date the level of the cardboard.
8. After one week, mark the tape to show where the cardboard is and measure the difference from the starting point.
9. Discuss why the volume decreased and what happened to the individual marshmallows.
10. Discuss what happens to snow over time on the playground or in students' yards.

Assessments
Informal assessment of student participation.

Materials/Resources
One package minature marshmallows, tall transparent jar, cardboard, weight that can fit into mouth of jar, masking tape

Special Considerations
Several jars could be constructed to see if the compaction of marshmallows is uniform. Older students could compute the percentage of compaction from their measurements.

How Glaciers Spread and Merge

LCMM, adapted from Jason Project

Grade Level
K-8

Content Areas
Science

VT Grade Expectations
VT S 47: Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

- Identifying examples of geologic changes on the earth's surface, where possible in the local environment.

NY Standards
NY Science Standard 4: Physical Setting Key Idea 2:

- Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.
- Describe volcano and earthquake patterns, the rock cycle, and weather and climate changes.

Duration
50 minutes

Learning Goals
Students will observe how ice fields can grow and join together to form one continental glacier.

Description

1. Mix pancake mix into a thick batter.
2. Heat and grease the griddle.
3. Drop three spoonfuls of batter far apart on the griddle.
4. Continue to add spoonfuls of batter to the center of each one. Students should notice how each "ice field" spreads from its center.
5. Keep adding batter until the individual pancakes flow together and converge.
6. Discuss how individual ice fields also grow and converge with others to form glaciers.

Assessments
Informal assessment of student participation and understanding of key ideas.

Materials/Resources
Pancake mix, measuring cups, large spoon, electric griddle or fry pan, cooking oil

Special Considerations
If conditions are right and you can turn the pancake over, you can often see growth rings for each addition to the glacier model.

How Glaciers Scour and Pluck

LCMM, adapted from Jason Project

Grade Level

K-8

Content Areas

Science

VT Grade Expectations

VT S 47: Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

- Identifying examples of geologic changes on the earth's surface, where possible in the local environment.

NY Standards

NY Science Standard 4: Physical Setting Key Idea 2:

- Describe the relationships among air, water, and land on Earth.
- Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.
- Describe volcano and earthquake patterns, the rock cycle, and weather and climate changes.

Duration

50 minutes

Learning Goals

Students will observe a model of glacial scouring and identify how modern landforms are related to glacial action.

Description

1. The day before the lesson, place gravel, sand and soil into the bottom of a milk carton. Fill the carton with water and freeze overnight.
2. Remove the ice blocks from their containers.
3. Lay each of the test surfaces on a table.
4. Have a student volunteer to drag the ice blocks down the test surface pressing down as they go.
5. Discuss observations students have about what happened as the ice was dragged across the surface.
6. Repeat the procedure with each of the test surfaces.
7. Discuss how each surface was affected by the ice block. What was similar and different?
8. Describe how the test surfaces are similar to rock layers of different hardness. Discuss how the effects of glaciers might be different depending upon the type of rock.
9. Discuss how the scraping of the test surfaces relates to the resulting landforms. Use Glacier diagram to identify landforms. Discuss any local features around your school that illustrate these land forms.

Scouring occurs when rocks are picked up at the base of a glacier and are dragged along the landscape, creating strations in the bedrock.

Plucking occurs when rocks the water at the base of a glacier freezes into cracks in the surrounding rocks. When the glacier moves, the ice pulls or "plucks" the rock out of the ground.

Assessments

Informal assessment of student participation and understanding of key ideas.

Materials/Resources

1 quart waxed milk carton; handful of each of soil, sand and gravel; wood board, about 12 X 30 inches; plasterboard, about 12 X 30 inches; plastic foam, about 12 X 30 inches; Glacial Landform worksheet

Special Considerations

Older students may be able to work in groups to prepare the demonstration materials and explain the process of each experiment.

How the Earth Rebounds

LCMM, adapted from Jason Project

Grade Level
K-8

Content Areas
Science

VT Grade Expectations
VT S 2: Students demonstrate their understanding of Predicting and Hypothesizing by…
- Using logical inferences derived from evidence to predict what may happen or be observed in the future.
- Providing an explanation (hypothesis) that is reasonable given available evidence.

VT S 47: Students demonstrate their understanding of Processes and Change over Time:
- Identifying examples of geologic changes on the earth's surface, where possible in the local environment.

NY Standards
NY Science Standard 4: Physical Setting Key Idea 2:
- Describe the relationships among air, water, and land on Earth.
- Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.
- Describe volcano and earthquake patterns, the rock cycle, and weather/climate.

Duration
50 minutes

Learning Goals
Students will observe how weight on a surface can cause compaction and what happens when that weight is removed.

Description
1. The day before class, mix the gelatin desert mix with the unflavored gelatin. Add water according to the package instructions, stir the mixture until clear, and chill in a transparent dish. Fill empty milk cartons with water and freeze them.
2. Remove the ice blocks from their containers and place them on the solid gelatin. Let them stand 20 minutes.
3. Have students predict what they think will happen. What does the gelatin represent? What do the ice blocks represent?
4. Remove the ice blocks and discuss if their predictions were correct.
5. Observe what happens over the next 10-20 minutes. While waiting, again ask students to predict what they think will happen.
6. Discuss how long it took to rebound and if it rebounded completely. How does this relate to the weight of glaciers on the surface of the Earth?

Assessments
Informal assessment of student participation and understanding of key ideas.

Materials/Resources
2 6oz boxes of gelatin desert (a light color is best)
2 portion-size envelopes of unflavored gelatin
4 cups boiling water
4 cups cold water
Clear glass or plastic dish, about 9 X 12 inches
One ½ pint waxed milk container
One ½ gallon waxed milk container

Special Considerations
This experiment takes time to observe. Teachers may want an additional activity ready while waiting for the rebound.

Glacier Maps

LCMM

Grade Level 4-12

Content Areas Social Studies, Science

VT Grade Expectations VT S 47: Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

- Identifying examples of geologic changes on the earth's surface, where possible in the local environment.

NY Standards NY Science Standard 4: Physical Setting Key Idea 2:

- Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.

Duration 40 minutes

Learning Goals **Students will identify the extent of glaciation by producing a map and identifying the areas of North America that were affected. This activity will use modern political references to reinforce knowledge of that geography.**

Description

1. Discuss the "Ice Age" when more snow fell than melted leading to the formations of glaciers that flowed south over much of North America.
2. Distribute a political map of modern north America and project a transparency of the same map on the overhead.
3. Review how glaciers flowed south over thousands of years and reached their maximum extent about 20,000 years ago.
4. Identify your location on the map and remind students that at this time the Champlain Valley was being formed under ice thousands of feet thick. Only the tallest mountains would appear poking through the ice sheet like small islands.
5. Move directly south and draw an east-west line on the over head map indicating the southern extent of the ice through northern New Jersey and the southern coast of Long Island. Ask students to copy the line you have drawn on their own map.
6. Extend your line eastward and north along the coast of Massachusetts and southern Maine. Have students copy the next section on their map as well.
7. Continue eastward one state or province at a time, sketching in the glacial perimeter, until you get to Newfoundland. Then return to New Jersey and begin moving westward and north one state or province at a time until you reach the northern edge of Alaska. From there draw the entire northern boundary more or less following the coastline of the Canadian islands in the Arctic.
8. Your map may look like a series of smaller segmented lines. Use a pen to draw over these to produce a smooth curve designating the perimeter of the glacial fields. Have students do the same on their maps.
9. Discuss familiar areas that were once covered by glaciers and what is there today. Guiding questions might include:
   - What percentage of the USA and Canada were covered by glaciation?
   - What major bodies of water were left after the glaciers melted?
   - What major cities are now located in areas that were once covered with ice?
   - What is the shape of the land left after the ice melted?

Glacier Maps (cont'd)

Assessments

Maps should be checked for accuracy.

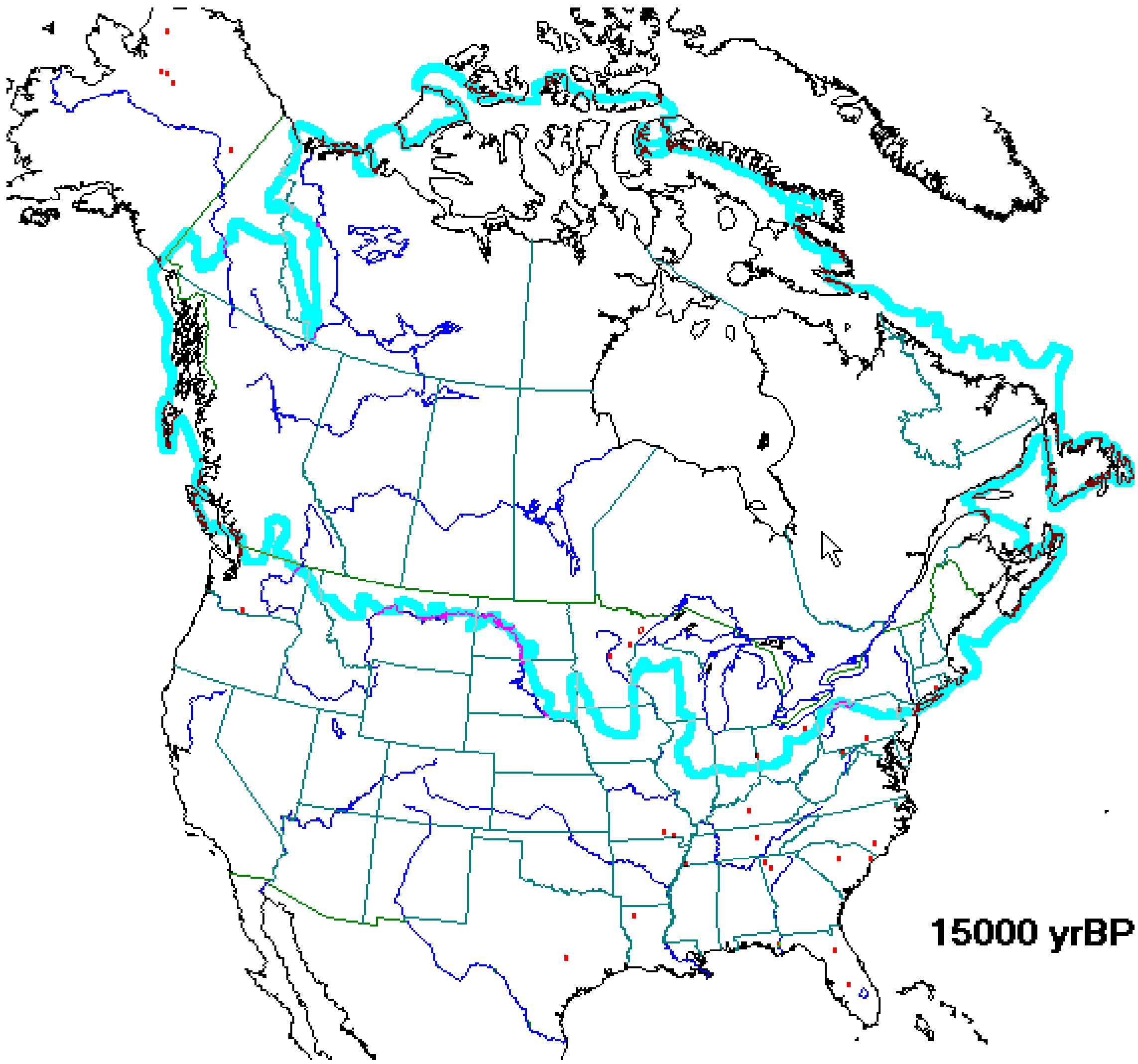
Materials/Resources

Ice Age Map Transparency, student outline map, overhead Projector

Special Considerations

Students who are not familiar with the names and locations of states and provinces will need extra help identifying each section as you proceed around the perimeter of the ice fields.

Name ______________________________ Date __________________________



LESSON

Lake Vermont and the Champlain Sea

LCMM

Grade Level 4-12

Content Areas Social Studies, Science

VT Grade Expectations VT S 47: Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

- Identifying examples of geologic changes on the earth's surface, where possible in the local environment.

NY Standards NY Science Standard 4: Physical Setting Key Idea 2:

- Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.

Duration 50 minutes

Learning Goals **Students will learn how the shorelines of Lake Vermont, the Champlain Sea, and Lake Champlain were formed by the retreat of the glaciers and the rebounding of the land.**

Description

1. Discuss how, after thousands of years, the glaciers began to melt. The weight of the glaciers had left indentations in the surface of the land where melt water collected.
2. Show the first map of where melt water collected forming a large lake in what is now the Champlain Valley. Note that the glacier still blocked the water from flowing out to the north and the mountains prevented the water from flowing east, west or south.
3. Discuss how Lake Vermont compared with modern Lake Champlain. Guiding questions might include:
   - How much larger or smaller is it?
   - What might the water have been like?
   - What kind of animals might have lived there?
   - What would be underwater then that is not now?

mention Tracy's article

4. Show the second map of the Champlain Sea. Note that once the glacier had melted far enough north, water from the ocean was able to pour through the St. Lawrence valley into the Champlain Valley. Discuss the same questions as before.
5. Show students the map of modern Lake Champlain. Note that after the weight of the glaciers was gone, the land rebounded upward and the ocean waters were no longer able to pour into the valleys. Instead the fresh water from the lands began to flow out through the St. Lawrence watershed.

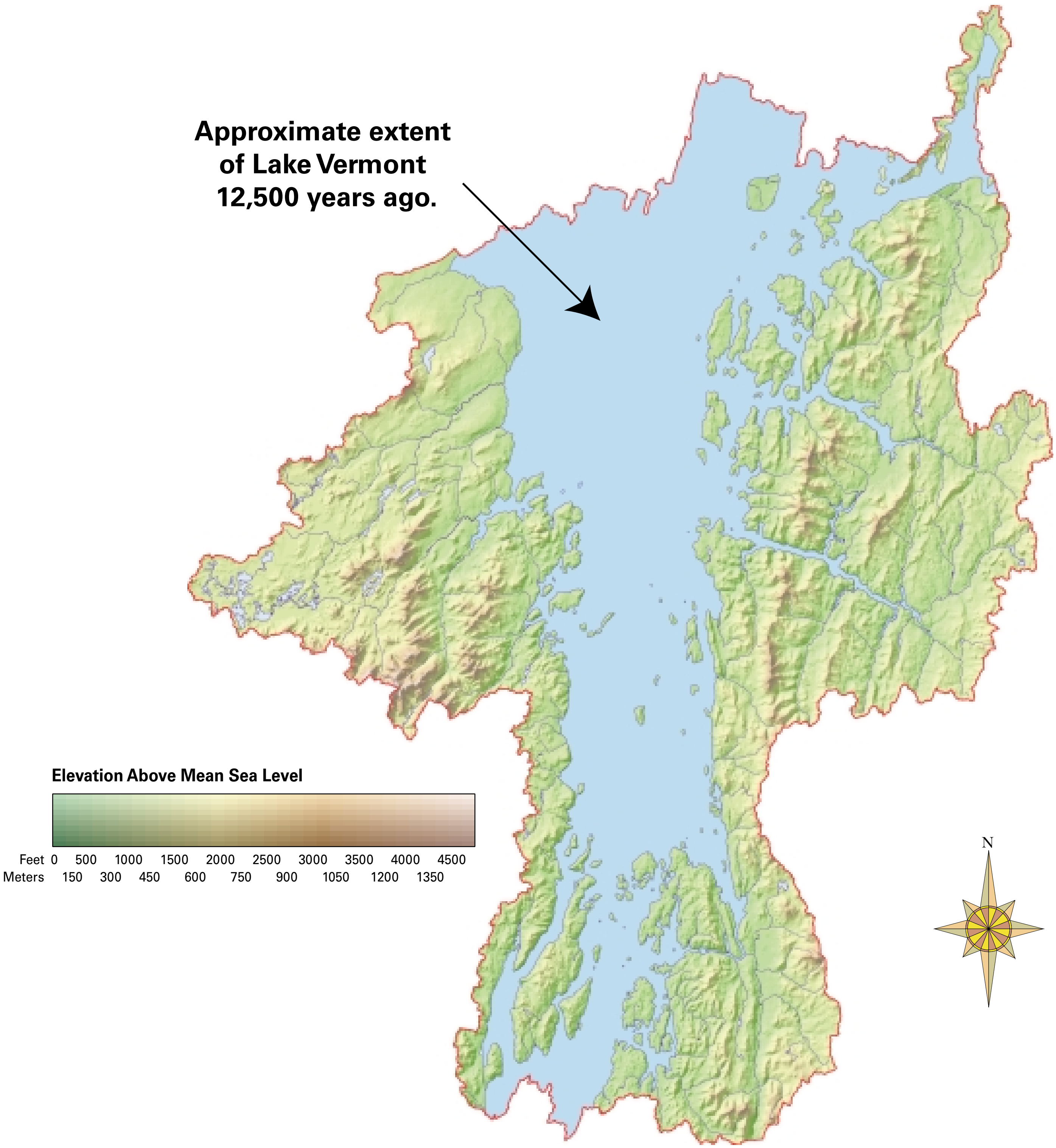
Maps should be checked for accuracy.

Assessments

Materials/Resources Three Champlain Valley Transparencies, overhead Projector.
The teacher may want to lay the three transparencies over each other to show the difference size of the various watershed evolutions.

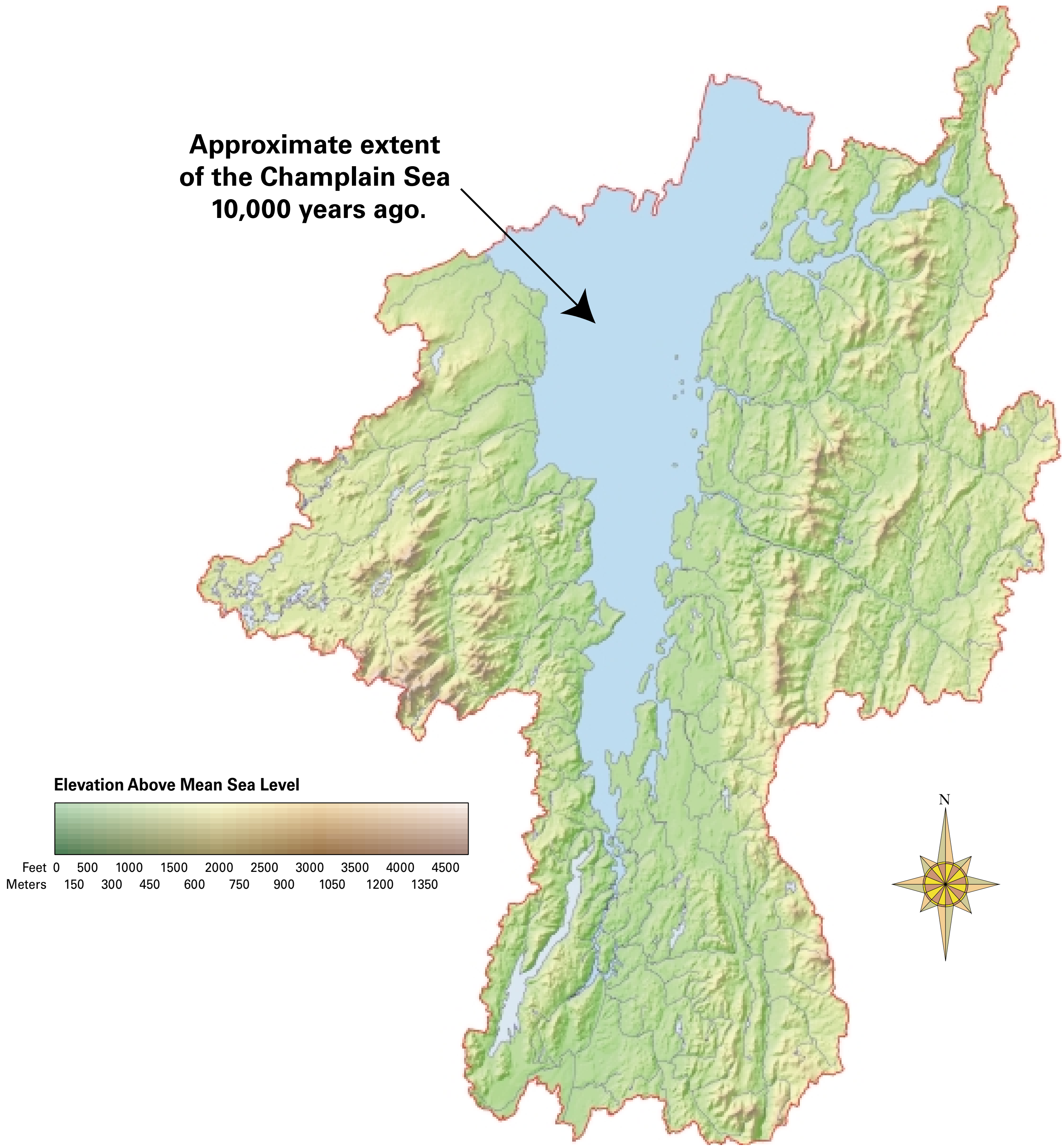
Special Considerations A reading or independent research project on the "Charlotte Whale" may be interesting for students who are unfamiliar with the story.

Geology - Lake Vermont



THE LAKE CHAMPLAIN BASIN ATLAS

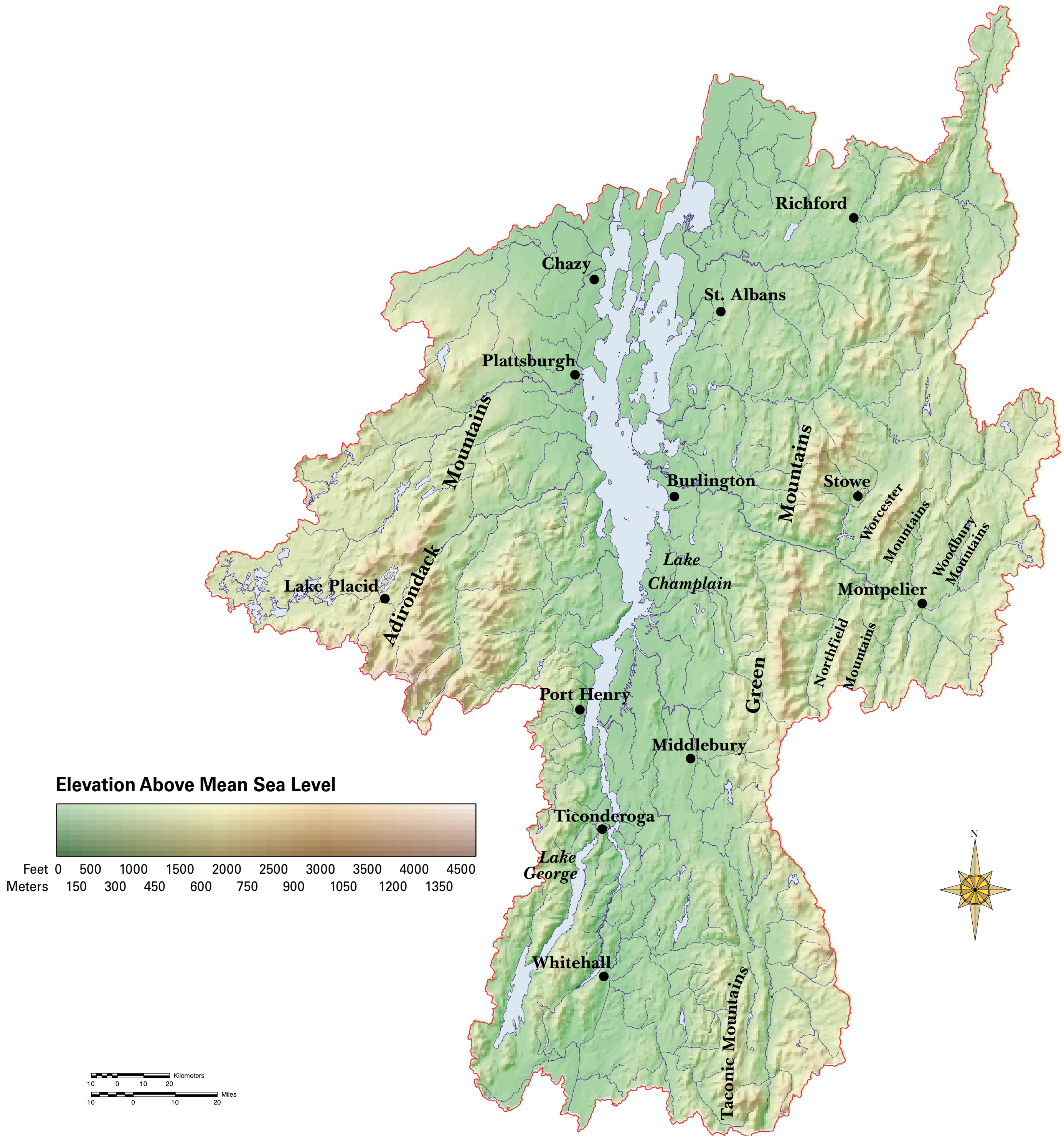
Geology - Champlain Sea



Map by Northern Cartographic.

THE LAKE CHAMPLAIN BASIN ATLAS

Landforms of the Basin



Map by Northern Cartographic

Fresh, Salty, Fresh

Tracy Truzansky, ECHO Center for Lake Champlain

The story of the Lake Champlain Basin and how it was formed goes back millions of years to the earth's geologic beginnings. Regardless of where you are on the planet, the earth beneath your feet is slowly but constantly changing. Imagine what the earliest inhabitants of this region must have thought about their world - how did the land, water and the life within it come to be? How did they make sense of such an awe-inspiring place?

Western Abenaki believed that Tabaldak, the Creator, made the world, but that Odzihozo, the Man Who Made Himself, created the Champlain Valley. Before he had legs, Odzihozo dragged himself around, gouging out the Champlain Valley and the river valleys in the land's surface. He piled up dirt with his hands to build the Adirondack, Green, and Taconic Mountains. Finally, he made Lake Champlain and was so satisfied with his work that he decided to stay there forever. Climbing on a bedrock knob in the middle of the lake, Odzihozo transformed himself into a rock. The Abenaki called this rock the Guardian's Rock, and for generations they have left offerings of tobacco there.

The Abenaki imagined Ojihozo's body making an impression on the land which created the lake bed. His hands formed the Green Mountains to the east, and the Adirondacks to the west, and his fingers created the many rivers that empty into Lake Champlain.

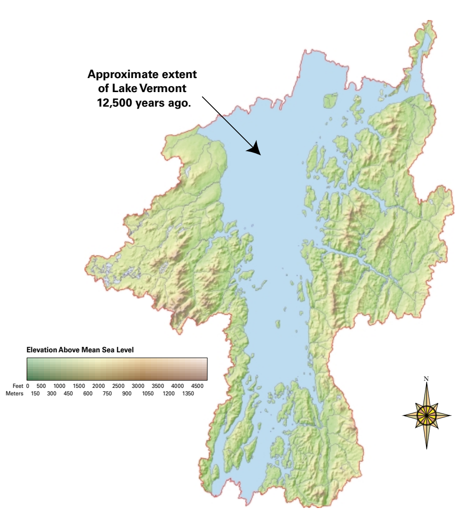
Many transformations of the land and water occurred over millions of years. The primary force that led to the way the land looks today was moving ice, or glaciers. A glacier forms when the climate of a region has more snow fall than snow melt for very long periods of time (thousands of years). About 2.5 million years ago a glacier spread southward from northern Canada into the Champlain Valley and southward to what is now Cape Cod, Massachusetts. This ice sheet would have been over a mile thick in Burlington, VT, and Plattsburgh, NY. The ice was constantly moving sliding mostly on *glacial till* - looser deposits of clay, sand and silt - which scoured the land like sandpaper.

Most of what is now the Lake Champlain Basin is made up of the remains of these surficial (surface) materials and are now lying on top of the current bedrock. Evidence of the power of the moving ice, flowing waters and grinding of the glacier can be seen as scrapes and striations (stripes) on exposed rock slabs and in the shape and curve of the foothills and river deltas of the region today. Have you ever seen huge boulders in the middle of the woods? It may have been dropped there by these glaciers; geologists call these deposits *glacial erratics*. Imagine the power of the ice if it could move a boulder that big across the land!

Fresh

THE LAKE CHAMPLAIN BASIN ATLAS

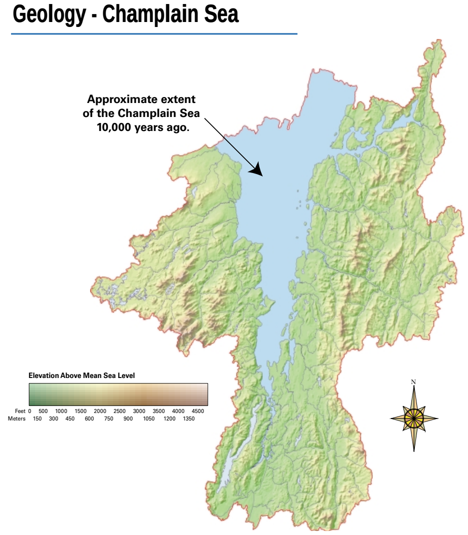
Geology - Lake Vermont



Salty

THE LAKE CHAMPLAIN BASIN ATLAS

Geology - Champlain Sea

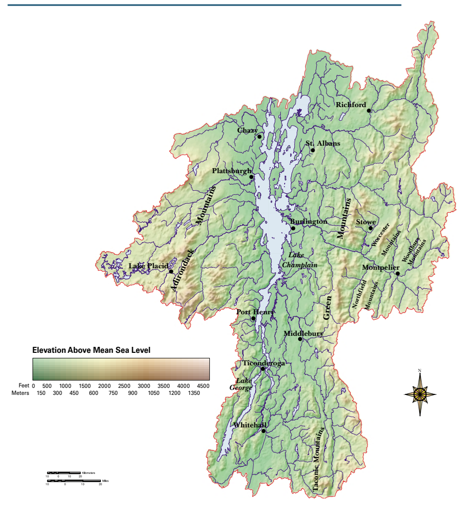


Map by Northern Cartographic.

Fresh

THE LAKE CHAMPLAIN BASIN ATLAS

Landforms of the Basin



Map by Northern Cartographic

Then, about 20,000 years ago, the region began to rapidly warm. The ice sheet became thinner melting first along the mountain slopes. Over time, the melting glacier shifted directions guided by river channels and the mountains. Vast volumes of water flowed southward as the ice melted forming Lake Vermont about 13,500 years ago. This body of water would have been thick with silt, mud and chunks of ice and would have been very deep - 500 feet deeper than present-day Lake Champlain. The shoreline of Lake Vermont would have touched Jericho, VT (which is 10 miles from the present day shoreline); and Mt. Philo would have been an island! The water coursing off the ice and through carved tunnels within the melting glacier would have exploded into the lake with a cold, gritty rush. Looking at the maps, can you find where you are right now? Was it under water 13,000 years ago?

Lake Vermont, with its blocks of ice and floating icebergs, only lasted for about 1,500 years. During this time, a huge ice dam was holding back the water from flowing northward. When the dam broke about 12,000 years ago, a huge volume of fresh water rushed out through the Gulf of St. Lawrence to the Atlantic Ocean. Suddenly, perhaps in just a few days time, the water level dropped 300 feet, leaving a muddy landscape behind.

The glacier still existed, but now the edge was much farther to the north. The weight of the glacier over thousands of years had caused the land to be depressed below sea level. When the ice retreated and the gateway to the Atlantic Ocean was opened, salt water from the ocean made its way south through the St. Lawrence Seaway back into Champlain Valley.

A gastropod fossil from the Chazy Reef. VT Geological Survey.

The mix of salt water with remaining glacial melt water created the Champlain Sea, 300 feet above present lake levels. Because the water was salty, the marine life was very different from today. Salt-water critters such as clams and seals lived here. One famous resident was the Charlotte Whale! We see the remains of this Champlain Sea and its coral reefs in the fossils it left behind.

Over the next 2,000 years, the land began to rebound. Slowly the level of the land in the northern region became the same as sea level. This effectively reversed the flow as the salt waters flowed back north to the Atlantic Ocean. Thus, a dynamic change took place where denser salt water was flushed out by the constant current of fresh water from rivers, streams and northern glacial melt into the valley.

The volume of sand and silt moving through the deltas, and the gradual settling of glacial materials were responsible for the broad expanses of favorable soils where plants could take purchase. Following the new plant growth came Ice Age animals (caribou, mammoth, salmon, etc). It was after this “Ice Age” that the first humans inhabited the newly-formed Lake Champlain Basin - the Paleo Indians.

Lake Champlain has been in its present form for about 9,000 years, but it’s still slowly changing. The valley is carved with every flood and storm. Wind and water continue to erode the mountains and the path of riverbeds. And as soon as the first people arrived here, humans began to influence geologic landscape by clearing land for crops. Today, humans have an even larger impact by paving roads, creating dams, and draining wetlands.

Aquatic Species in Lake Champlain

Matt Witten, LCMM

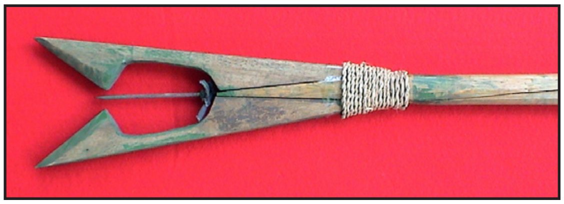
For hundreds of millions of years, the waters existing in this region have been teeming with life, starting with the smallest critters. Plankton and various shelled and crustacean creatures were living 450 million years ago in the Iapetus Sea. Abundant plankton give rise to an abundance of animals that eat the plankton, most notably fish. The abundance of fish in Lake Champlain has always attracted humans to the shores and tributaries of this beautiful and productive lake.

How Fish Arrived Here

During the Ice Age, a period starting about three million years ago, glaciers advanced and retreated across North America. Each time a glacier advanced, aquatic animals disappeared from the frozen land, surviving in warmer waters farther south. When the glaciers retreated northward, the aquatic animals gradually made their way back from "glacial refugia" (places where fish, aquatic insects, crustaceans, etc. could still live in warm enough water), migrating along the waterways that linked rivers, ponds, and lakes. All of the present-day native fish gradually took up residence in Lake Champlain between 13,500 and 8,000 years ago (Langdon et al., 2006).

Some of the fish currently in the lake can be traced to eastern (Atlantic Ocean) refugia or western (Mississippi River and Great Lakes) refugia. For example, sea lamprey, shad, and the Atlantic salmon came in from the Atlantic, whereas bowfin, northern pike, and the largemouth bass came back in from rivers and streams connected to the Mississippi. Vermont and New York had access to fish coming from the west through the Mohawk and St. Lawrence Rivers, whereas the Appalachian Mountains blocked those western species from swimming to eastern New England (Langdon et al., 2006).

Replicated 15th century style socketed ivory harpoon tip. Wobanakik Heritage Center.



Fishing Spear. Wobanakik Heritage Center.

At different times during thaws, fish could make their way to Lake Champlain via a variety routes, depending on the changing landscape. During the period when Lake Vermont existed – about 12,500 years ago – the water level was 300-600 feet higher than Lake Champlain is today, and drained south to the Hudson. This enabled fish to swim in from the Mohawk River. Later, when the land had rebounded in the south of the Champlain Valley, but the northern area was still pressed down from the retreating glaciers' weight, sea water rushed in from the St. Lawrence, bringing in an entirely new assemblage of species. At this time, the salt water made the lake inhospitable to some freshwater species, forcing them into tributaries. A later migration (at about 8,000-10,000 years ago) of western fishes likely occurred when Lake Champlain once again became entirely freshwater. These fish came down the St. Lawrence, swam up the Richelieu, and into the lake (Langdon et al., 2006).

North American fishes continue to move along their natural recolonization routes, and, in addition take advantage of new routes created by humans over the past 200 years. The Champlain Canal links the south end of the lake to the Hudson River, and the Chambly Canal to the north provides a direct water link to the St. Lawrence. Non-native fish species such as the white perch, gizzard shad and the brook silverside have probably come up either the Chambly Canal or the Champlain Canal (Langdon et al., 2006).

The Champlain Valley is currently home to a great diversity of fish species. Sixty-eight species are native, and another 13 species of fish now living here were introduced by humans or arrived via canals. Each one of our fish species plays a specific ecological role within the lake (Langdon et al, 2006).

Fish Habits and Habitats

Because there are 81 species of fish in Lake Champlain, we cannot describe all of these fishes here. The variety of fish is amazing, and the species fall into different groupings of habitats, of which Lake Champlain has several types. Below we describe the dominant habitats and some of the most interesting fishes that live there.

Among the habitats that Lake Champlain provides are principally:

- Deepwater, where the water is colder and often holds more oxygen
- The open (or "pelagic") and generally warmer upper layer of water
- Marshy bays and tributaries, often with mucky bottom
- Rocky bottom
- Sandy shoreline

In general, each fish species frequents one or two of these habitat types because of its physical needs and its hunting and hiding behaviors.

Deepwater
Most of the salmonids, which include the trouts (e.g., brown, rainbow, and lake), Atlantic salmon, and whitefish, need to be in cold water for its clarity and high oxygen content, and therefore usually stay in deepwater and in some cases swim upstream into cool rivers and streams. These fishes are well known for their favorable eating by humans. They are the quintessential "sport" fishes.

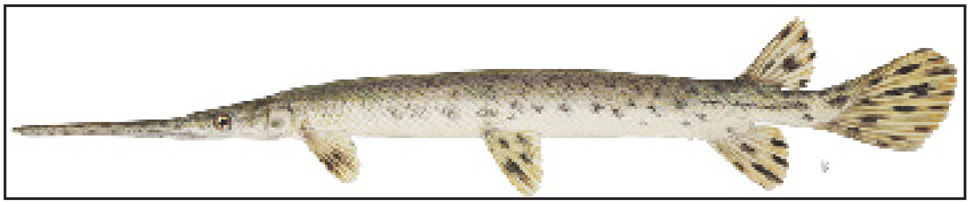
Warm, open water
The emerald shiner, a beautiful iridescent minnow, frequents a variety of habitats, going sometimes to shallow areas over sand or gravel, and traveling in schools out near the surface into the open water. Emerald shiners eat plankton and sometimes insects. Also in the open water near the surface is another small fish, the gizzard shad, which also feeds on plankton as well as on vegetation, which it can digest due to its specialized digestive system including a gizzard. The gizzard shad is not native to Lake Champlain, probably having made its way up the Champlain Canal from the Hudson River (Witten, 1996).

Marshy, weedy areas
Like the other members of the pike (Esox) genus, the chain pickerel frequents weedy, shallow areas of water such as marshy bays. The most common pike in Vermont, the chain pickerel is a tough cookie, able to withstand acidity, high salinity, and very warm water temperatures (even over 90° F). Like other

pikes, the chain pickerel lies in wait in vegetation, then rushes out suddenly to chomp on prey such as fish, crayfish, frogs, snakes and even small rodents (Langdon, 2006). People fish for pickerel in several different ways, including fishing through the ice in the winter, and also "pickerel shooting," an activity which involves shooting near the fish as it goes upstream to spawn, thus stunning it enough to retrieve it with a spear. Farmers near Lake Champlain once considered this an activity to undertake between the winter work and before starting spring work. One spring a farmer shot 132 pickerel and put them down in brine, and that was the main part of his meat supply that summer (Beck, 1985).

Another fish living in mucky, marshy areas is the carp, an introduced species from Asia and Europe which can grow to 40 pounds! Female carp are extremely fecund, sometimes having as many as two million eggs, which they broadcast over vegetation. During nuptial activities, adults move into shallows where they can be seen thrashing about, fins often violently flopping into the air (Werner, 1980).

Rocky bottom
The spottail shiner, which is very distinct because of its ink-like blot near its tail fin, is often found over gravelly or rocky bottoms. It is a far-reaching species, found across the northern area of the continent, and can range from the surface down to depths of 30-60 feet (Langdon, 2006). The rock bass, a type of sunfish, can be abundant over rocky areas, averaging about 8-9 inches in length. The rock bass feeds on insects, small fish, mollusks, and crayfish, and can live for 10 or more years (Werner, 1980).



Longnose Gar (Lepisosteus osseus) Fish Artwork by Ellen Edmondson and Hugh H. Chrisp, NYS DEC.

Sandy shoreline
Schools of banded killifish can often be seen in shallow, sandy bays of Lake Champlain. This small fish often mistaken for a minnow has a dozen or more very distinct and closely placed vertical bars on its silvery sides. When killifish are threatened, they can burrow into sand or gravel, which may be necessary when being stalked by great blue herons wading stealthily near shore (Witten, 1996). Although Burbot, the only freshwater codfish, tend to swim in deep cold waters of the lake, they come to spawn over sandy beds. Like the carp, burbot do not build nests, but rather broadcast their plentiful eggs over the sand (up to a million at a time). The burbot is for some reason not considered highly desirable here, but is considered by Europeans and Russians to be delicious. At one time, the burbot (or ling) was caught in abundance on Lake Champlain and salted to preserve it (see below).

How People Have Fished Here

Archaeologists have discovered that, long before the arrival of Europeans, Native Americans used several methods for catching fish in our region. Fish hooks (made of bone) would have been used to catch the biggest fish and to fish through the ice. Weirs – fences made of brush and set in streams or other channels for catching fish – would have caught moderate to large fish, and smaller fish would have been caught using nets. Although direct evidence of nets does not exist, because the material used to make the net (whether it be twine, gut, or leather) would have long ago decomposed, certain shapes of rock implements strongly suggest they were used to make a more effective net (Crock, 2008).

For example, weights to hold down the bottom of the net seem to have taken two forms. The plummet was shaped with a short stem on top of a spherical body - it looks a lot like a spinning top. These would have been tied to the net using the stem, to keep the lower portion of the net flush with the lake bottom to prevent fish from escaping. Also found at shoreline sites are notched pebbles, very simple tools with a notch flaked off a pebble to allow for fastening to a net, which also would have weighted down the net's bottom (Crock, 2008).

One example of a site where fish remains have been found is the Bohannon site near the lake in Alburgh, which dates to A.D. 1450-1600. At this site, where Native Americans were fishing and cooking, bones from a number of fishes were found including sturgeon, pickerel and pike, bullhead (a kind of catfish), bass species, yellow perch, and walleye (Crock, 2008).

Those fish that were too small to be caught by line or in weirs were likely netted. Weirs appear to have been very important to Native Americans fishing in our region. One weir in Maine was found to have been used and re-used over a period of 4,000 years based on dates from weir posts, which were well preserved because they had been stuck in the muck at the outlet of Sebasticook Lake (Crock, 2008).

Lake Sturgeon (Acipenser fulvescens). Fish Artwork by Ellen Edmondson and Hugh H. Chrisp, NYS DEC.

Samuel de Champlain, the French explorer who arrived on Lake Champlain in 1609, found the fish in the lake to be remarkable, especially one type - the longnose gar, which still can be found here in warm, marshy areas of the lake and its tributaries. He wrote in his travel notes:

> There is also a great abundance of fish, of many varieties; among others, one called by the savages of the country, Chaousarou, which varies in length, the largest being, as the people told me, eight or ten feet long. I saw some five feet long, which were as large as my thigh; the head being as big as my two fists, with a snout two feet and a half long, and a double row of very sharp and dangerous teeth. Its body is, in shape, much like that of a pike; but is armed with scales so strong that a poniard could not pierce them. Its color is silver-gray. The extremity of its snout is like that of swine. This fish makes war upon all others in the lakes and rivers. It also possesses remarkable dexterity, as these people informed me, which is exhibited in the following manner. When it wants to capture birds, it swims in among the rushes, or reeds, which are found on the banks of the lake in several places, where it puts its snout out of water and keeps perfectly still: so that, when birds come and light on its snout, supposing it to be only the stump of a tree, it adroitly closes it, which it had kept ajar, and pulls the birds by the feet down under water. The savages gave me the head of one of them, of which they make great account, saying that, when they have the headache, they bleed themselves with the teeth of this fish on the spot where they suffer pain, when it suddenly passes away (Grant, 1967).

Other historical accounts of fish and fishing in the lake date to the 1800s. There is little or no written documentation of ice fishing before the 1800s, but it appears that ice fishing is a longstanding tradition on Lake Champlain. One account by the New York State Agricultural Society in 1852 stated:

> Although tough, tasteless, and disagreeable, the ling [also known as burbot] is taken at immense numbers, and salted by the poorer classes, for winter food. Holes are cut in the ice, and as the fish passes beneath it is pierced by a fork or any pointed implement, and is even seized by the hand …At night…a brilliant fire is enkindled on the ice at the opening, and the fish is thus taken in great abundance, and with ease. (Posen, 1986)

Other accounts from the 1850s show that settlers placed great importance on the winter fishery in Lake Champlain:

> The smelt, a small but very fine fish, of marine origin and migratory habits, have recently appeared in the lake and are taken though the ice in large quantities.…Many of the lake fish are highly esteemed, and secured in ice, are exported by rail roads to the southern cities and watering places, where they command exorbitant [sic] prices. (Watson, W. C., 1852).

By the end of the 1800s century, the winter ice fishery was being intensively pursued. The earliest statistics of the fishery, compiled for the years 1894 and 1895, show catches of 33,170 pounds and 39,076 pounds landed on the New York side of the lake (Greene, W. C., 1930.) During the period from the mid-1800s to the 1930s, a large amount of winter fish that went to Albany and New York City restaurants from Lake Champlain ports were sent down fresh on the overnight train to arrive early the next morning. As much as one ton of fish per night went out from the Lane Company in Port Henry. Fishermen would fish day and night for weeks at a time! (Posen, 1986.)

During the late 1800s and early 1900s there was also commercial fishing going on during the spring and summer seasons. This sometimes took the form of illegally setting nets to catch fish as they swam upstream to spawn. At various times the Vermont Legistature outlawed and permitted net fishing, which sometimes was blamed for wiping out whole spawning runs at the mouth of streams such as Otter Creek but was also considered an important source of subsistence (Glenn et al., 2005).

Current Conditions for Aquatic Life

Since the early 1900s, Lake Champlain has become known for its “sport fishing”; few if any people make a living off the fish they catch in the lake. The lake is managed for its overall ecological health as well as for drinking water and for its fishery. Federal, state and Canadian provincial governments, as well as non-profit organizations such as the Lake Champlain Committee, are involved in conserving aquatic life in the lake and improving the lake’s condition.

A range of human activities has affected the fish in Lake Champlain in many ways. Construction, farming, and an increase in paved surfaces have added more silt and excess nutrients (mainly phosphorus and nitrogen) to the lake via streams and rivers. The turbidity and eutrophication that results from these disturbances has been detrimental to many species of fish as well as the organisms that support them. Other activities such as damming rivers (which can disrupt spawning runs); the building of bridges, marinas and other structures; overfishing of some species during certain periods in history; and, various types of pollution contribute to a less ideal environment for fish.

It is not known why some species have begun to diminish in the lake, but a number of native species are having trouble thriving. The most notable is the lake sturgeon, whose population drastically declined in the 1950s after being actively fished for its eggs and its spawning habitat was greatly reduced and damaged by siltation. The sturgeon is listed as an endangered species in Vermont. Another fish that has become increasingly rare, most likely due to increased sediment in the water, is the mooneye, which prefers warm, shallow areas that are free of silt. The American eel, which has the incredible requirement of swimming all the way back to the Atlantic Ocean – south of Bermuda to the Sargasso Sea – in order to spawn, is also diminishing in number. This remarkable fish makes its way, sometimes over land, to get to the next body of water, and can grow up to 40 inches in length! (Langdon, 2006).

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Watershed Construction

LCMM

Grade Level 4-8

Content Areas Social Studies, Science

VT Grade Expectations

VT S 2: Students demonstrate their understanding of Predicting and Hypothesizing by…
- Using logical inferences derived from evidence to predict what may happen or be observed in the future.
- Providing an explanation (hypothesis) that is reasonable in terms of available evidence.

VT S 48: Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…
- Diagramming, labeling and explaining the process of the water cycle.

NY Standards

NY Science Standard 4: Physical Setting Key Idea 2:
- Describe the relationships among air, water, and land on Earth.

Duration 50 minutes

Learning Goals **Students will identify factors in topography that affect the flow of water within a watershed.**

Description

1. Place a variety of objects over an outside area. The can be large or small, but something large enough for a class to stand all the way around is good.
2. Cover the area with a waterproof sheet. Clear plastic will work, but something that will hide the objects below is easier to observe.
3. Discuss with students the features on the landscape you have created; i.e. high points, valleys, etc.
4. Discuss how water travels downhill and have students predict what will happen when water is introduced into the system.
5. Use a garden hose or large watering can to “rain” on your landscape.
6. Pause after a few minutes and discuss whether students’ predictions were accurate. Determine if all the water is draining into one watershed or several. Have students predict what will happen if it continues to rain.
7. Continue adding water to the system until it reaches a point of equilibrium.
8. In teams have students sketch a map of the watersheds you have created on your landscape

Assessments Informal assessment of student participation and understanding of key ideas.

Materials/Resources Variety of objects, plastic tarp or sheet, garden hose with spray nozzle or large watering can

Special Considerations This is best done in warm weather and there is always some risk of getting wet!

Champlain Watershed Map

LCMM

Grade Level 4-12

Content Areas Social Studies, Science

VT Grade Expectations VT S 48: Students demonstrate their understanding of Processes and Change over Time within Earth Systems by…

- Diagramming, labeling and explaining the process of the water cycle.

NY Standards NY Science Standard 4: Physical Setting Key Idea 2:

- Describe the relationships among air, water, and land on Earth.
- Explain how the atmosphere (air), hydrosphere (water), and lithosphere (land) interact, evolve, and change.

Duration 50 minutes

Learning Goals **Students will demonstrate understanding of the concept of a watershed, and the specific drainages that make up the Champlain Watershed.**

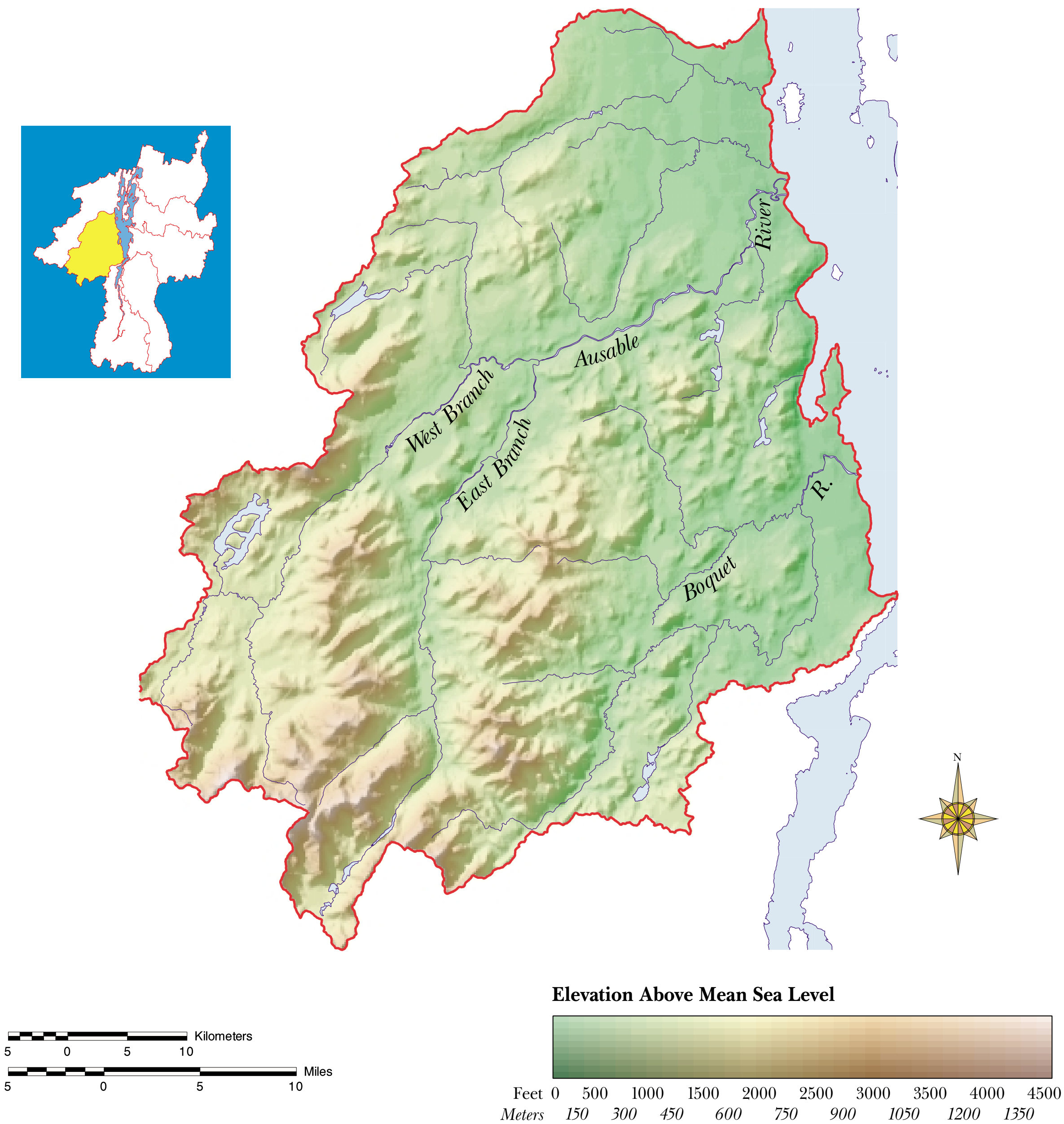
Description

1. Distribute copies of the Champlain Watershed Map to work groups of two or three
2. As a class orient the map by identifying major land features, rivers, and towns.
3. Find your town on the map
4. As a class, identify the route(s) water falling on your town would take to Lake Champlain. List the different bodies of water on the route from your town to the lake.
5. Assign each group 2-3 other towns and have them list the bodies of water that form it drainage route to the lake
6. Have groups share their findings

Materials/Resources Champlain Valley Watershed Maps. We have reproduced the Ausable/Boquet River watershed in this curriculum. Get the watershed map of your area from Lake Champlain Basin Program's Basin Atlas.

THE LAKE CHAMPLAIN BASIN ATLAS

Boquet/Ausable Basin



Map by Northern Cartographic

Forests and Trees

Tracy Truzansky,
ECHO Lake Aquarium and Science Center

Our life began with the creation and transformation of this land, passed down to countless generations in the oral tradition. We were created out of the wood of an ancient tree that still thrives here. We have always been here, kin to the ancient forests. Our life, the life of the grasses and trees, marshes, fields, and forests, is connected to us, as all human beings are joined to our mothers by the umbilical cord, as the trees and plants are rooted to the soil." —Hilda Robstoy, Dee Brightstar, Tom Obomsawin, and John Moody (1994)

The Abenaki and the Northern Forest

Over the millions of years of shifting landforms, this region has allowed for a myriad of living and non-living elements to exist. Of all these important elements, perhaps the most fundamental support for human habvitation is the forests. They have sustained our lives for the past 12,000 years, ever since the first Native Americans entered the Champlain Basin.

The natural history of a region begins with the soil. 20,000 years ago, a massive ice sheet covered the Champlain Valley, a mile thick in some places. As the climate warmed, the retreating glaciers moved northward, leaving behind an ice melt which formed Lake Vermont, and a great amount of glacial till, or unsorted rock fragments.

The massive weight of the glacier had depressed the land below sea level, which allowed an influx of salt water from the St. Lawrence Seaway to the north. For over 2,000 years, sea life inhabited what has become known as the Champlain Sea.

Gradually, the land rebounded, reversing the water flow, and causing the basin to fill with fresh water once again. This "flushing" effect left behind clay and silt deposits, enriching the soils in the Champlain Basin, and allowing for varied forests to emerge.

Initially, after the glacial retreat, this region was a tundra, as evidenced by pollen records. The first Native Americans to this region, the Paleo Indians, hunted large megafauna on this open landscape. About 11,000 years ago, the first trees gradually began to take hold. Over the next few thousand years, spruce and fir began to dominate the landscape. 6,000 to 4,000 years ago, pine and oak trees became prevalent as the climate warmed even further. These "old growth" forests boasted widely-spaced oaks and towering white pines in bands that extended uninterrupted for miles.

Archaic & Woodland Forests 9,500 to 300 years ago. Fisher Museum of Forestry.

The Champlain Valley's fertile soils, abundant wildlife and lake access allowed for plentiful food, water and easy transportation, whereas the higher elevation forest communities had drier land, and were more susceptible to prevailing winds. The floodplain tree species would have included maples, oaks, ash, birch, beech, chestnut, elm, white pine, hemlock, hickory, basswood and cedar. Each of these trees provided immeasurable value to the Native Americans for food, utensils, tools, shelter, and transportation, and held important spiritual significance as well.

Each tree species had multiple uses. Nut trees such as chestnut, hickory and oak and the early tapping of maple trees for sap to boil for syrup are obvious examples of important food trees.

Wigwams or longhouse shelters were made from strong poles from birch, elm, chestnut and oak with basswood or cedar strips to hold the poles in place. Bark from these trees was often used for the roof. Baskets have long been a Native American art form with splints made of maple, hickory and black ash (also known as “basket ash” for its flexibility, beauty and strength) but served many utilitarian purposes from gathering food, cooking and storage. Medicines were also regularly gathered from the seeds, leaves, bark and roots of trees in season.

Before steel and iron tools were introduced, a tree had to be cut with a stone ax. From there, the craftsman would carve a myriad of objects for use in the home, for the hunt, or for the ceremony. Household objects were often made from wood, such as the mortar and pestle, used to grind grain and corn. The burl of a tree was often utilized for bowls, ladles, and spoons. This large dense ball occurs naturally on a tree, often covering an injured area, and is ideal for objects that rquire strong, hard wood that resists cracking or “checking”.

Many hunting and fishing tools were carved from wood, such as spear and atlatl handles, and the bow and arrow. The dugout canoe was constructed by first burning the log and then carving the interior into shape. Later, the bark of a birch tree provided the exterior of a canoe, covering its cedar ribs.

Many of the objects required further shaping; a special tool called the “beaver tooth scraper” was used to smooth the wood and do final detail carving. Sometimes the wood was stained with hemlock bark. In some cultural traditions, animal, spirit and human effigies were painted in red (life energies) or black (war, death) in distinctive designs to show personal attributes or tribal connections. The ball club was made this way.

Land Clearing at its Height, 1840. Fisher Museum of Forestry.

The Native Americans utilized the forests extensively; some groups even clear-cut for planting crops. The arrival of Europeans, however, has altered the forests even more substantially. In just over 250 years, Vermont forests had dwindled to only 20% of their original size to create farms and graze livestock. In the 17th and 18th centuries, industries capitalized on the abundant forests of the Adirondacks and Green Mountains for lumber, potash, ship building, and clear cut to make way for stone and iron mining.

Today, these forests are begining to regain their strength. Vermont is nearly 80% forested again, though only a low percentage of the trees are mixed hardwoods. Modern human activity continues to influence their health. Erosion, suburban sprawl, highway runoffs all threaten this vast natural resource. Hopefully, our stewardship, and that of the next generation, will insure that these forests remain.

...Then he took his great bow and fired arrows into the ash trees. Each time an arrow struck a tree a human being stepped forth. These people could dance like the ash trees in the wind, they were graceful and their hearts were green and growing, not made of stone. They were the first Abenaki.

--Joseph Bruchac, *Rooted Like the Ash Trees: New England Indians and the Land*, 1987

Hardwood Forest Recovery Continues Today. Fisher Museum of Forestry.

Native Names for Common Trees of the Eastern Woodlands

Gifts of the Forest, Native Traditions in Wood and Bark: An Exhibition from the Mashantucket Pequot Museum and Research Center Curated by Stephen Cook	
Tree	**Abenaki Name**
Black Ash	maahlakws
White Ash	ogemakw
Maple	mskwebages
Pine	wigebimezi
Basswood	goaak
White Birch	maskwamozi
Oak	asaskemezi
Walnut	bedegomenozi
Cedar	koksk

Trees Used for Medicines

From the Cowasuck Band Website, Pennacook-Abenaki People	
Tree	**Medicinal Purpose**
Quaking Aspen	Intestinal Parasites
Eastern Hemlock	Pain (like aspirin) and itching skin
Tamarack	Coughs
White Pine	Coughs and Sore Throats
Balsam Fir	Disinfectant
Striped Maple	Respiratory Aid

ECHO Lake Aquarium and Science Center at the Leahy Center for Lake Champlain on Burlington's Waterfront is home to more than 70 species of fish, amphibians and reptiles. Our mission is to educate and delight visitors about the ecology, culture, history and opportunities for stewardship in the Lake Champlain Basin. ECHO's education programs emphasize inquiry-learning through science experiments, animal demonstrations, movies, games, arts and exhibit interpretation. Our goal is to form sustainable partnerships that support environmental research, professional development and engaging science experiences for students, teachers and the general public. For more information go to our website at www.echovermont.org or call toll free 1877-ECHOFUN. For questions pertaining to field trips, curriculum support and professional development contact Tracy Truzansky, Director of Education at ttruzansky@echovermont.org x120

Native Americans & Natural Resources

Tracy Truzansky, ECHO; adapted from Project Learning Tree

Grade Level 4 - 8

Content Areas Science, Social Studies

Duration 50 minutes over two periods

Learning Goals **Explore how natural resources provided means for survival for Abenaki and other Northeastern tribes. Compare lifestyles then and now regarding natural resources.**

Description

1. Assign students to pair up and research one of the following questions as it relates to the lifestyle of a local Native American tribe in the time around Samuel de Champlain's arrival in our region (1600's).
   - How did they get their food – hunting, farming, fishing?
   - How did they prepare their food – utensils, cookware, fire building?
   - What did they do if the needed medicine?
   - Where did they live – what natural features in the landscape were needed for survival?
   - What kinds of homes did they have?
   - What kind of transportation did they use?
   - What were their sources of energy?
   - What was their clothing made from – what was the style like?
   - What artifacts were left behind or used for trade?
   - What kind of celebrations or ceremonies did they have?
   - What did they do for recreation?
2. Have each student make one drawings or mount photos that depict the items gleaned from the questions above. Title their pictures.
3. Have each pair take turns sharing their research and then sort their pictures into one of three groups – "S" items needed for survival, "M" items needed to maintain lifestyle, and "L" a luxury item.
4. Repeat the same activity using students' present day lifestyles. Sort into S, M and L.
5. Review each group of pictures. Open the discussion for students to review each period of time separately. Examples of questions:
   - What are the criteria for evaluating an item's necessity?
   - Are items listed for survival that are truly not essential?
   - Any items that could go in more than one column?
   - On what basis do you judge an item a luxury?
6. Now compare both time periods together and ask:
   - Are there items from both periods that are similar in form or function?
   - Which items might move to a different category based on need over time?
   - What are the raw materials from which the items are made?

Native Americans & Natural Resources (cont'd)

7. Guide the conversation to help students understand that the source of each item comes from natural resources and that even long ago; survival depended on natural resources that came from the land and very often the trees and plants that lived it the forest. Technology and creative invention has helped refine designs and the use of natural resources to meet basic needs.

Assessments

Pre/Diagnostic: Ask students to select an object from the classroom and list what they think the item is made of – what is the source of the materials?
Formative: Assess student dialogue or have student assess each other on a scale of 1 – 3 on how capable are they in coming up with rationale for their opinions and ideas.
Summative: Encourage students to write an opinion paragraph or essay that asks: "If you had to give up a natural resource, which one would you choose and how would it affect your life?"

Materials/Resources

Access to research sources – internet, books, essays, short stories, photo archives, or special guest speakers

Special Considerations

Research local Native story tellers or historians that can help you secure materials for research.

Extension Questions

What were the particular species of trees and plants that grew in the Lake Champlain Basin that were particularly valued by the Native Americans?

Permission to adapt activities from Project Learning Tree's PreK-8 Environmental Education Activity Guide has been granted by the American Forest Foundation to the Lake Champlain Maritime Museum for a one-time use to enhance the Quad Curriculum. Educators in Vermont can receive the complete guide by attending a PLT workshop. Contact Rebecca Gies, VT PLT State Coordinator, at 802-241-3651 or Rebecca.Gies@state.vt.us, or visit www.plt.org for more information.

Poet-Tree

Tracy Truzansky, ECHO; adapted from Project Learning Tree

Grade Level 3-8

Content Areas Language Arts, Social Studies and Science

Duration 50 minutes in two or more lessons

Learning Goals **Express points of view and attitudes about forests and trees using various forms of poetry. Analyze poetry to discover its meaning.**

Description

1. Ask students to name benefits of trees and forests. Discuss experiences they have had in woods or forests. Describe aloud how they might feel standing next to a tall, old tree or a new sapling. Do they have a favorite tree? What characteristics of trees make them unique?
2. If possible, take students outside and explore the different trees found in a nearby park or playground.
3. Form a circle around one tree (or just stand in a circle in the classroom) and close your eyes. Imagine how a forest would look, smell, and sound before European settlers arrived. What might be similar and different from the wooded areas of today? Discuss.
4. Review parts of speech – nouns, verbs, adjectives, adverbs, etc.) Make lists of words related to trees and forests that fit each part of speech.
5. Give students the samples of some types of poetic forms.
6. Ask each student to choose a poetic form (or assign a poetic form) and write a poem describing trees and the forest - it could represent the past, present or future in our region.

Assessments

Pre/Diagnostic: Choose a very simple poetic format (such as acrostic) and assess student understanding of parts of speech and creative writing skill.
Formative: Keep all drafts of the poems to show a progression of writing ideas. Share poems and encourage critical review from peers. Encourage students to draw poem ideas from another student's verse.
Summative: Revise and collect all the poems into a book to read aloud to younger students. Encourage more writing in more complex forms of poetry.

Materials/Resources Word cards on the parts of speech. Samples of poem forms.

Special Considerations This activity will vary considerably depending upon the sophistication of students.

Extension Ideas In discussion ask: Does your poem mention the influence of people on forests? Does it mention the value of tree products? Does your poem have a spiritual tone? What might someone from another time think of your poems?

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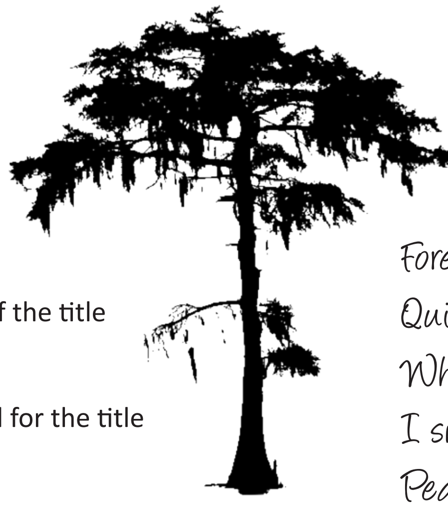
Haiku

Japanese poetry of three lines

(1) 5 syllables
(2) 7 syllables
(3) 5 syllables

Willow
Gracefully bowing
Swaying in the cooling breeze
Have you stood here long?

Cinquain



Five lines of poetry

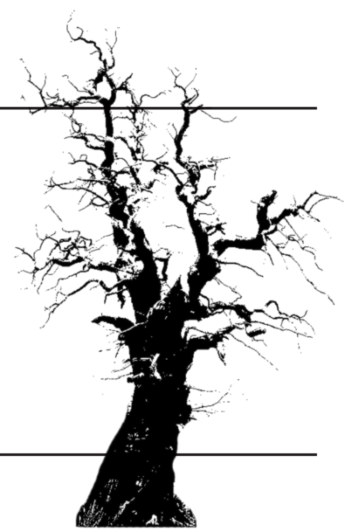
(1) 2 syllables - title
(2) 4 syllables - description of the title
(3) 6 syllables – action
(4) 8 syllables – feeling
(5) 2 syllables – another word for the title

Forest
Quiet and strong
Whisp'ring air through needles
I smell the pine scent sharp and fresh
Peaceful

Acrostic

The first letter in each line, when read vertically spells out the name of something or conveys a message.

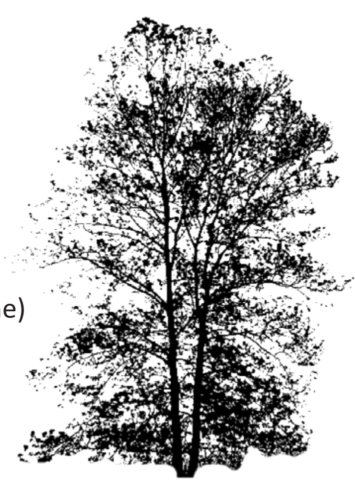
Loose soil beneath.
Ongoing compost.
Gone from the sky.



Windspark

A poem with five lines with the following prompts:

(1) I dreamed…
(2) I was…(something or someone)
(3) where
(4) an action
(5) how



I dreamed
I was a nest
Snug against the tree branch
Holding feathered friends
against the storm
Securely

Poems by Tracy Truzansky, ECHO Center for Lake Champlain

Picture the Forest

Tracy Truzansky, ECHO; adapted from Project Learning Tree

Grade Level 4 - 8

Content Areas Science, Language Arts, Visual Arts

Duration 50 minutes

Learning Goals **Leisure and recreation can have an impact on forests and trees. Learn ways of appropriately exploring nature and how to develop and follow rules for the protection of natural resources.**

Description

1. Have the children make a list of all the rules for learning and exploring outdoors.
   - Stay on the trails
   - Be safe and stay with the group
   - Don't litter
   - Pick up litter left by others
   - Don't carve or draw on trees, rocks or property
   - Show respect for living things
   - Be careful with fire
   - Leave a place better than you found it
   - Use quiet voices
   - Take pictures or write stories
   - Limit collecting to one of each thing
2. Make a list of things that might be fun to collect while hiking. Discuss what people might do with a nature collection?
3. Collect enough natural items (pressed flower, shell, stone, bark, etc) for one different object for each child in the class. Do this on a hike, or provide your own items.
4. Hide them in the classroom or on the playground within certain boundaries.
5. Have the children get into pairs with one child being the "camera" with their hands covering their eyes and one person the "photographer" guiding them carefully to an object.
6. The "photographer" positions the "camera" and they take a quick 3 second peek capturing a memory of the object. Switch roles.
7. Discuss the phrase "Take Only Pictures, Leave Only Footprints".
8. Make a poster using this phrase and incorporating their object into the poster.
9. Discuss how the ethic of respecting nature might reflect the behavior of people who lived off the land long ago. What might have been the result if they had cut all the trees or collected all of one type of plant?

Picture the Forest (cont'd)

Assessments

Pre/Diagnostic: Review the rules before going on a hike in nature. Assess their behavior in following their own rules.
Formative: Can students transfer the knowledge about behavior in nature to behavior in school?
Summative: Encourage students to write a short story about someone breaking one of the rules of respecting nature.

Materials/Resources

Natural objects, poster board

Special Considerations

Select an outdoor area where students can be in your view at all times. Consider giving students a demonstration of how to guide someone safely – not pushing or pulling.

Extension Questions

Are their other forms of respect that help people live happily together in a community? What is the difference between living and non-living things in nature? What consequences will trash have on the natural environment? Which human impacts happen quickly or slowly? Can impacts on the environment happen even if you can't observe it?

Permission to adapt activities from Project Learning Tree's PreK-8 Environmental Education Activity Guide has been granted by the American Forest Foundation to the Lake Champlain Maritime Museum for a one-time use to enhance the Quad Curriculum. Educators in Vermont can receive the complete guide by attending a PLT workshop. Contact Rebecca Gies, VT PLT State Coordinator, at 802-241-3651 or Rebecca.Gies@state.vt.us, or visit www.plt.org for more information.

ECHO Lake Aquarium and Science Center at the Leahy Center for Lake Champlain on Burlington's Waterfront is home to more than 70 species of fish, amphibians and reptiles. Our mission is to educate and delight visitors about the ecology, culture, history and opportunities for stewardship in the Lake Champlain Basin. ECHO's education programs emphasize inquiry-learning through science experiments, animal demonstrations, movies, games, arts and exhibit interpretation. Our goal is to form sustainable partnerships that support environmental research, professional development and engaging science experiences for students, teachers and the general public. For more information go to our website at www.echovermont.org or call toll free 1877-ECHOFUN. For questions pertaining to field trips, curriculum support and professional development contact Tracy Truzansky, Director of Education at ttruzansky@echovermont.org x120