Water Resources

Geography & Geology

Ecosystems

Human History

Culture & Arts

The Catskills

A Sense of Place

Standards-based lessons that promote appreciation and stewardship of the unique natural and cultural resources of the Catskill Mountain region.

Module II: Geography and Geology of the Catskills

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Module II: Geography and Geology of the Catskills

Compiled and portions written by
Aaron Bennett, AmeriCorps Educator
Nathan Chronister, Director of Education
Marie Ellenbogen, AmeriCorps Educator

The Catskill Center for Conservation and Development, Inc.
Arkville, New York

State of the Arts
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Geography & Geology

The human geography and the geology of the Catskill Mountains are among the things that make the region unique within New York State. Geography and geology allow us to compare our place in the world with all others, and teach people about the nature of their world and their place in it. Translated, geography means a description of the Earth *(geo* means Earth, and *graphia* means description). Geology, similarly, is the study of the Earth (again, *geo* means Earth, and *ology* is the study of). The relationship between geography and geology is an easy one to see. Geology is the physical component of the Earth's geography, meaning conceptually, geology underlies everything, and determines Earth's geography. This relationship will become more evident later on in this module.

The Earth can be depicted in many different ways. One way is to describe the Earth as "an oblate spheroid with an equatorial circumference of approximately 24,902 miles; its surface is covered by water and land in a ratio of 2.3:1, and that surface ranges from 29,028 feet above sea level to 35,840 feet below sea level (the top of Mount Everest to the bottom of the Mariana Trench)". (National Geographic Standards: 1994) Rather than only examining the Earth as a physical object, geography and geology allow us to examine all of the different people, places, cultures, and environments that comprise this oblate spheroid.

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- Vocabulary words that are *italicized* throughout this module are later defined in the Glossary.

- Following each activity are listed NYS Learning Standards that are met by the activity. There is a good possibility that the activity may meet more standards than those listed. The number of the standard, its title, and the topic heading are written out. Some topic headings are divided into key ideas, and their numbers are listed where applicable.

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Introduction to Geology

Geology is defined as the science that studies the physical or fossil history of the Earth, the rocks of which it is made up, and the physical changes that it has undergone or is currently undergoing. The Catskill Mountain region is unique in terms of its geology, making it very different from surrounding areas.

Rocks

There are many types of rock, and each kind has a particular place in the history of the Earth. Rocks are made up of many smaller parts, called *grains*, which vary in shape, size, and color. These grains are mixtures of various substances, most of which are called *minerals*. Minerals are naturally occurring and have physical and chemical properties that characterize each type. Therefore, rocks consist of various minerals, glass, or solidified organic matter (e.g. coal) and cover a significant part of the Earth's crust.

Rocks are classified as three different types: igneous, metamorphic, and sedimentary. *Igneous* rocks, or "melt rocks" are rocks that form from the hardening of once-molten or liquid rock (magma). Examples of this rock type are basalt and granite. Granite is a coarse-grained, light-colored rock formed by the crystallization of magma deep within the core of a mountain range. Any fine-grained, dark colored igneous rocks are basalt. Rocks that are the end result of heat, pressure, and/or chemical actions upon another form of rock are *metamorphic* rock. These can be thought of as "changed" rocks. Marble, slate (fine-grained), and gneiss (coarse-grained with alternating bands of minerals) are examples of metamorphic rock. *Sedimentary* rocks are formed from the accumulation and *consolidation* of loose sediments. These rocks provide us with an accurate record of the Earth's geologic history because they layer one on top of another and collect fossils from the Earth's surface long ago. Another term for the various layers is *strata.* Like the Grand Canyon, the Catskills Mountains are almost entirely composed of sedimentary rock.

Catskill Rock

There are four major types of sedimentary rock present in the Catskills. The sedimentary rocks found underneath the high peaks region and the surrounding lowlands in order of their deposition are Helderberg marine limestone, Hamiliton marine shales, Catskill Delta shales and sandstones (Floodplain shales and River sandstones), and Terrestrial Conglomerates. The Helderberg Mountains, which lie along the northeastern boundary of the Catskill region, are composed of *limestone*. These carbonate rocks often form cliffs and contain caves. Limestone is not very resistant to chemical weathering, as it dissolves readily in the presence of acid. The Helderbergs are geologically different from the rest of the Catskill region.

Shale forms from the consolidation of clay and mud, and is the most common rock in New York. This, the principle bedrock of this area, is fine-grained, dark-colored, and flaky, so it erodes easily. When ordinary sand hardens into rock, the result is *sandstone*. Sandstone is often gray or may have a reddish-brown color due to iron oxide staining. It has a sandy texture from its constituent grains. Most cliffs you see in the Catskill region are composed of sandstone. Sandstone is most abundant in the upper elevations, with the exception of “bluestone”, which is common at lower elevations.

Conglomerate dominates the Shawangunk Mountains and is also found crowning the Catskill high peaks. Conglomerate, often called “puddingstone” is a type of rock that is a mixture of gravel-sand deposits with pebbles, cobbles, or even boulders that have been rounded because of stream transport and held together by a cement-like parent material (e.g. calcium carbonate or iron oxide). These are commonly found in the Shawangunks and some cliffs in the central Catskills. Loose quartz pebbles are often found at higher elevations in the Catskills, emerging from erosion of conglomerates. The Shawangunk Mountains are very different geologically than the majority of the Catskill region.

It is important to keep in mind that rocks are constantly changing over time. Somewhere on the planet, rocks are constantly being weathered or eroded, and in other places, they are being formed. Much like the “water cycle”, geology has a cycle of its own, but this cycle takes millions of years to complete. This is called the *rock cycle*. As you look at the rock cycle, you will notice that many different natural processes affect the inter-relationship between the three rock types: erosion-deposition, burial-uplift, melting-crystallization, and pressure changes. These processes occur in various settings: the atmosphere, biosphere, ocean, crust, and upper mantle. A diagram of the rock cycle can be found in Activity 2.

The Lithosphere

The *lithosphere* is defined as the continuous shell of solid rock around the Earth, and it includes the crust (both continental and oceanic) and part of the upper mantle. The lithosphere is composed of seven large plates and some smaller ones that move around on the Earth’s surface. What look like solid, unmoving land masses (the continents) are not solid at all, but rather plastic-like forms that rest on a hot fluid-like mantle. The various plates can interact with one another in three ways: 1) Collide 2) Slip by one another 3) Move apart. When collision occurs, at *convergent* boundaries, crust is destroyed. Mountains may be formed when two continental plates collide (e.g. the Himalayas). The origin of much of the American northeast, the Appalachian and Catskill Mountains in particular, was affected by convergent boundaries between two plates. The remaining information on the lithosphere (the next two paragraphs) is important information, but un-related to the geology of this region.

When one plate is driven beneath another plate, it is called *subduction* and these areas are often associated with the most disastrous earthquakes and volcanoes. The “Ring of Fire” in the Pacific Ocean is a system of subduction zones where the Pacific plate collides with the Eurasian and Philippine plates, resulting in highly active areas with great potential for earthquakes and volcanoes. Nine hundred, or 66 %, of the world’s active volcanoes are located around the Pacific Rim. Along the eastern part of the Ring of Fire, the San Andreas Fault represents a *transform*

boundary between the Pacific plate and the North American plate. Where plates slip by one another at transform boundaries, no crust is created or destroyed.
At *divergent* boundaries, where plates move apart, openings are generated and molten material moves in to form new oceanic lithosphere. Shallow earthquakes and mild volcanic activity are typical of these areas. At any of the three types of plate boundaries, earthquakes begin at a *focus,* the point within the earth where a fault rupture starts. The place on the Earth's surface directly above the focus is called the *epicenter*. There are no major faults in the Catskill region.

The Geologic Time Scale

Geology tells us that the Earth is very old, 4,600 million years or more. Because the Earth's history covers such a long period of time, scientists use a "calendar of events" to simplify the story. This calendar is called the *Geologic Time Scale* (see figure on the next page), and is comprised of different units called *periods* that separate various events. Over the course of the eighteenth and nineteenth centuries, the Geologic Time Scale was gradually developed to provide us with a road map of the Earth's history. The Geologic Time Scale was based on fossils, which are continually buried within sedimentary rock, thus preserving important clues to the Earth=s history. The Earth's history was subdivided first into *eons*, then subdivided again into *eras*, then once again into *periods*, and finally into *epochs*. It is believed that the Earth is 4,600 million (4.6 billion) years old, and at some time around 3,600 million years ago (the Archean Eon), the first life arose. These life forms were simple bacteria.

The most recent eon, the Phanerozoic, is subdivided into three eras. The beginnings of invertebrates, fish, amphibians, algae, ferns, and conifers marked the Paleozoic Era. Reptiles also appeared late in this era. In the Mesozoic Era, flowering plants arrived and large reptiles (dinosaurs) are were at their peak, and then become extinct. In the most recent era (65 million years ago to the present), the Cenozoic, mammals became numerous, angiosperms, grasses, and herbs became established, and 1.6 million years ago, humans appeared. There is a more detailed time scale, including the various periods, available in the pages to follow.

The Geologic Time Scale is a fairly accurate account of the Earth's history. However, it has been revised many times and will continue to change throughout the years as more discoveries are made, and as more accurate scientific methods and technologies arise. Radioactive dating is one method that has helped make the time scale more accurate. *Radioactivity* is the breaking up of particles (such as the nuclei of atoms) into smaller ones. Minerals, which compose rocks, contain radioactive elements that can be used to calculate the age of the rock. It is impossible to predict when any one radioactive nucleus will decay, but provided a large number of nuclei, it is feasible to predict how many will decay in a given time. Since radioactive nuclei decay in a predictable way, we can use their decay to calculate the age of rocks, remains of living tissue, and other materials. Carbon 14 and uranium 238 are two radioactive isotopes that are commonly used for very accurate dating.

The Geologic Time Scale encompasses a different span of time than most people are used to thinking about. To put the Geologic Time Scale in perspective, imagine if the Earth's existence were scaled down to twelve hours. Starting at midnight, the first life-bearing shells would not even exist until 10:30 AM (570 million years ago). Land plants would not appear until 11:00 AM (420 million years ago), and the dinosaurs' arrival (225 million years ago) would be as late as 11:30 AM. Humans would not have appeared until the last couple of seconds before noon. The last ice age would have come to a close (14,000 years ago) during the last 1/4 second before noon! Just as the day is not over at noon, there are still millions of years left before the story of the Catskills will be finished. We can only guess what lies ahead, but it is quite possible that some of the students in your class may influence that future.

GEOLOGIC TIME SCALE

Era	Period	Millions of years ago	Plant / Animal life	Catskills
CENOZOIC	Quaternary	1.6	Modern animals. First humans.	Present-day Catskill Mountains. Glacial periods.
	Tertiary	66	Mammals become common.	
MESOZOIC	Cretaceous	144	Dinosaurs disappear at the end of this period. Modern fish. Modern forests.	
	Jurassic	208	First birds, sharks appear. Flowering plants appear.	Uplift and erosion of Catskill Delta. Break-up of Pangaea.
	Triassic	245	First mammals. Dinosaurs appear. Bony fishes appear. Conifers increase.	
PALEOZOIC	Permian	286	Modern insects appear. Amphibians decline. Seed ferns disappear.	Shawangunk Mountains form.
	Carboniferous	360	Reptiles, insects appear. Seed ferns, Conifers appear. Tropical coal forests.	Formation of Pangaea. Catskill Delta formed.
	Devonian	408	Fish, amphibians appear. First forests. Horsetails, ferns appear.	Acadian Mts erode. Panther Mt meteor. Acadian Mts formed.
	Silurian	438	Scorpions & spiders (first air-breathers on land). First land plants.	Shawangunk rocks form. Sea retreats.
	Ordovician	505	First vertebrates. Worms. Echinoderms. Algae dominant.	Taconic Mts form in east. NY covered by shallow sea.
	Cambrian	570	Many invertebrate species. Trilobites. Algae, fungi, plant spores appear.	
PRECAMBRIAN		4,600	First evidence of life	Formation of Earth

Adopt-a-Rock

Grades:

3rd - 6th

Objective:

Students should develop greater communication, mapping, and perceptual skills and take a larger interest in physical science.

Method:

Students are given a list of rules to help them choose a rock to “adopt”. They then make journal entries about their rock, in addition to drawing a map of where they found it. They then form a hypothesis about their rock’s history.

Materials:

“Everybody Needs a Rock”, by Byrd Baylor with pictures by Peter Parnell, Adopt-a-Rock certificate (enclosed), writing paper or journals.

Time:

Preparation time: 10 minutes
Class time: 30 minutes

Procedure:

1. Read the book *“Everybody Needs a Rock”,* by Byrd Baylor to the class. This book can be found in most library systems. It is highly recommended that you use this book with the activity (it will heighten appreciation of rocks), but it isn’t completely necessary.

2. Assign the students to find a rock outside of school time, preferably during the weekend. They should follow the list of ten rules. You should write these rules on the chalkboard (simplify if needed) for them to copy into a notebook that they should have with them while picking a rock.

    1. Find a place made out of nothing but rocks. (Explain that it does not have to be a large area. It should be an area where there are a variety of rocks.)
    2. It should be quiet and don’t let anyone talk to you. (Don’t worry if it’s not totally quiet)
    3. Look at the rock closely by bending over with your head almost touching the ground.
    4. Don’t pick a rock too big. Make sure it can fit in your pocket comfortably.

5. Don’t pick a rock too small. You don’t want to lose it.
6. It should feel good enough to touch over and over.
7. Look for rock with interesting colors. It may look different when it’s in the sun or under water.
8. Any shape is good but make sure the rock looks good all by itself.
9. Make sure the rock has a good smell.
10. Don’t get help from anybody when choosing your rock.

3. After “adopting-a-rock”, students should make journal entries that include the following: date, time, place, weather conditions, a description of their rock (color, size, shape, texture, etc.), how old they think their rock is, what they think it is made of, and why their rock is special. Students should bring their rocks and journals back to the classroom.

4. During class time, hand out Adopt-a-Rock certificates, one per student. Have students fill out the certificates using their journals and their rock as a reference.

5. Also in class, instruct students to draw a map from memory of where they found their rock. It does not have to be to scale. They should mark on the map the location of where they found their rock and any other interesting features.

6. Explain that students should keep their rock for a long time, at the least throughout the duration of the Geography & Geology module because they will continue to learn more about their rock every time they do an activity. Each time you perform a relevant activity that may relate to their rocks, have them record the information in their journals.

7. Optional: After you are finished with this module and geology for the year, instruct the class to write anything in their journal that they have learned about the rock or that is different about their rock now that they know more about the geology of the Catskill region.

Extension:

Students can write a story of how they think the rock got to where they found it and post it on a classroom bulletin board. Students can also write a poem about their rock. The outline for Activity 1: Water Poetry in the Water Resources module can be used as a reference.

Assessment:

1. Did the students follow the rules for collecting their rock?
2. Are the students keeping information in their journals, and updating it as they learn more about geology?
3. Does the class know where rocks come from? Where do the students think theirs came from?

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading; Speaking and Writing
Math, Science, and Technology
Standard 3 - Mathematics: Measurement
Standard 4 - Science: Physical Setting 2

Social Studies
Standard 3 - Geography 1

Source: This activity based on contents of the book "*Everybody Needs a Rock*", by Byrd Baylor. The activity was suggested by Hertha Schulze and developed by Marie Ellenbogen.

Adopt A Rock In The Catskills

Where I Found My Rock:

Color(s) and Special Markings:

How it feels:

Shape:________________________ Porous (water drop seeps in): ❑**Yes** ❑**No**

Length:____________cm Width:____________cm Height:____________cm

Overall Size: ❑Boulder (need two hands to lift it)
❑Cobble (can lift with one hand and bigger than an egg)
❑Pebble (smaller than an egg)
❑Sand/Silt/Clay (need a magnifying glass to see)
Remember: Your rock should not be too big or too small!!

Other Interesting Characteristics (sparkles, changes color under water):

My Favorite Thing About My Rock:

________________________________**was adopted by:**
(Print Rock's Name)

________________________________**on** ___/___/___
(Print Your Name)

Signature:

The Rock Cycle

Grades:

4th - 7th

Objective:

Students will be introduced to the rock cycle, the three types of rocks and how they form, and how rocks can change over time.

Method:

Much like the Water Cycle activity in the Water Resources module, this activity provides a visual illustration and includes key vocabulary words so the students will be more likely to understand such an abstract concept. Students follow the cycle using a diagram and label important terms.

Materials:

Labeled diagram and blank diagram (enclosed), coloring utensils, sedimentary rock samples collected locally or from a rock kit.

Time:

Preparation time: 10 minutes
Class time: 30 minutes

Procedure:

Note: All of the vocabulary used in this activity is listed in the Glossary of this module. You should familiarize yourself with the terms prior to performing the activity. Much like living things and water, rocks also go through a cycle. The "rock cycle" is a much harder concept to grasp than the water cycle or a life cycle, taking place over hundreds of millions of years.

1. Establish a small collection of local rocks or get a rock kit. Show the class some samples of locally collected, sedimentary rocks. The most common sedimentary types in the Catskills are sandstone (rough and usually grayish or bluish), shale (smooth, gray or reddish color), and conglomerate (with pebbles in it).

2. Pass around the rocks asking them to speculate about how the rocks might have formed. If you have a rock with visible layering it should be easier to guess. Do they know there are three

different ways rocks form? Students might suggest that the rocks formed in a volcano in which case you can use the opportunity to say that some rocks form that way, but these rocks did not.

3. Ask the class what a “cycle” is. Have them give you examples. Ask them if they know about the water cycle or a life cycle. Is there a beginning or an end to a cycle? Do rocks go through a cycle? Tell students that they will study the rock cycle to learn how rocks form and change.

4. Distribute the blank diagrams, one per student, and have them take out their coloring utensils.

5. As a class fill in the blanks on the diagram. Ask where they think the cycle begins? Because it is a continuous cycle, it doesn’t matter where you begin. Ask where they would like to start.

6. Wherever you decide to start, label the arrow and the rock type, and continue on in the appropriate direction. Students can color the arrows the same color, and the three rock types different colors.

7. Make sure the various processes (arrows) are colored in and discussed. For grades 6 and 7 you should use: Burial & cementation, metamorphism, melting, magma, crystallization, weathering (erosion), sediments, and uplift are all important parts of the cycle. For grades 4 and 5, you should simplify the terms, using: Burial, increased pressure/temperature, melting, liquid rock, hardening, weathering (erosion), sand, and uplift. Igneous, metamorphic, and sedimentary rocks should also be labeled. Sedimentary rock is shown in layers marked with various patterns. Again, this is the type of rock found in the Catskills.

8. The three arrows that cross over the cycle indicate that parts of the cycle can be bypassed because of various geologic events. For example, uplift may bring sedimentary or metamorphic rock to the surface without it ever becoming igneous rock.

Assessment:

1. Did the class understand that there is no beginning or end to the rock cycle?
2. Did the students learn that the rocks in the Catskill Mountains are sedimentary rocks?
3. Could the class understand that the cycle does not always go in a complete circle and certain events can disrupt it, causing its alteration?

Use the enclosed quiz to assess students’ knowledge of the presented material. Quiz answers:

1. The rock cycle, like all cycles, does not have a beginning or an end.
2. The three types of rock are igneous, metamorphic, and sedimentary – which we have in the Catskills.
3. Metamorphic rock turns into magma by undergoing metamorphism, which occurs due to increasing pressure and temperature as the rock gets closer to the Earth’s core.
4. Rocks will not always go through the cycle in the same manner. Geologic events, such as sudden uplifts or volcanic eruptions (or lack there of) may alter the natural cycle.

5. A sudden uplift, or mountain building event, would push buried sedimentary rock up to the surface, where it will erode again – passing over much of the cycle.

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading

Math, Science, and Technology
Standard 4 - Science: Physical Setting 1,2,5
Standard 6 - Interconnectedness: Systems Thinking

Source: Activity developed by Aaron Bennett and Nathan Chronister.

The Rock Cycle Quiz

Name: ___________________________ **Date:** __________ **Teacher:** ____________________

Directions: Answer the questions below using the information you learned in the activity.

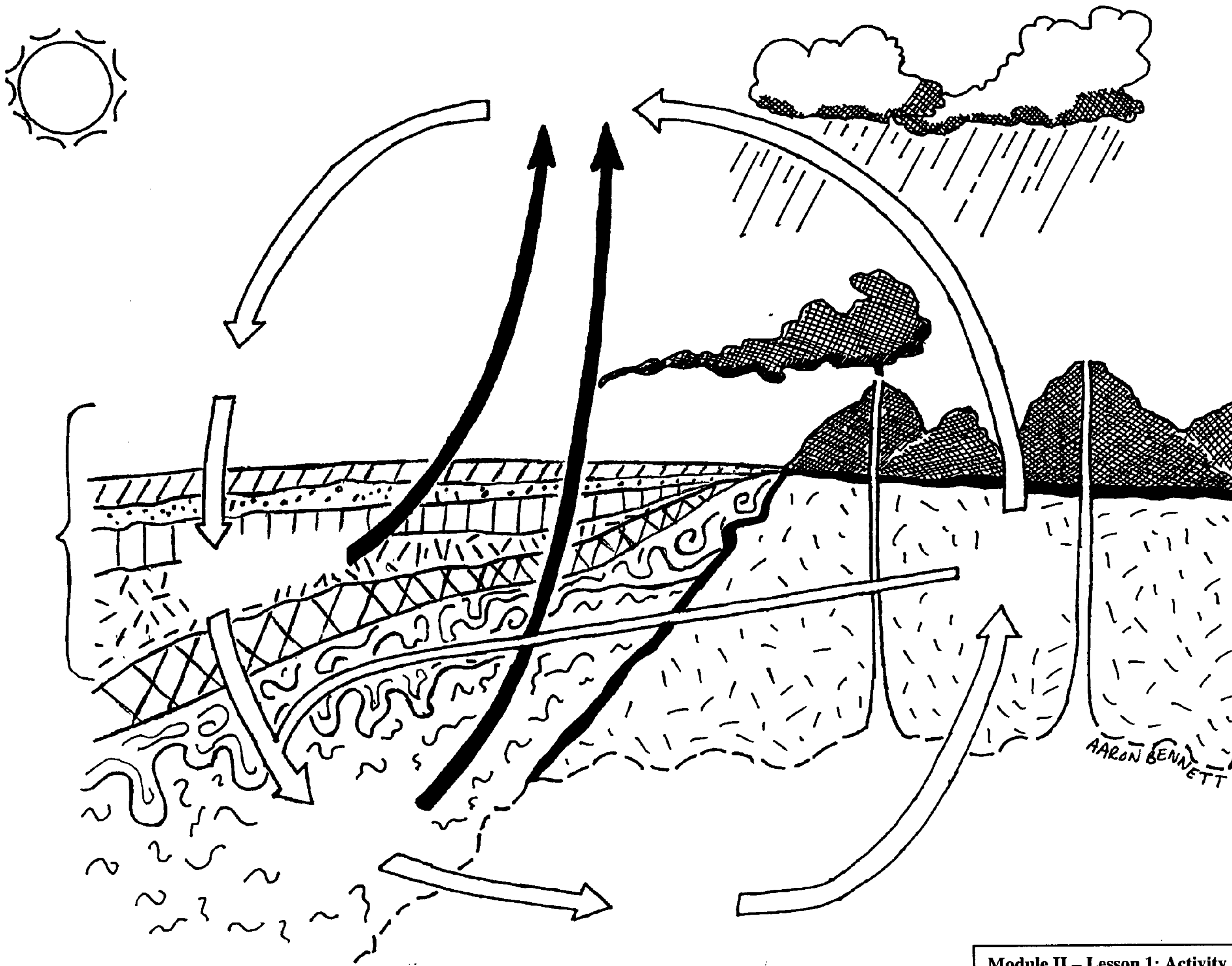
1. Where does the rock cycle start?

2. What are the three types of rock? Which one do we have in the Catskills?

3. What causes metamorphic rock to change into “liquid rock” or magma?

4. As rocks continue through the cycle, do the rocks always follow the same path, or can something cause it to change?

5.What might cause sedimentary rock to skip over most of the rock cycle (i.e. becoming metamorphic rock, magma, and then igneous rock)?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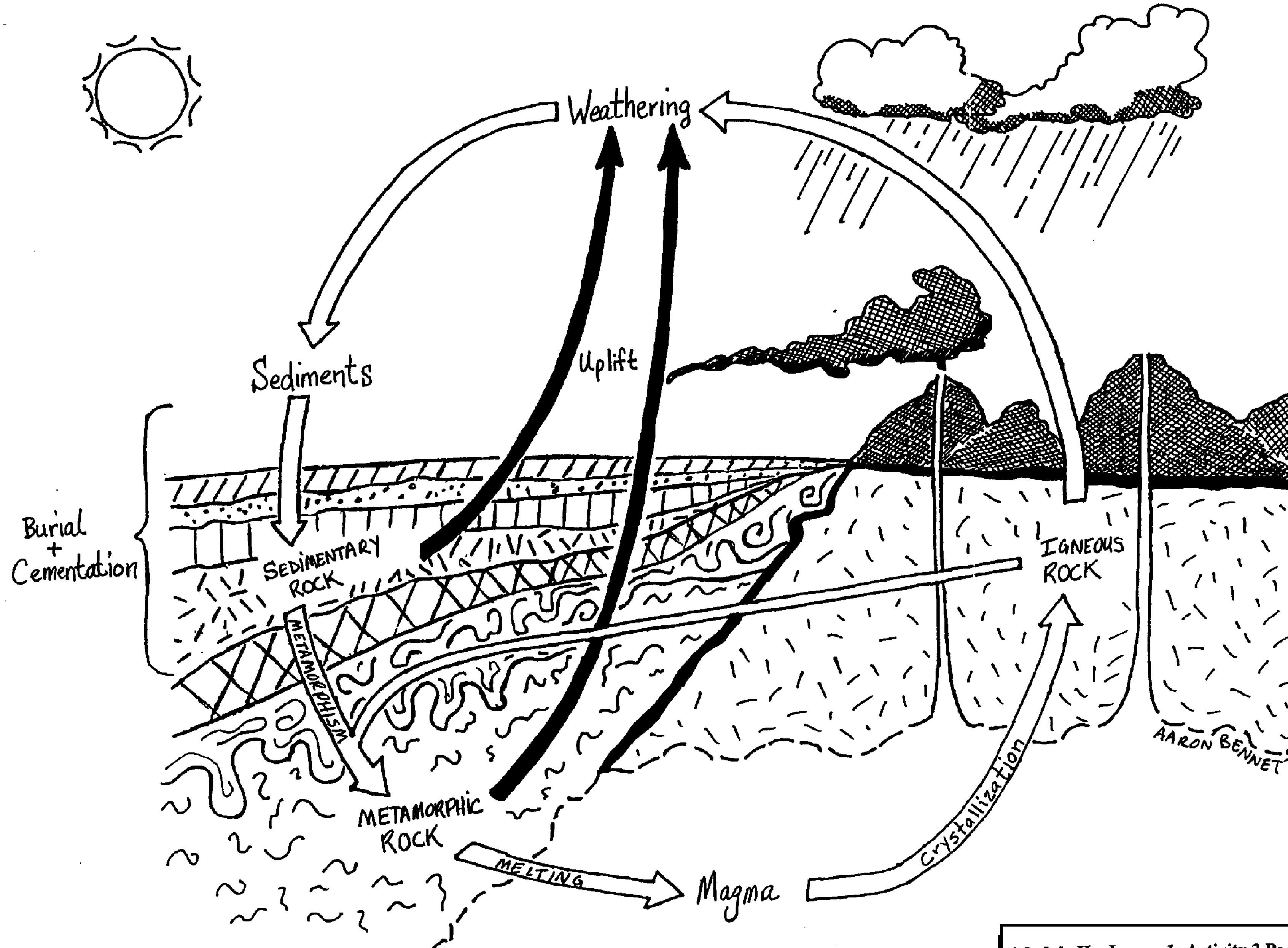
Weathering
Sediments
Burial + Cementation
SEDIMENTARY ROCK
METAMORPHISM
METAMORPHIC ROCK
Uplift
MELTING
Magma
Crystallization
IGNEOUS ROCK
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The Geologic Clock

Grades:

4th - 7th

Objective:

Students will gain an understanding of how old the Earth is, what events occurred millions of years ago, and where human history fits in to the Earth's geologic time scale.

Method:

Each student will construct his or her own Geologic Clock that will act as a timeline of Earth's extensive history. Instead of telling time in hours, minutes, and seconds, this clock will tell time in millions of years.

Materials:

Data for the clock (enclosed), large sheets of paper (preferably construction paper) for each student, a circular template (you make), scissors, rulers (one per student), and writing/coloring utensils. See also the Geologic Time Scale in the Lesson 1 summary for reference.

Time:

Preparation time: 20 minutes
Class time: 45 minutes – 1 hour (if doing extension)

Procedure:

1. This activity should be used after giving the students some background information on geologic time, and a brief history of how the Catskill Mountains were formed (from the erosion of a 5,000' high plateau beginning some 300 million years ago). Information provided in the lesson summaries covers all of the necessary topics for the activity.

2. Make one (or a few) template(s) out of cardboard or thick paper that students can use when cutting out their clock. Large construction paper will allow enough room on the clock to write in the necessary information. The templates can be a full-circle or a half-circle (they fold paper in half and cut) or even a quarter-circle (fold paper into quarters) whichever you feel will work best for your class.

3. Ask the class if they know what a time-line is. Show an example of a time line that is in one of their books or one that you have in the classroom of for example, American history. Explain that they will be making their own time-line except it will be a circle, like a clock. The starting point will be 12:00 midnight (formation of the Earth) and the end is 12:00 noon (the present day).

4. Show the class the clock face template that you have made, and proceed to explain how they will make their own.

5. Distribute paper, scissors, rulers, and the template(s). When students are finished cutting out their clocks, collect the templates, scrap paper and scissors.

6. Each student should now label his or her clock by marking all twelve hours and three 15-minute marks between each hour. These marks only need to be approximate. Place a large dot in the center of each clock as well.

7. Use the chart provided to fill in the clock. In the chart, we use “MYA” as an abbreviation for “million years ago”. Write the first entry on the chalkboard (e.g. 12:00 - Formation of Earth - 4,600 MYA). Have students write the year under the 12:00 and draw a straight line, using a ruler, to the middle of the clock. On that line is where they can write “Formation of Earth”.

8. Continue down the list until you reach the present day at 12:00 noon. You can have students color in the various blocks of time between the different events. Emphasize the enormity of time by pointing out that the last ice age left this region some 14,000 years ago, which would be less than 1/4 second before noon on the geologic clock.

Extension:

For higher ability levels, have your students enlarge the portion of the geologic clock from 10:00 AM - 12:00 noon with an extra piece of paper and plot other important information. For a challenge, have them try to calculate what time each would appear on the clock. Correct times are listed in parentheses below.

For your information, each minute equals 6.4 million years

First Land Plants - 420 MYA (10:55)
First Fish - 410 MYA (10:54)
First Insects - 350 MYA (11:05)
First Conifers - 320 MYA (11:10)
First Reptiles - 300 MYA (11:13)
First Mammals - 250 MYA (11:21)
First Birds - 145 MYA (11:44)

Assessment:

1. Were the students able to understand the assignment and make a legible clock?
2. Could the class comprehend how millions of years are depicted as minutes and hours on their clock?
3. Use the enclosed quiz to assess students' knowledge of the presented material. Quiz answers:
    1. The Earth is about 4,600 million (or 4.6 billion) years old.
    2. The dinosaurs lived on Earth for about 160 million years until a huge meteor impact caused their extinction 70 million years ago.
    3. Most of Earth's history dates back only 450 million years (10:50 AM or later on the clock).
    4. Most of the student's time-line events will occur near the present-day.
    5. Just as most events in Earth's history are located near the end of its time-scale (due to a lack of evidence and the inability to reveal evidence from its origin), students will cluster events at or near the end because they can remember (have more evidence of) recent events better than events from many years ago.

NYS Learning Standards:

Math, Science, and Technology
Standard 4 - Science: Physical Setting 2
Standard 6 - Interconnectedness: Magnitude and Scale

Social Studies
Standard 2 - World History 2

Source: Adapted by Aaron Bennett from *Environmental Education Program: Curriculum in Science Field Studies Grades K-6*

EARTH'S HISTORY	WHEN (Millions of years ago)	TIME
Formation of Earth	4,600 (4.6 billion)	12:00 AM
Oldest Rocks Formed	3,800 (3.8 billion)	2:05 AM
First Living Organisms	3,600 (3.6 billion)	2:36 AM
Acadian Mountains	375	11:00 AM
Catskill Delta Forms	350-340	11:05 AM
Shawangunk Mountains Form	290-275	11:12 AM
Dinosaurs Appear	230	11:20 AM
Pangaea Begins to Separate	200	11:26 AM
Dinosaurs Become Extinct	70	11:49 AM
Ice Ages Begin	1.6	15 seconds before 12:00 PM
First Fully-Modern Humans	200 thousand years	2 seconds before 12:00 PM
End of Last Ice Age	15 thousand years	less than 1/4 second before 12:00 PM

Geologic Clock Quiz

Name: ___________________________ **Date:** __________ **Teacher:** ____________________

Directions: Answer the questions below using the information you learned in the activity and throughout the lesson.

1. About how old is the Earth?

2. How long did the dinosaurs live on Earth?

3. When did most of the events on your Earth history time-line occur, before 11:00 AM or after?

4. Try to make a time-line of eight important events in your life beginning with birth, and ending with today in the space below. Where do most of the events occur, in the beginning, near the middle, or at the end?

5. Why do they occur there and not in other parts of your life?

Fossil Dig

Grades:

4th - 7th

Objective:

Students will be able to see how fossils form and what can be learned from them once they are uncovered and studied.

Method:

This activity works best if two different classes perform the activity simultaneously. If that is not an option, groups from the same class can do this. Each class makes mud layers and places objects between them. After a few days (once the mud dries out), the other class will perform a "dig" to uncover the clues left by the other class.

Materials:

Clayey soil (not sand), large margarine tubs or other suitable containers (1 per group), water, a dishpan, plastic tablecloths or newspaper (if done inside), toothpicks (thick, round ones work best), other objects that can be used to pick at the fossils, and fossils (ideas include: twigs, fresh leaves, small pine cones, shells, feathers, and clean chicken bones).

Time:

Preparation time: variable (1 hour, maximum)
Class time: 2 periods (3-4 days apart), 1 hour each

Procedure:

Note: You should practice making the mud mixture ahead of time in the dishpan to get the appropriate consistency. You will need to make it a thick mud mixture so the activity will work. Remember, this activity requires two class periods with three or four days in between to allow fossils to dry.

1. If you have any real fossils to show, or if can get your hands on some, it would be a great introduction to this activity. If you have not already gone over how sedimentary rocks are ideal for preserving fossils, do so. Review how sedimentary rocks form (layers of sediment burying other layers, compacting it into rock), the Catskills are composed of shale at lower elevations and

sandstone at upper elevations; both are sedimentary rocks. This information is all included within this module.

2. Ask students some general questions like: Does anyone know what a paleontologist studies? How would a paleontologist recover fossils? What can you learn by observing fossils?

3. Explain the purpose of this activity and instruct them to decide on what items they want to bury so the other class (or groups within your class) can dig them up. Coordinate with the other teacher so not all items are similar.

4. If doing the activity with another class, have two groups per class, or if doing it within you own class, use four groups (use your judgment for group size dependant upon the ability of the students). Distribute the materials. Have the students in each group put their names on the tub or number the tubs so you can tell them apart. If possible, take the students outside for step 5, or place plastic tablecloths or newspaper down on the floor or a large table.

5. Students can now place a layer of mud in the bottom of the container. Press the objects (leaves, shells, etc.) into the mud and cover with 3-5 cm of mud. Once the first layer is covered, students can now add more objects and more layers of sediment until the container is full.

6. Let the mud mixtures completely dry in the sun for about three or four days.

7. Exchange the dried tubs with the other class, or distribute tubs among your class (whichever option you chose). Emphasize the their objective, which is to retrieve the fossils in *perfect* condition. They are trying to retrieve and preserve the fossils. They should take their time and be patient when doing this.

8. Have the students use the toothpicks or other digging tools to recover the fossils. Once all of the fossils have been recovered, display them so each group can see what was found.

9. Have each group tell the rest of the class the fossils that were found, and what clues to the past they could determine based upon the fossils. For example, if twigs or leaves were found, what types of trees existed (deciduous or evergreens, etc), if feathers were found, what kinds of birds existed, etc.

10. Discuss with the class how geologists and paleontologists can use fossils to uncover the Earth's history and how they can be useful in discovering locations of fossil fuels like petroleum, which result from decomposition of organic matter. This would be a good place to talk about the ancient Gilboa Forest, discussed in detail in Lesson 3. Here are some discussion questions you may find useful:

- Do you think leaves can become fossils?
- After millions of years, what would be left of the leaf?

- Are new fossils being formed today? What conditions are needed?
- What kinds of things might become fossils today?

Extension:

1. Instead of leaving objects in place and burying them, you can leave only their impressions. You would need to let the mud dry overnight before adding the next layer. This approach shows how footprints could be preserved as fossils. Plant impressions, however, do not form this way. The plant is buried by sediment and only after will it rot away.

2. Students can research what types of fossils geologists and paleontologists have found in the Catskills. The New York State fossil is the *Eurypterid*, which occurs in the nearby Shawangunk Mountains. The fossil forests of Gilboa are among the oldest known forests on Earth. Again, this is covered in Lesson 3. There are numerous places to go fossil hunting in the Catskills, see the “Places to Visit” in the appendix for field trip ideas.

Assessment:

1. Did the class understand what fossils are and how they become preserved?
2. Was the class able to successfully dig-out the objects without fracturing the fossils?
3. Were the students able to identify the fossils correctly, or were the objects you chose to difficult?
4. Could the students work effectively in their groups?
5. If you did this activity with a second class, would it have worked better with only your class? If you did it within your own class, would it have worked better if another class were involved?

NYS Learning Standards:

Math, Science, and Technology
Standard 4 - Science: Physical Setting 2
Standard 7 - Interdisciplinary Problem Solving: Strategies

Social Studies
Standard 2 - World History 2

Source: This activity adapted from The United States Geological Survey's *Learning Web*.

Introduction to Geography

By joining the physical and human dimensions of Earth, geography allows us to study the interdependency of living things and the physical environment. Geography shows us the correlations between people and places and the connections between people and the environment. "Geography is a field of study that enables us to find answers to questions about the world around us -- about where things are and how and why they got there." (National Geographic Standards, 1994)

In order to appreciate these relationships, we must first understand *space* and *place*. *Space*, as defined by the National Geography Standards is "the environmental stage upon which the drama of geography is played out", and *places* are "particular points on the environmental stage where the action occurs". Location, distance, direction, shape, and pattern all identify our *space* in the world. Relationships between physical environmental characteristics (e.g. climate, topography, and vegetation) and human characteristics (e.g. economic activity, settlement, and land use) define our *place* on the planet.

What Can We Learn From Geography?

Despite the plethora of maps that are produced for countless reasons, here is a list of some details that most maps portray.

- **Location** - This can be though of as a "global address". Every place on this planet has a specific location. A set of imaginary lines that crisscross over the Earth's surface, forming a grid system called latitude and longitude, was developed so that a precise location of a place is possible. Lines measuring distance east and west beginning at the *prime meridian* in Greenwich, England are lines of *longitude*. Longitude lines, all of which merge at the poles, are called "meridians". Meridians measure from 0° at the prime meridian to 180° at the International Date Line (half way around the globe). *Latitude* lines measure the distance of a point north or south beginning at the *equator*. Latitude lines are called "parallels" because they are always the same distance apart. Unlike meridians, parallels measure from 0° to 90° from the equator, together, these lines are used as a grid system, allowing geographers to state locations accurately.

The measurement unit degrees (°) are broken down into smaller units allowing for more precise descriptions. There are 60 minutes (') in each degree unit, and there are 60 seconds (") in every minute. One degree of latitude always equals about 69 miles, one minute is just over a mile, and one second is approximately 100 feet. Measurements in longitude vary from 69 miles at the equator to 0 at the poles because the lines converge at the poles. For example, Woodstock, NY is located at 42° 02' 20" north latitude and 74° 06' 38" west longitude. Delhi, which is northwest of Woodstock, is located at about 42° 16' 30" N and 74° 55' 00" W.

- **Directions** - Direction is just as important to understand as knowing “right” from “left”, or “above” from “below”. Maps use north, south, east, and west to describe where one point is in relation to another.

- **Place** - What makes a place unique? Each place on the planet has its own personality based on the physical and human characteristics that shape it. Different types of maps will uncover assorted clues about the personality of a certain place. Characteristics that we see on maps might include how topography has limited housing in areas or helps determine the weather. Maybe shapes of buildings exhibit how they were used in the past, living near a national park hampers development, or structures in urban areas tend to be taller and buildings in rural areas more spread out.

- **Relationships with Places** - How do people conform to their environment and what is the relationship between the two? Many cities throughout the world require their citizens to get regular emissions tests on cars and closely monitor water usage, while in many rural areas, people are not required to get emission tests or manage their water use. Roads cannot always be built over mountains; they must go around. Cities are built in valleys and often near water bodies.

- **Movement** - How do people, products, and information get from one area to another? People must interact with people in other regions every day. The United States gets bananas from Central America, clothes from Southeast Asia, and oil from the Middle East. Why do we need to get these goods from other parts of the world, but not milk or corn? Information is shared daily with other parts of the world via newspapers, television, radio, telephones, and the Internet. Routes of transportation can be seen on maps. Highways, train tracks, and ship routes are all determined by topography and by the location of communities.

- **Regions** - How can we define or contrast two places on Earth? Regions are changing, and new ones are forming as time passes. There are two basic types of regions, *cultural* and *physical*. Political, economic, religious, linguistic, agricultural, and industrial features determine cultural regions. Physical regions are established by natural barriers such as land formations (continents, mountains, waterways), climate, soils, or vegetation. Each country and city has different regions, as does each town or village. One house within that village even has its own regions.

Maps

Although there are countless types of maps in the world today, all maps attempt to accomplish the same goal: simplifying an extensive amount of information. The definition of a *map* is the representation on a flat surface of all or part of the Earth’s surface, to show physical, political, or other features, each point on the diagram corresponding to a geographical position according to a definite scale or projection. The *scale* of a map is simply the relationship between distance on the map and distance on the ground. *Projection* involves illustrating the curved surface of the Earth on a flat surface map, so that each point of the map corresponds to one point on the Earth’s natural surface. Maps can be very diverse, both in their themes, and in their scales.

The scale of a map is usually given as either a ratio or a fraction (e.g. 1/1,000 or 1:1,000). The representative fraction scale means that one unit of measurement (1 inch or 1 centimeter) depicts 1,000 of the same units on the surface of the Earth. The map distance (the first number) in the scale is always 1. The *larger* the second number is, the *smaller* the map scale. A larger scale map allows for more detailed information, however it will cover less area. On the other hand, a map with a smaller scale will sacrifice the very detailed information, in order to show greater land coverage. The most important factor when deciding what scale to use is the map's intended use. People use many different types of maps depending on what they are interested in. You could make a map of the entire state of New York, or a very specific map showing a single building or one hiking trail in the state.

Maps can be very simple or quite complex. A hiker would want to use a map with all the hiking trails on it, while a tourist might want to look at a map with museums, inns, state parks, and other points of interest labeled on it. A simple map could include all of the counties in New York, as opposed to a more complex map, which might include all townships, roadways, and water bodies in the state.

With the use of Global Positioning Systems (GPS) and Geographic Information Systems (GIS), the information on newer maps has become more accurate and simpler to display. Global Positioning devices receive signals from a system of special satellites orbiting the Earth. They use those signals to determine the exact location of the GPS receiver to within meters, or in some cases centimeters depending on the type of receiver. Geographic Information Systems typically refers to computer databases for geographic information. GIS allows users to generate customized maps and perform complex analysis of geographic data.

Why Maps Intrigue Us

Throughout this Geography and Geology module you will find many maps, differing in one way or another from one to the next. Essentially they all have something in common; they enable us to present a great amount of information in a simple and easy-to-understand manner. To fully understand maps, we must not only grasp the information that is printed on the map, but we must be able to understand the underlying causes. For example, most everyone is familiar with a map of the United States and can recognize the various states and water bodies. But how many people understand the reasons for each state boundary and why the lakes are where they are? If you truly understand geography, you will know why the differences exist. The boundaries in the East were drawn after settlement had occurred, where people were familiar with the territory; therefore, boundaries often followed the topography, rivers, and lakes. The state boundaries in the West were determined prior to settlement; therefore lines of latitude and longitude usually separate the states.

State boundary lines are not the only lines determined by latitude, longitude, waterways, or topography. Township lines are determined similarly. Just as many different counties make up a state, different townships (or towns) make up a county. Cities, villages, and hamlets are located within townships. Many people often misunderstand this concept. People often incorrectly refer to a village as a "town". A township is a larger area of land that has its own government and may include several villages and/or hamlets. A village is an incorporated place where a village government has been established in addition to the town government. Hamlets, which generally have smaller populations than villages, are unincorporated areas governed by whatever town the hamlet is located in. You may wish to show students these differences by simply gathering around a map of the area, asking them where they live, and having them explain to the class what state, county, township, and village or hamlet (if any) they live in. A correct answer could be something like: New York State, Greene County, Town of Coxsackie, and hamlet of Earlton.

The various political boundaries on a map are just one aspect of geography. To gain a broader perspective, let's look at some other important features of Catskills geography. You will notice that some county boundaries follow topographic features such as the Hudson or Delaware Rivers. In addition, there are six reservoirs that stand out, and a "blue line" that surrounds much of the area. There are high mountains in the eastern Catskills and lower ones in the west. There are more people along the Hudson River than there are in the western part of the region.

As you study the geography of the Catskills, you should be able to explain questions such as: How and why were these reservoirs created? Why were their current locations chosen, and what impacts did they have (or what impacts do they still have) on the local communities? What does the "blue line" show, and why was it established? How were the boundaries for the line chosen? Why are the mountains higher near the Hudson River? Why are the summit elevations of the mountains so uniform? How is it that no large cities are located on the rivers in the central Catskills? Why do Interstates 88 and 87 parallel large rivers like the Susquehanna and Hudson?

These are just some of the questions that your students will be able to answer as they study the geography of our region. Obviously there are many more questions to be addressed, and hopefully this module will help you start addressing them with your students. Quite often, geography is only thought of in a physical context, but it is the interlinking of physical and human contexts that makes up geography.

Compass Rose

Grades:

3rd - 6th

Objective:

While familiarizing themselves with a compass, students will also become acquainted with a grid system and how to graph points on it.

Method:

Students will follow directions to plot locations on a grid system in order to create a compass rose showing the cardinal and the intermediate directions.

Materials:

A copy of the enclosed grid for each student, ruler or straightedge, and crayons or colored pencils.

Time:

Preparation time: 10 minutes
Class time: 45 minutes

Procedure:

1. If you have not discussed grid systems and what a compass is used for, do so now. Perhaps draw an X-Y axes on the board, showing how to plot points (1,1) and (2,4).

2. Draw another X-Y axes next to it, and ask the class if they know how to label it like a compass. Point out the 4 different quadrants (NE, SE, SW, and NW). Make sure the students realize how much alike both axes are.

3. Distribute the grid handouts to all students.

4. Explain that they are to plot the 16 points that you give them on their grid. Depending upon student's ability level, have them plot the points on their own, or go through them as a class. Write the following 16 coordinates on the chalkboard:

DOT	LOCATION	DOT	LOCATION
1	North 8 East 0	9	South 8 West 0
2	North 2 East 1	10	South 2 West 1
3	North 4 East 4	11	South 4 West 4
4	North 1 East 2	12	South 1 West 2
5	North 0 East 8	13	South 0 West 8
6	South 1 East 2	14	North 1 West 2
7	South 4 East 4	15	North 4 West 4
8	South 2 East 1	16	North 2 West 1

5. Once the dots are plotted, instruct the students to connect the dots in numerical order beginning at the origin, point (0,0), and ending up back at dot #1. Make sure they have access to a ruler or some straightedge to connect the points. Straight lines should also be drawn from each dot to the origin.

6. Color every other triangle with the same crayon or colored pencil.

7. Ask the class if they know what this is a diagram of.

8. Instruct students to label the following points: At point (North 4, East 4), write the letter A. At point (South 4, East 4) write the letter B. At point (South 4, West 4) write the letter C. At point (North 4, West 4) write the letter D.

9. Ask the class what letters A, B, C, and D represent. They can also label the cardinal and intermediate directions on their compass rose.

Assessment:

1. Did the students understand the cardinal directions and what compasses can tell us?
2. Were they able to color in their compass rose correctly?
3. If you asked the students basic geographical questions like: Is the United States north or south of Canada? Are the Catskills north or south of New York City? Are they east or west of the Hudson River? Could they answer them correctly?

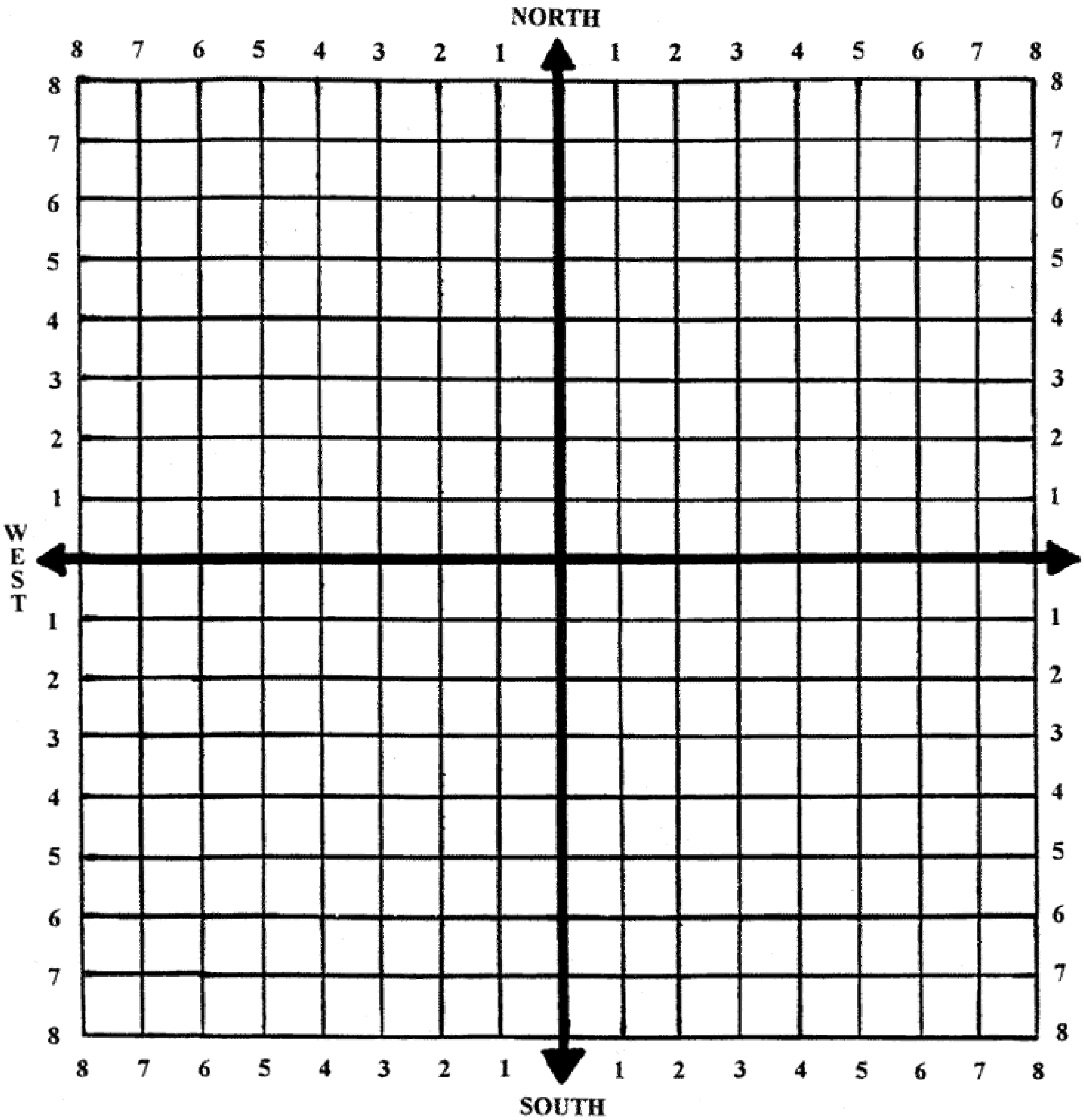
NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading

Math, Science, and Technology
Standard 3 - Mathematics: Number and Numeration; Operations

Social Studies
Standard 3 - Geography 1

Source: This activity developed by Aaron Bennett.


NORTH
SOUTH
WEST
EAST
8 7 6 5 4 3 2 1 1 2 3 4 5 6 7 8

School Map

Grades:

3rd - 6th

Objective:

Students will become familiar with basic map-drawing concepts and techniques. Students will be able to distinguish between different types and features of maps, and be able to explain their significance.

Method:

Students will first draw a mental map of their school or schoolyard. Depending upon age and ability, students then walk around the school or schoolyard and draw another map, comparing it to the first one. Older groups should draw the "birds-eye view" of the school, including and labeling all major rooms in the school or features outside the school.

Materials:

For each student, a few large pieces of paper, a ruler or straightedge, pencil, and eraser. Crayons could be used for schoolyard maps (trees, dirt, pavement, etc).

Time:

Preparation time: 10 minutes
Class time: 1-1.5 hours (divided into 2 class periods)

Procedure:

1. Be sure to give the students a general overview about maps and some of the features that are commonly shown on maps. Talk about the many different types of maps, and show examples of ones you have in the room. Tell the students that maps allow us to distribute information in a manner that is very visual and easy to understand. You may wish to use the Lesson 2 summary or other activities in this module as an introduction to differences and similarities among maps.

2. Decide if you'd like the class to draw maps of the classroom, the building, or the schoolyard. Once that decision is made, have each student draw a mental map (sketch) of the site. They should only use pencils for this. For younger elementary classes, you might have them draw only the classroom and its contents. Older students should be able to incorporate more detail such as the different hallways, rooms, water fountains, large objects in certain rooms, and steps onto their maps.

3. For the second part, list the areas/objects on the blackboard that students should include in the second map. For older groups, have them walk around the area to figure out what they need to include. This map is of the same area, just more detailed. Tell the students what to include in the legend. You may also ask them to draw a compass rose or an arrow pointing north.

4. Explain what a map scale indicates. Please note that a map does not have to be drawn to scale, but it should say, “not drawn to scale” in the legend. The students should at least try to make their maps somewhat proportional. You may also wish to draw your own map of the area the students will draw. This will allow them to identify errors quickly, and help in the discussion.

5. Distribute the paper and straightedge (rulers depending on age) to each student. Help them get started by giving the outside dimensions (on the map, not of the actual building) of the area they are to draw. Be sure to mention that they should draw their map *lightly* in case they need to erase.

6. Once they have completed their maps, have student’s compare the first map with the second map they generated. Ask them what they forgot on the mental map, but included on the second one. Willing students could show the class each of their maps and explain similarities and differences.

Extension:

For older students, have them construct a classroom map to scale, in addition to the others. This shows students that maps can be even more specific and more accurate. This map could include desks, shelves, tables, and even computers. The scale would be larger, and therefore the map can be more detailed.

Assessment:

1. Did most of the maps in the class look similar? Did the maps look like the map you made?
2. Were all of the areas on the list labeled?
3. Did the students remember to include a legend on their map?

NYS Learning Standards:

Math, Science, and Technology
Standard 3 - Mathematics: Measurement
Standard 6 - Interconnectedness: Models, Magnitude and Scale

Social Studies
Standard 3 - Geography 1

Source: This activity was developed by Aaron Bennett.

Understanding Maps

Grades:

3rd - 6th

Objective:

This activity should give students a very basic introduction to interpreting and using maps. This activity is designed to lead into the more in-depth activities that will follow in this module.

Method:

Students will use a simple map to answer specific questions about distance, direction, natural features, roads, and buildings.

Materials:

Worksheet and map (enclosed), overheads of worksheet and map (optional), ruler, crayons (optional).

Time:

Preparation time: 10 minutes
Class time: 45 minutes

Procedure:

1. Ask the class what kinds of maps they are familiar with and have used before. What types of information are on maps? Explain why people use maps, and give some examples they do not come up with, e.g. subway maps, building floor plans, maps of the ocean floor, etc.

2. Distribute copies of the map and worksheet to each student. The map shows an area near Woodstock.

3. If you have a map of New York State, you might want to show them what area of New York their map is showing. Also, ask them why and what is different about their map compared to the one of the entire state.

4. Give an overview of this map so they understand the symbols, villages, compass directions, etc. Explain the scale, and explain how it can be used to calculate a distance.

5. Have the students complete the worksheet on their own. The overhead transparency is a great way to review the exercise. (For younger students, you can do the activity along with the students, using the overhead.)

6. Review the question sheet as a class by calling on volunteers to give their answers and discussing each one.

Extensions:

Find a local topographic map and ask similar map questions about an area they are familiar with. Review the scale and symbols. You could then perform Activity 5 of this lesson, which explains topographic maps in more detail.

Assessment:

1. Based on their worksheet answers, do students understand basic map concepts?
2. Could the students draw a map of their own if given some basic direction?
3. Were students willing to share their answers with you, or did they seem uncomfortable with them?
4. Use the enclosed quiz to assess students' knowledge of the presented material. Quiz answers:
    1. Maps types could include: topographic maps, relief maps, trail maps, road maps, subway maps, floor plans, a world map, etc.
    2. A map legend displays various information like: the scale, title, publisher, color/symbol keys, maybe the compass, and the date.
    3. The second map has the smaller scale. Remember, the larger the second number is, the smaller the map scale.
    4. The map with the larger scale (the first one) is able to show more detailed information, because it will cover a smaller area.
    5. The second map (with the smaller scale) would be able to show the greatest amount of land area.

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading

Math, Science, and Technology
Standrad 3 - Mathematics: Measurement
Standard 6 - Interconnectedness: Magnitude and Scale

Social Studies
Standard 3 - Geography 1,2

Source: This activity developed by Aaron Bennett.

Understanding Maps Worksheet

Name: ________________________ **Date:** __________ **Teacher:** ______________________

Directions: Answer all of the questions below.

1. What direction would you have to travel to get from Shady to Lake Hill? _________________

2. What is the highest mountain on this map? ____

3. The church is closest to what village? ____

4. On this map, Route 212 crosses over what stream? ___________________________________

5. Is the road that runs along the western edge of Cooper Lake a dirt road or a paved road? ____

6. How far is Lake Hill from Shady? (In a straight line, not along the road) ____________ miles

7. Does the Beaver Kill stream flow from North to South, or from East to West? ____________

8. What stream is the school across from? ____

Understanding Maps Quiz

Name: ___________________________ **Date:** __________ **Teacher:** ____________________

Directions: Answer the questions below using the information you learned from this activity and throughout the lesson.

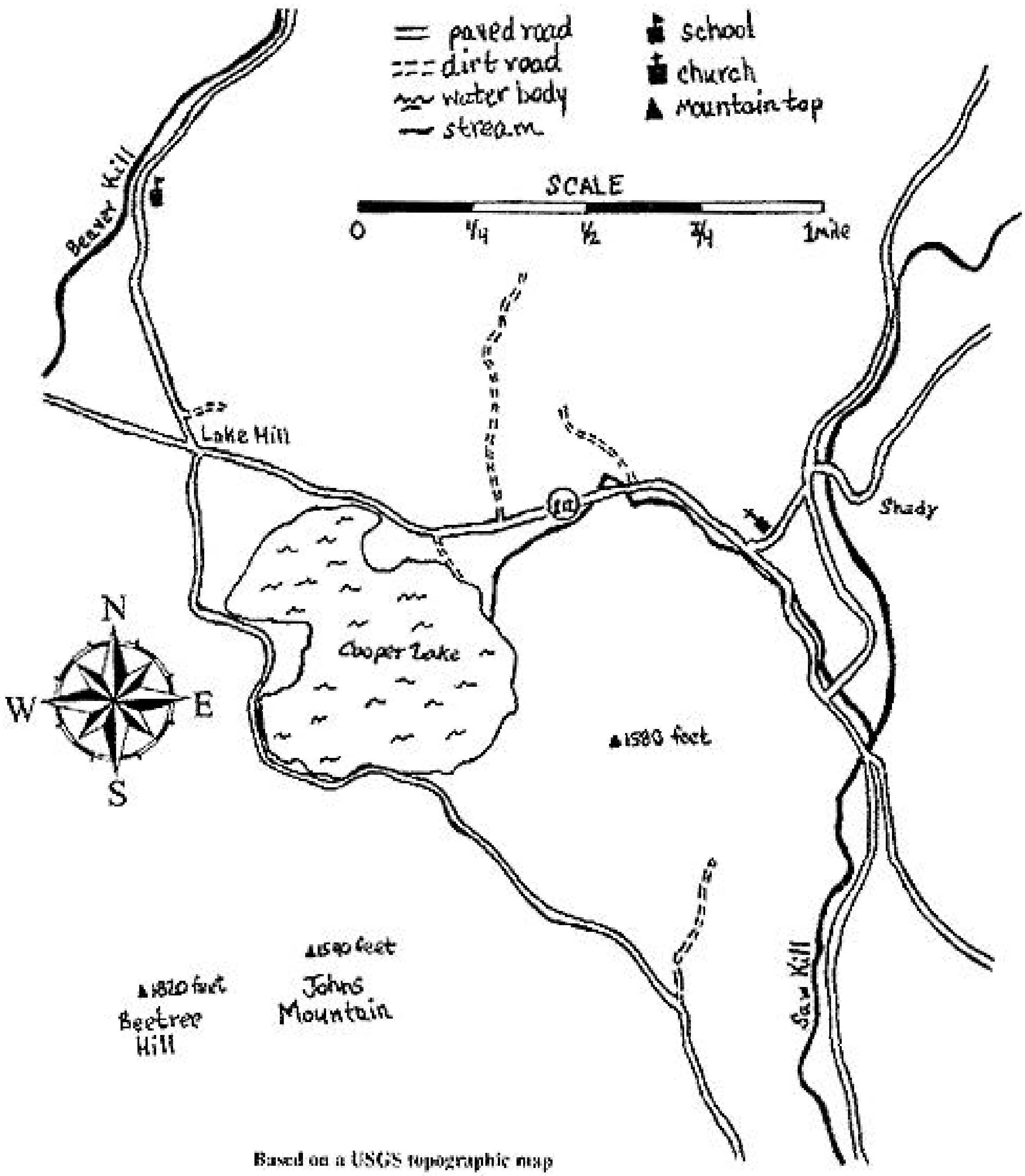
1. Name three types of maps.

2. What are three things that could be included in a map's legend?

3. Pretend you have two maps. The first map has a scale of 1 inch = 1 mile, and the second has a scale of 1 inch = 3 miles. Which map has the smaller scale?

4. Of the two maps listed above, which map would show more detail, meaning the information on the map is closer to how it looks in real life?

5. Of the two maps, which one would show the most land area?



Based on a USGS topographic map

What's Your Latitude, Dude?

Grades:

6th - 9th

Objective:

Students will be able to distinguish between the various coordinate grid systems, latitude, longitude, and where they are located on the imaginary grid system of the Earth. They should also begin to grasp the concept of "regions".

Method:

Students create a grid of latitude and longitude lines using the floor tiles in their classroom. They then create a smaller version on graph paper. The graph paper is then used to plot the coordinates of their desk and other desks, making a map of the classroom. The third part of the activity calls for students to look at United States and/or world maps and locate regions, and discuss what constitutes a region. As a wrap-up, students will answer questions about the Catskill region

Materials:

Graph paper, markers, masking tape, The Catskill Center's map (enclosed with the module), other maps of the United States and the world (a globe too, if available).

Time:

Preparation time: 15 minutes
Class time: variable (two class periods of 1 hour each, maximum)

Procedure:

Part I

Note: Do not discuss latitude and longitude in this part; wait until Part II.

1. Prior to beginning the activity, set up two lines that cut the classroom into four equal quadrants. Use masking tape or a marker, whatever works best. These two lines will represent the equator and the prime meridian. The resulting quarters may be labeled A, B, C, and D. Also, you must decide on what numbering system will work for your classroom floor, see step #3 below.

2. Students should already be familiar with coordinates from doing the Compass Rose activity (Activity 1). Ask the class if they know what a grid is. What are coordinates? What do coordinates tell us?

3. Divide the class into four groups, one group per quarter, and instruct them to locate the two lines that form their quadrant. Instruct students to label, with tape and markers, the lines made by the floor tiles from each centerline outward. Label from 0 to 90. They do not have to label every line. They do not have to go all the way to the wall. It depends on the size of the classroom and the size of the tiles. Each tile may represent 5 or 10 degrees but every other or every fourth one may be labeled, again all depending on the classroom. Make sure each group is using the same scale. (One group should not be using a tile to represent 5 degrees while another uses 10 degrees)

4. After students have labeled the floor, bring them back to their desks and distribute the graph paper. Instruct them to draw the classroom grid to scale on the graph paper.

5. Each student should determine the coordinates of their desk, go up to the chalkboard, and write them down, along with their name. For example, if their desk is in quarter A and on point 50, 40 they should write 50, 40 A. Once all of the students have done that they should plot everyone's desk on their graph paper, using a pencil. (Use your desk as an example when explaining how to read the coordinates.)

Part II

1. Ask the class: What are latitude and longitude lines? What do they tell us? What does the grid on the floor and their graph paper represent? Explain the necessary information relating to *latitude* and *longitude* (equator, prime meridian, degree measurements, hemispheres), which can all be found in this lesson's summary or the glossary.

2. Which line on their graph represents the equator and prime meridian? (Longitude lines run north to south while latitude lines run east to west.) They can use a compass to find out which centerline runs north-south, or you can randomly pick a north direction. Students should then label the compass directions on their graph.

3. Have the class label the equator and prime meridian. They should change the coordinates of their desk from 50, 40 A to 50° N, 40° E. (The conversion will depend on which centerline is the equator and which is the prime meridian.)

4. After they have changed the coordinates on their graph paper, ask questions such as:

- What line of latitude does (Tommy's) desk lie on or near? What about longitude?
- How many desks are on 50° W longitude? On 40° N latitude?
- How many desks are on the prime meridian? The equator?

- If Ana went to Jane's desk, how many degrees of longitude and latitude would she travel?
- How many desks are in the northern hemisphere? What about the eastern?

Part III

1. Have students find the equator and prime meridian on the world map (or globe if available). What hemisphere are they currently in? Northern or southern? Eastern or western?

2. Have students find the latitude and longitude of various towns/villages on The Catskill Center's map. If a classroom map of the world or United States is available, have students follow latitude and longitude lines from their locale and find other places in the USA or world that lie along the same lines. (The closest latitude and longitude lines they will most likely be able to follow on a world or United States map are 74° W or 75° W and 42° N or 40° N). If you have in-class Internet access, try www.topozone.com, where you can find very accurate coordinates.

3. Using a detailed physical map of the USA or the world, ask each group of students to select a place on the map. They are not allowed to select any city or country. Instead, they must choose a **region**. Help students understand this concept by using the description on the second page of the lesson summary, and verify compliance before continuing.

4. Once each group chooses a region, ask the class to discuss what that region might be like and write it down on a piece of paper. Based on latitude, what is the climate like? Based on longitude, when was the area first settled? Is the area mountainous or flat? Watery or dry? What language might they speak? What crops might they grow? What do you think it would be like there?

5. Wrap up the discussion of regions by coming back to our region, the Catskills. Ask the students some questions relating to the regional map that is provided. Have different students read the map and give answers. Some example questions:
   - Why does the Catskill region map have more detailed longitude and latitude lines than the world or United States maps?
   - What is the longitude of the Millbrook Covered Bridge? What county is it in?
   - What line of latitude is Liberty closest to? Longitude?
   - If you were to travel up the Hudson River, would you cross lines of latitude, or lines of longitude?
   - Between what two lines of longitude is John Burroughs Memorial State Historic Site? What two lines of latitude? What town is it in?
   - The Catskill Park falls between what two lines of longitude? Between what two lines of latitude?

Assessment:

1. Can the students explain the various details involved with latitude and longitude?
2. Can they tell the difference between the two?
3. Can the students differentiate what constitutes a region as compared to what constitutes a city or country?

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading

Math, Science, and Technology
Standard 1 - Analysis, Inquiry, and Design: Mathematical Analysis 1
Standard 3 - Mathematics: Modeling/Multiple Representation; Measurement
Standard 6 - Interconnectedness: Models; Magnitude and Scale

Social Studies
Standard 3 - Geography 1,2

Source: This activity developed by Aaron Bennett and Marie Ellenbogen.

Watershed Drawing with Topographic Maps

Grades:

5th - 12th

Objective:

Students develop map skills and confidence in use of maps; practical application of maps in understanding the physical environment (e.g., non-point source pollution, streams, and watersheds); broader understanding of local water issues.

Method:

The teacher provides an introduction to topographic map concepts using overheads. Students complete a matching activity to practice recognition of contour line features. Then students use real topographic maps to identify local features and find the boundary of a watershed.

Materials:

Topographic maps of the local area, wet erase markers (red, green, and blue) for each group, large paperclips, plastic covering, copies of the worksheets (provided), map overhead (provided).

Note: USGS Topographic maps, scale 1:24,000, of most areas can be borrowed from The Catskill Center if needed. They can also be found at local hunting and fishing stores or ordered inexpensively ($6 each) through Timely Discount, 1-800-821-7609. You'll need one for each group. Ideally, the maps should be adjacent quadrangles so they can be joined together at the end of the activity.

- Dry erase markers do not work for this activity because they wipe off too easily.
- Plastic sheets are paper-clipped onto the topographic maps, allowing the students to draw on the maps without ruining them. An alternative is to have the maps laminated.

Time:

Preparation time: 20-30 minutes
Class time: 1 hour

Procedure:

1. **Preparation:** Use tape or large paper clips to mount the maps onto poster board or cardboard

and cover with clear plastic or acetate sheet. The students will write on the plastic with the wet-erase markers.

On each map, find a contour line that forms a complete circle and is marked with elevation; mark the line with an X. Find a stream on the map that branches at least twice, whose watershed lies mostly or entirely within the quadrangle. Mark this stream with an arrow at the lowest point, i.e., at its mouth. Be sure that the watershed is not too complex for the students to draw. If the stream is too large or too difficult, find another stream or use a tributary. If you are in doubt, lay a piece of plastic over the map and outline it yourself:

- Trace the stream in blue, from *low to high* elevation. Try to pick a stream that has at least one branch. Also, pick a stream that is completely on one map, along with its surrounding watershed.
- Mark each of the *peaks* on the *edge* of the watershed in red. Mark only those peaks on the *edge* of the watershed. If you are unsure whether the peak is inside, outside, or on the edge, imagine you are a drop of rain falling on that peak:
  - If you would flow *into* your stream from all sides of that mountain, then it is *inside* the watershed.
  - If you would *not* flow into the stream from any side of the mountain, then it is *outside*.
  - If you would flow *into* your stream from one side, but into *another* stream from the other side, it is on the *edge* of the watershed.
- Outline the watershed in green by connecting the dots on the peaks, following the highest elevation. Follow ridges. Stay away from valleys and notches.

2. **Introduction to topographic maps:** Discuss the following, using the map overhead.

- Topographic maps (“topo”=place, “graph”=draw) depict the shape of the land surface using contour lines.
- Uses include: hiking, hunting, geology, hydrology, and watershed study.

Definition: *Contour lines* are lines drawn so that each line represents a particular elevation. They can show us where mountains and valleys are, and they show how the surface of the Earth is shaped.

- On most maps, each line is 20 feet higher or lower than the one next to it. Where the lines are close together on the map, the land in that place is steep. Where they are far apart on the map, the land in that place is relatively flat. (Demonstrate how to find the elevation of a point on the map.)
- Show how to find a peak. A valley or notch is indicated where the lines bend or point in, towards the peak. A ridge is shown where the lines bend or point away from the peak.
- Features: Explain the major symbols on topographic maps: place names, water symbols, roads, town boundaries, buildings, etc.

3. **Contour Matching Activity:** Have students complete Parts 1 and 2 of the contour matching worksheet, then review.

4. **Main Activity:** Divide the class into groups. Have each group assign a note-taker, a map-marker, and a direction-manager. Give each group a map, a set of markers, and a worksheet. Help the students complete the worksheet as necessary.

Part II

Understanding Topographic Maps

- Obtain several adjoining topographic maps. Prepare a set of questions for each of the map sections. Sample questions are given below.
- Divide the class into groups, and hand out a different topographic map to each group. Give each group the appropriate questions.
- After each group finishes answering the questions, have the class try to piece together the different quadrangles to form one big map.

Sample Questions: ROXBURY QUADRANGLE

1. What is the elevation of Irish Mountain?
2. What is the name of the stream that runs along Route 30?
3. Near what village does the East Branch of the Delaware River begin?
4. Is Montgomery Hollow located on a mountain or in a valley?

Extension:

Building a 3D model of your watershed:

1. Copy a topographic map of a small watershed onto cardstock several times (one copy for every 100 foot contour). You may wish to enlarge the map. Glue one map to a piece of corrugated cardboard; this is the base-plate for the model.
2. On each sheet, highlight a different 100’ contour line wherever it appears on the map. If you alternate highlighter colors this will help students keep track of map pieces.
3. Have students cut out several dozen small spacers from corrugated cardboard.
4. Have students cut out the shape of each highlighted contour line.
5. Have students stack the shapes on top of each other, with spacers glued between each interval, to make a 3-dimensional model of the watershed.

Assessment:

1. Did using the overheads provide the class with an appropriate introduction of how to read topographic maps?
2. Were they able to answer matching questions correctly or couldn't they grasp the concept of contour lines without a more detailed discussion?
3. Do the students understand what a watershed is? Ask students if they live in a watershed. If they say no, this indicates that they do not understand what a watershed is. All land is part of a watershed.
4. Use the students' performance on the worksheets to measure map skills.

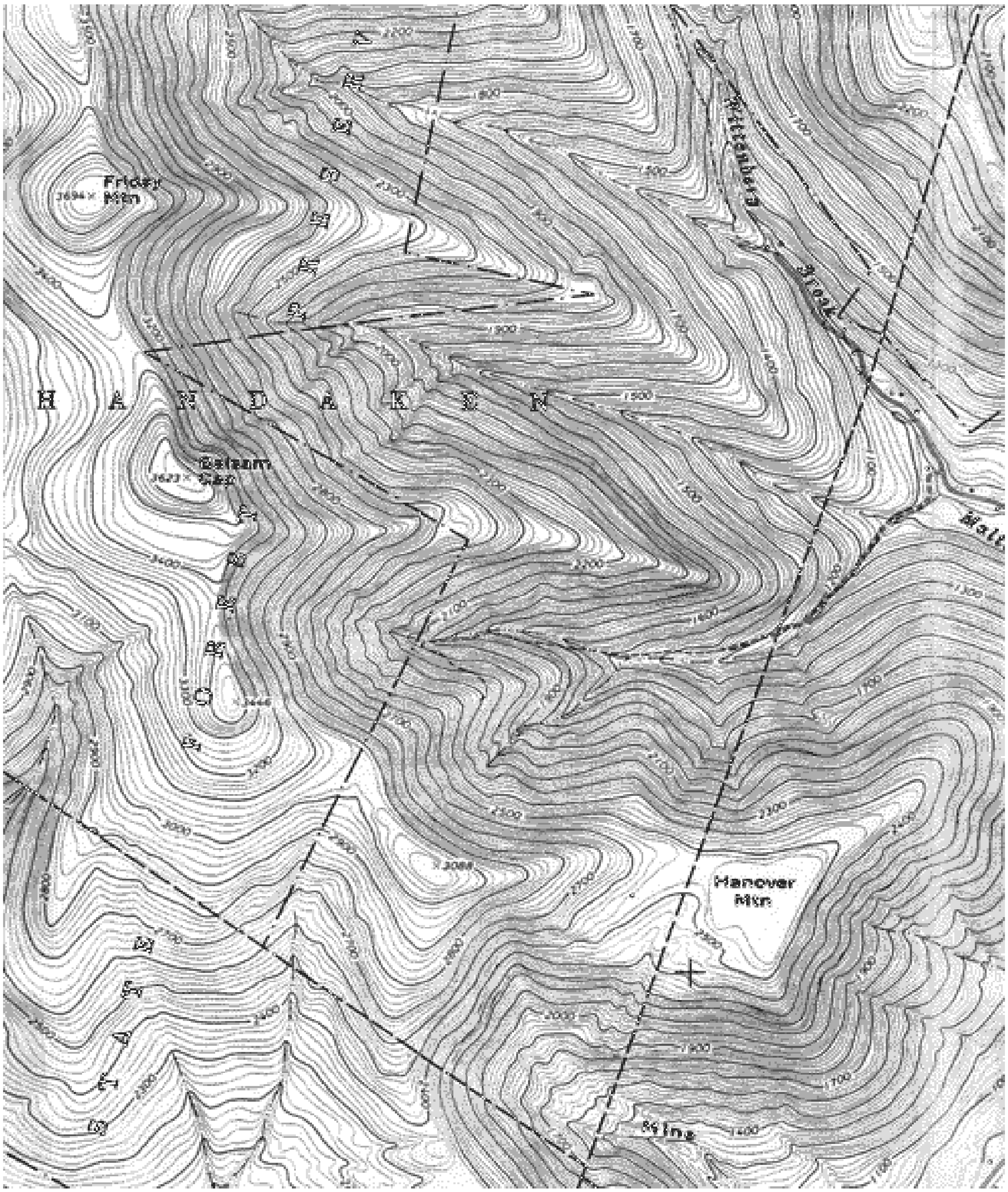
NYS Learning Standards:

Arts
Standard 1 - Creating, Performing, and Participating in the Arts: Visual Arts

Math, Science, and Technology
Standard 1 - Analysis, Inquiry, and Design: Scientific Inquiry
Standard 4 - Science: Physical Setting 2; The Living Environment 7

Social Studies
Standard 3 - Geography 1,2

Source: This activity developed by Nathan Chronister and Aaron Bennett.

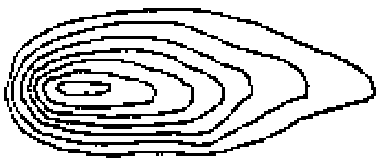

Friday Mtn
HANDAKEN
Balsam Cap
Hanover Mtn

Contour Matching Activity

Purpose: To visualize the actual shapes of land forms by using the contour line patterns.

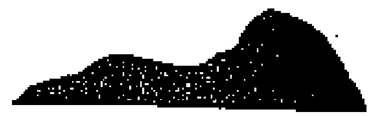
Activities:

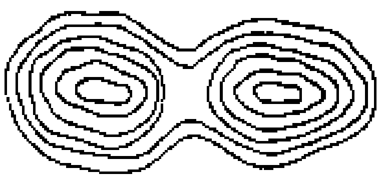
I. Match the contour lines on the left with the correct hillslope profiles on the right.



A

1





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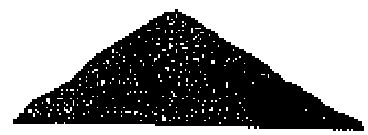
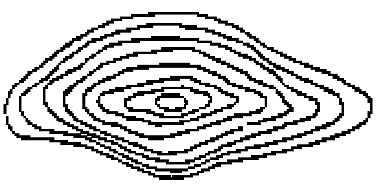
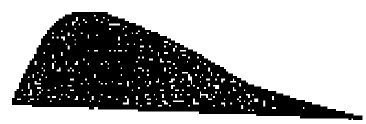
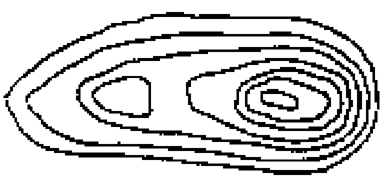




C

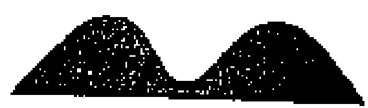
3



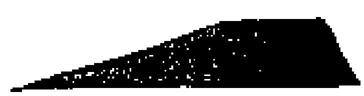


D

4



II. Draw the contour lines for the mountain profile given below.



Watershed Drawing Activity

Names: ______________________________ **Date:** __________ **Teacher:** __________________

Directions: Work together in your groups to answer the following questions.

1. a. What is the name of your map? ______________________________
   b. What is the scale of your map? ______________________________
   c. Which map shows the land to the East? ______________________
   West? ______________________
   North? ______________________
   South? ______________________

   d. Find a few places on the map that you know and list them here.

2. Find the contour line marked with an X.
   a. What is the elevation at the X? _____________Feet
   b. With your red marker, begin at the X and carefully trace the contour line until it returns to the X.

3. Find a stream on your map marked with an arrow.
   a. With your blue marker, beginning at the arrow, trace the stream in the direction indicated by the arrow. This is uphill, against the flow of water in the stream. If the stream branches, follow each branch of the stream until it ends.
   b. With your red marker, put a dot on each mountain peak that separates your stream from the streams around it.
   c. With your green marker, outline your watershed by connecting the red dots. Don't connect them using straight lines, though. Figure out where the high ground is that forms watershed boundaries, and draw your lines there.

Elevation Profile

Grades:

6th - 9th

Objective:

Students will become more familiar with how topographic maps present information and how to visualize the real-life topography of an area by using the contour lines on a topographic map.

Method:

Students will plot an elevation profile of the topography of a cross-section through the Echo Lake area by taking information directly from a topographic map.

Materials:

Any topographic map you can find, a ruler for each group, the map of the Echo Lake area (enclosed), profile chart (enclosed), and the contour lines question sheet (enclosed). Make one copy for each group and an overhead of each item (optional).

Time:

Preparation time: 10 minutes
Class time: 1 hour

Procedure:

Note: The Echo Lake profile is relatively simple, making it ideal for elementary students. For older students, have the students use a different topographic map and pick their own profile line.

1. Determine the best number of your students to put in a group. We recommend two or three. Make the necessary number of photocopies, one set per group.

2. Show the class an actual USGS topographic map (ideally the 7.5 x 7.5 minute ones, they are most commonly used). If they have not had any experience with this type of map, use the material in the previous activity (Lesson 2 - Activity 5).

3. Distribute the materials for this lesson. Make sure the students see things on the map such as Echo Lake, the stream that drains the lake, the two mountains, and numbers 1-4. Explain that two points on the map have been marked “A” and “B”. Answer any questions they may have relating

to their understanding of the map.

4. Instruct the groups to go ahead and complete *only* Part I of the question sheet. Go over the answers, you may wish to have overheads made of the question sheet and the map to use with the entire class before beginning the next part.

5. When you are ready to start Part II, ask the class if they know what a *profile* is. Just as you see profiles of people, cars or objects, you can see profiles of mountains and valleys. Explain that instead of looking at the land from above, like maps do, they are going to look at it from the side (a profile of the land).

6. Read through the first paragraph of Part II on the question sheet with the class. When going over the following instructions, it may be helpful to do part of the profile as a demonstration on the overhead. For younger students, you can go through the entire profile with the class.

7. Have the groups use the edge of a piece of paper to line up points A and B. Mark the points on the edge of that paper and label them A and B respectively. Between A and B, they should now place a mark (on their paper) wherever a thick, solid line (100’ contour line) meets the edge of the paper. Label the elevation at each intersecting point (ex. 2,200’, 2,300’, 2,400’ etc.).

8. Once completed, they now should place the marked-up edge of their paper along the A-B axis on the Topographic Profile sheet. Transfer all of the marks (and optionally, the elevations) to the A-B axis. If they write the elevations, they should write them vertically so there is enough room.

9. From each point on the A-B axis, have students draw a straight line with a ruler up to the appropriate elevation on the Elevation axis on the left. Place a dot where the line you are drawing meets the line indicating the elevation. Do the same thing for all marks along the A-B axis.

10. Instruct the class to connect the dots freehand, but they should do it without making perfectly straight lines - drawing smooth curves through each dot. Explain that in real life there are no sharp edges, angles, and corners where we find contour lines on a topographic map.

11. Have the students complete the Part II questions at the bottom of the question sheet.

Assessment:

1. Did the students seem to grasp the concept of a topographic map?
2. Was working in groups successful, or would it have been better to do it by themselves?
3. Did all of the student’s profiles turn out in the correct V-shape of the valley?
4. Use the worksheet answers to assess students’ understanding of the presented material.

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading; Speaking and Writing

Math, Science, and Technology
Standard 3 - Mathematics: Number and Numeration; Model/Multiple Representation; Measurement
Standard 6 - Interconnectedness: Models; Magnitude and Scale

Social Studies
Standard 3 - Geography 1,2

Source: This activity developed by Aaron Bennett.

Contour Lines Profile Question Sheet

Name: ___________________________ Date: __________ Teacher: __________________

Part I

To answer the following questions, look at the topographic map of Echo Lake.
On the map, there are numbers (1,2,3,4) and letters (A,B). Remember that lighter contours lines measure every 20 feet of elevation. Darker contour lines measure every 100 feet of elevation.

1. Most of Echo Lake is in which county?

2. What is the exact elevation of Overlook Mountain?

3. Which mountain is higher, Overlook or Plattekill?

4. The stream that flows out of Echo Lake travels in what direction?

5. Is location #1 in a valley or on a mountain?

6. If a stream formed at location #2, would it flow towards location #3 or location #4? Why?

Part II

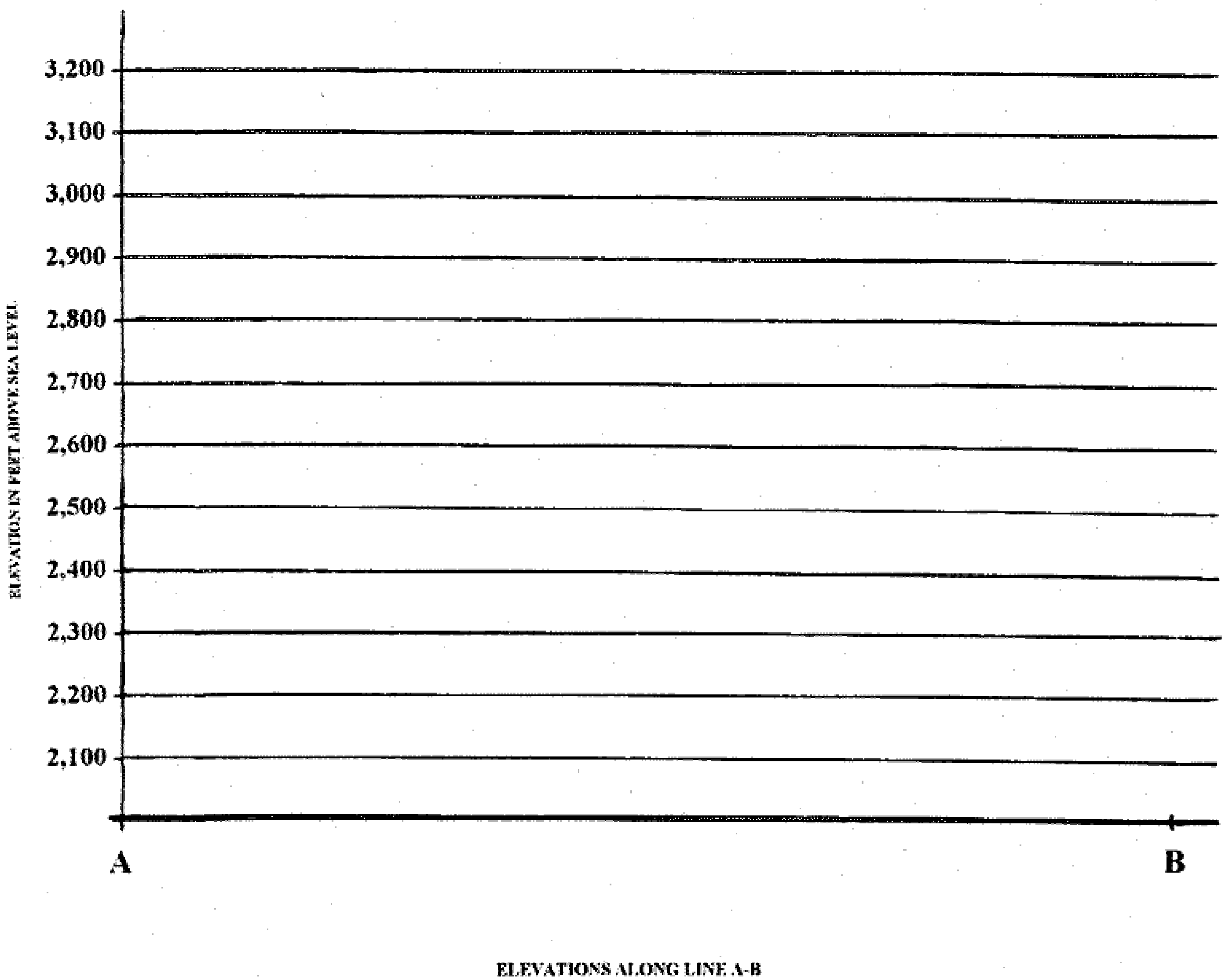
Topographic maps are difficult to use in the beginning, but with practice they become easy to understand. You can draw a *profile* of the mountains to help you see what they really look like. On your map, imagine you were collecting bugs in the stream that flows away from Echo Lake. If you were facing upstream and you looked up at the mountains, you would be looking east. The line on your map (line A-B) connects the highest points that you would be able to see. How would you go about drawing that as accurately as possible? Let's find out.

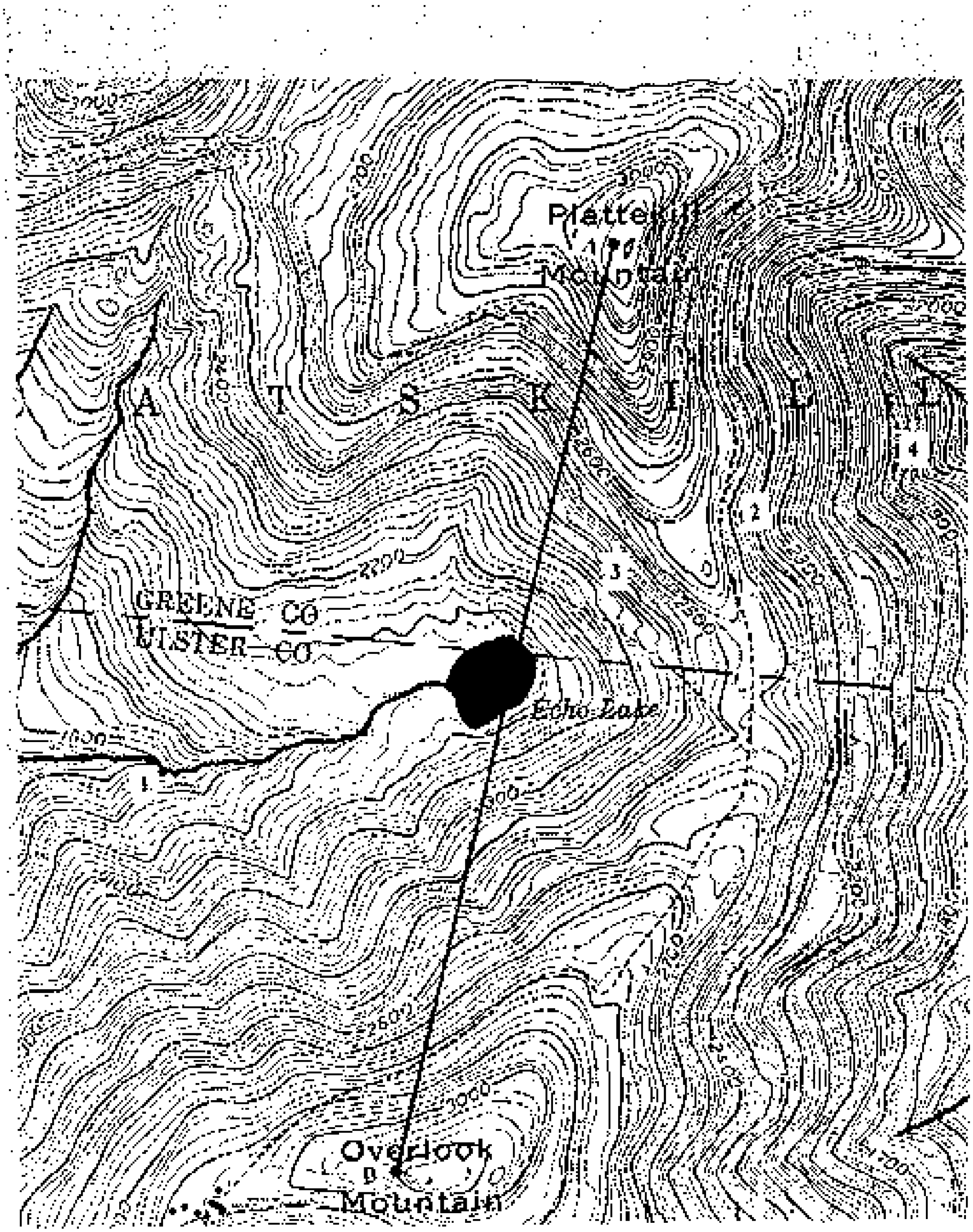
Follow your teacher's instructions so you can make a graph that will show the profile of the mountains. Once you have completed the profile, answer the questions below.

1. Label Plattekill Mountain, Overlook Mountain, and Echo Lake on your profile.

2. Which mountainside is steeper, Overlook or Plattekill? (Look carefully)

Topographic Profile near Echo Lake




Plattekill
Mountain
GREENE CO
ULSTER CO
Echo Lake
Overlook
Mountain

Physical Geography of the Catskills

The Foundation

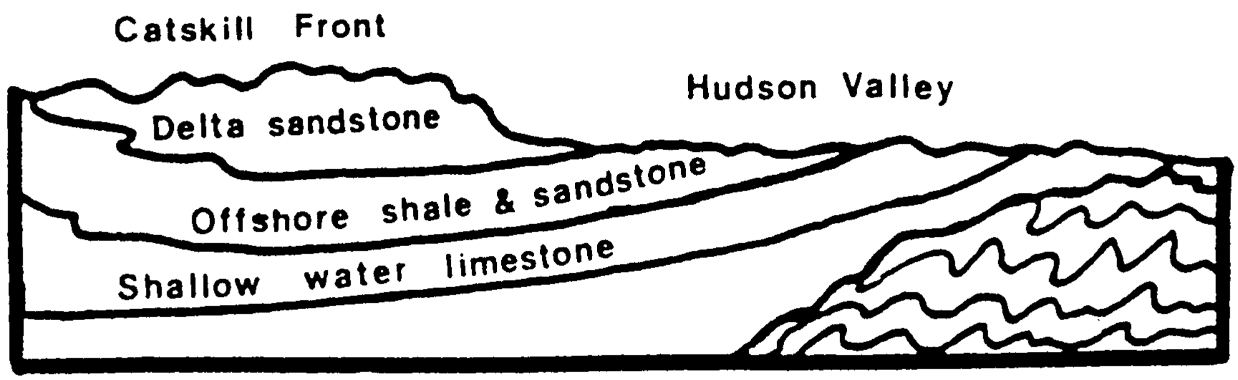
In the Ordovician Period (505-450 million years ago) the present-day Catskill Mountain region was part of a shallow sea that reached across most of New York State. To the east, along what is now the Massachusetts and Connecticut border, there was a high mountain range, the Taconics. As the ancestral Taconic Mountains rose up, our area started to become inundated with red sand and mud sediment from the erosion of the recently formed mountains. These immense mountains continued to fill the sea with sediments, causing the sea to retreat westward and laying the foundation of our Catskills. Some 430 million years ago, New York State was dry land.

As the ancestral Taconics were eroding away, 375 million years ago, another major orogeny took place. (Orogeny means "mountain genesis".) This Acadian Orogeny was the result of a collision between the European and North American plates. Over tens of millions of years, from the middle to late Devonian, folding and faulting continued. The Acadians stretched from Greenland to somewhere south of New York State. Geologists can only speculate at the size of these mountains, but certainly they were higher than any mountain range on the east coast today. Judging from the amount of Devonian sandstone that is present in the Catskills, geologists estimate that the Acadians may have risen 20,000' or more above the ocean. The only remnants of the massive Acadians are the Berkshire Mountains that we see today.

The Acadians size and history closely resemble those of the Himalayas, which were the result of a collision between Asia and India. Just as sediment from the present-day Himalayas washes into the Bay of Bengal, the Acadian Mountains eroded away towards the end of the Devonian Period, with streams carrying silt, mud, sand, and clay down into another inland sea that had formed over New York State. As the deposition of sediment continued at the base of these eroding mountains, the sea gradually grew shallower. By the early Carboniferous Period (340 million years ago), the enormous deposit of sediment had filled in the sea, leaving an extensive river *delta* that has been termed the Catskill Delta.

Because fast-moving streams carry larger sediment particles than slow-moving streams, the coarser sediments from the Acadian Mountains were deposited in the eastern part of the Catskill Delta. Close to the base of the Acadian Mountains, the delta was composed of coarse sands and gravels, while the finer particles were carried farther west. This is why the eastern Catskills are crowned with erosion-resistant conglomerate and sandstone, and why the hills farther west are made largely of more erodible shales. The thicker deposits of more erosion-resistant sediments account for the gradual decrease in the size of the mountains as one goes farther west. In the high peaks of the eastern Catskills, you will often find quartz pebbles atop these summits amongst the balsam fir trees. These same pebbles once tumbled down Acadian Mountain streams.

The Catskill Delta remained near sea level for millions of years. Then, 280-250 million years ago, there was yet another substantial mountain-building event. The North American and European continents pushed together, causing the plates to buckle. The end product was the Appalachian Mountain range, which runs from Tennessee to Newfoundland. This crustal convergence had a peculiar effect on the Catskill Delta, though. While other parts of the Allegheny Plateau were distorted by the collision, our Catskill region was only uplifted without any folding of the rock layers. In effect, the Catskill region is a great fossil delta preserved in stone. Because the Catskill Mountains were carved from a nearly level plateau, the peaks are relatively uniform in height. This northern portion of the Allegheny Plateau reached heights of 5,000-6,000 feet above sea level. It remains nearly 2,000 feet higher than portions of the Allegheny Plateau in Pennsylvania and western New York, in part due to the erosion resistance of the horizontal, undisturbed rock layers. Some geologists do not consider the Catskills to be true mountains because they formed through the erosion of a plateau rather than folding and faulting of the rock layers. They call it a “dissected plateau”.



Cross-section of the eastern Catskills and western Hudson Valley showing structure of sedimentary rocks. Highly distorted rocks at lower right were deformed by the Taconic Orogeny. Image courtesy Robert Titus, *The Catskills - A Geological Guide*.

The Fossil Record in the Catskills

The Middle Devonian shale and sandstone deposits in present-day Gilboa allow us to take a trip back it time. When discovered, the Gilboa Forest was the oldest known fossil forest in the world. The Gilboa trees that existed over 350 million years ago were primitive tree ferns that thrived on a swampy shore. Although primitive, these trees were the predecessors of the extensive coal forests that would appear in the Carboniferous Period. This ancient forest will be discussed in detail later in the lesson.

Geologic records for the Late Paleozoic Era and the Mesozoic Era for much of New York State are incomplete. Very few fossils for this time span have been recovered. A new and violent geologic cycle began with the dawning of the Mesozoic Era. This new era brought about widespread uplift and erosion. The lack of a stable, depositional environment contributed to the lack of fossils from these periods. It is known from fossils found elsewhere that dinosaurs lived during the Mesozoic Era and that modern trees first appeared then. During the Jurassic Period, 200 million years ago, the *Pangaea* super-continent broke apart, separating North America from Europe. Dinosaurs became extinct at the end of the Cretaceous Period, about 65 million years ago, bringing the Mesozoic to a close.

Shawangunks and Helderbergs

The rocks that make up the Shawangunk Mountains were formed 420 million years ago in the Silurian Period, as compared to the Catskill Mountains, whose rocks only date as far back as the late Devonian Period (some 370 million years ago). The escarpment of white conglomerate, which today reaches a height over 2,000 feet in places, formed around 280 million years ago after much tilting, folding, faulting, and uplifting in the Earth's crust.

The Shawangunk Mountains are often viewed as the foothills of the Catskill Mountains because the central Catskills dwarf them. Geologically, though, the Shawangunks are different than the Catskills. The rock is older, it's a different type, and the mountains themselves are folded like the rest of the Allegheny Plateau. Although the rock is over 400 million years old, the mountains themselves did not form until about 280 million years ago. These mountains are termed a *cuesta*. This is a long ridge with a steep face or escarpment on one side, and a long, gentle slope on the other. The Helderberg Mountains are another example of a cuesta.

Geologically, the *limestone* bedrock of the Helderberg Mountains forms the northeastern boundary of the Catskills. The Helderberg rock was formed over 400 million years ago, later buckled by the Acadian mountain-building event, and subsequently buried by their erosional sediment. Limestone is composed largely of the shells of marine creatures and is rich in fossils. It is very susceptible to chemical weathering and often forms caves. The Helderberg limestone bedrock extends west through Schoharie and Otsego counties along the Mohawk River valley.

The Ice Age

Our current era, the Cenozoic, began around 65 million years ago. The Quaternary Period, which we are in now, began 1.6 million years ago when the Tertiary Period ended. Over the last 1.6 million years, there have been at least four ice ages, separated by relatively short episodes during which the ice melted partially or even entirely. The four ice ages occurred during the Pleistocene Epoch (part of the Quaternary Period). The oldest, the Kansan, was followed by the Nebraskan glaciation, about 1.5 million years ago. The Illinoian glaciation entered the Hudson Valley from the north and carved out the soft shales from the lower slopes of the eastern edge of the Catskills as it flowed south. A warmer climate followed, and over time, the ice retreated marking the end of the glaciation 130,000 years ago. The most recent glaciation to cover the majority of the Catskills and the Hudson River valley was the Wisconsin glaciation. This glacial advance most likely had more of an effect on the Catskills we see today than the previous ice ages.

Glaciers form as a result of snowfall that does not melt in the summer. Instead, more snow accumulates each year, gradually piling up to a great depth. The weight pressing down on the lower layers of snow is so great that the snow becomes ice. Once an ice mass becomes 70-100 feet thick, it begins to flow under the pressure of its own weight and gravity. The source of the Wisconsin glacier was the area near the Hudson Bay in northern Canada. The glacier headed in a south or southwesterly direction through northern New York. This ice age concealed almost all evidence of previous glaciations as it scoured out valleys, smoothed mountaintops, and destroyed everything in its path. As it flowed, its route was determined by the surrounding topography.

The Adirondack Mountains partly restricted the flow of the glacier in the northern part of the state, and the Catskills provided a similar barrier. However, the advancing ice sheet eventually buried the Adirondacks. It was more than a mile-and-a-half thick in places. The climax stage of the Wisconsin glacier is termed the *Woodfordian advance* (see diagram). This stage occurred about 21,750 years ago. The Wisconsin glacier extended east to Cape Cod, and south as far as Long Island, which is really just a huge sand and gravel deposit (*moraine*) left behind as the glacier reached its peak and subsequently retreated. Glaciers continue to flow as long as snow is accumulating on top of the ice sheet. As the climate warmed, the ice melted, resulting in the retreat of the glacier. The ice did not actually flow back to the north but instead melted first in the south and later in the north.

Along its journey, the glacier encountered the southern rim of the Mohawk Valley; the Helderberg Mountains, just south of Albany. The ice sheet overtook these lower mountains, and continued west along the Mohawk Valley between the Adirondacks and Catskills. The Catskills helped funnel the glacier to the west in addition to directing it south down the Hudson Valley.

Picking up where the Illinoian glacier left off, the Wisconsin carved up the eastern edge of the Catskills once again. Today, a ten-mile-long front (called the *Catskill Front* or more commonly *The Wall of Manitou*) remains. This drop of more than 2,000 feet to the valley floor is evidence that the glaciers truncated the eastern side of the landform that was present and left this sandstone escarpment in its place. As the massive ice sheet moved down the Hudson Valley along the eastern edge of the Catskills, parts of the glacier called *lobes* began to move west in two areas where streams had carved into the Catskills. The ice began to flow through the valley now occupied by Schoharie Creek in the northern Catskills and the East Windham valley in the northeast (see diagram).

Two smaller tongues of ice also ripped through the region with awesome force, Kaaterskill Clove and then later at Plattekill Clove (see diagram). A V-shaped valley between two mountains, characterized by steep sides and a "young" stream is called a *clove*. Kaaterskill Clove is a five-mile-long, V-shaped valley that begins 600 feet above sea level, and ends at an elevation of 1,900 feet at it's source. Plattekill Clove, four miles south of Kaaterskill, changes 1,300 feet in elevation as well, but in only three miles! The cloves in the Catskills are areas where signs of glacial activity are very obvious. These two cloves were literally disfigured by glaciers. Here, the glacial movement was fierce; the Earth stripped down to its sandstone bedrock in places and scraped apart in others, ledges broken off, streams rerouted, and *erratics* (large boulders transported by glaciers that generally differ from the underlying bedrock) dumped haphazardly. It is believed that the Wisconsin glacier only invaded these two cloves; therefore the streams are very young. The glacier left the cloves only 15,000 years ago. Glaciers would soon ascend the Esopus Creek valley and other cloves along the Catskill front, subjecting them to this same sort of defacing.

The Wisconsin Glacier eventually buried the Catskills to a height of at least 3,500 feet above sea level. A diagram that follows shows what New York might have looked like if the Woodfordian advance did indeed cover the Catskills in ice up to 3,500'. There is an ongoing dispute the may never be settled among geologists as to how much was buried during the last ice age. A glacial geologist, John Lyon Rich, was studying Slide Mountain in 1916. He found evidence that Slide would have been buried only up to 3,900' (its summit is 4,180'). He found no glacial *striations* above 3,900'. Evidence of a long period of chemical weathering and thicker soils meant that the most recent glacier did not reach the summit. However, in 1928, when a fire tower was erected on Slide's summit, George Halcott Chadwick discovered glacial striations in the bedrock when excavation was done for the base of the tower. Chadwick, a man who dedicated his life to the geology of the Catskill Mountains, concluded that the Wisconsin glacier had indeed covered Slide Mt. A clear answer has not been unveiled. It is clear that the geology of the mountain changes at around 3,900', and the best part is that you do not have to be a geologist to see it. The glacial marks become less prominent, and there is a sudden appearance of quartz pebbles. The equivocal evidence only provokes the question: Was Slide Mountain and island surrounded by a sea of ice, or was it too buried by this massive ice sheet?

During the glacier's retreat, many interesting topographic features were left as evidence in the Catskill Region. The lower elevations that were submerged in ice often portray a different look. The older stream valleys are much more U-shaped, many mountains contain *cirques* (bowl-shaped areas), and many mountaintops and hilltops are rounded off. All of these features are typical of alpine glacial erosion by smaller glaciers following and/or preceding the major ice advances in the area. Another feature can be seen in many old fields, not only in the Catskills, but also throughout the state. These fields have large boulders dispersed in them sporadically. These boulders, which were carried down by the advancing ice sheet and were deposited when it retreated, are called *erratics*. "Sunset Rock", near North Lake, is an example of a glacial erratic, as well as a great place to use your imagination to recapture the Wisconsin glacier moving down the Hudson Valley.

Evidence of Glaciers

Other features include *moraines*, *eskers*, *kames*, *kettle lakes*, and *drumlins* that can be found throughout the region. The Cassville-Cooperstown *moraine* is the best example of one in the region. Located just south of Cooperstown, large piles of coarse sediment (cobbles, gravel) were ground up and deposited by a glacier after it melted. The landscape in the northwestern Catskills is filled with evidence of glaciation. Small bowl-shaped lakes that formed from the melting of ice blocks that once occupied the depression (*kettle lakes*). A local example of this occurred where Lake Capra and Colgate Lake are currently located in Greene County. As the glacier melted, the surrounding moraines blocked the outflow of the meltwater, and as a result, two kettle lakes were formed. Long ago, streams cut through the moraines, but man-made dams eventually replaced the glacial dams.

Modest, conical hills, or *kames*, are types of moraines located between depressions (kettles) that are composed of sand and gravel deposits. *Eskers* are long, low, meandering ridge of glacial *till* (sand and gravel) dropped by streams that flowed on of through tunnels in a retreating glacier.

Streams can easily make their mark on moraines and other topography created by glaciers, as they easily dissect the permeable material.

Drumlins are among the most common topographic features in New York State. A drumlin is a distinct, elongated hill, usually between a half-mile and one mile long, 600-1,200 feet wide, and up to 150 feet tall, made of glacial *till* generated underneath a glacier and later sculpted by its passage. Usually egg-

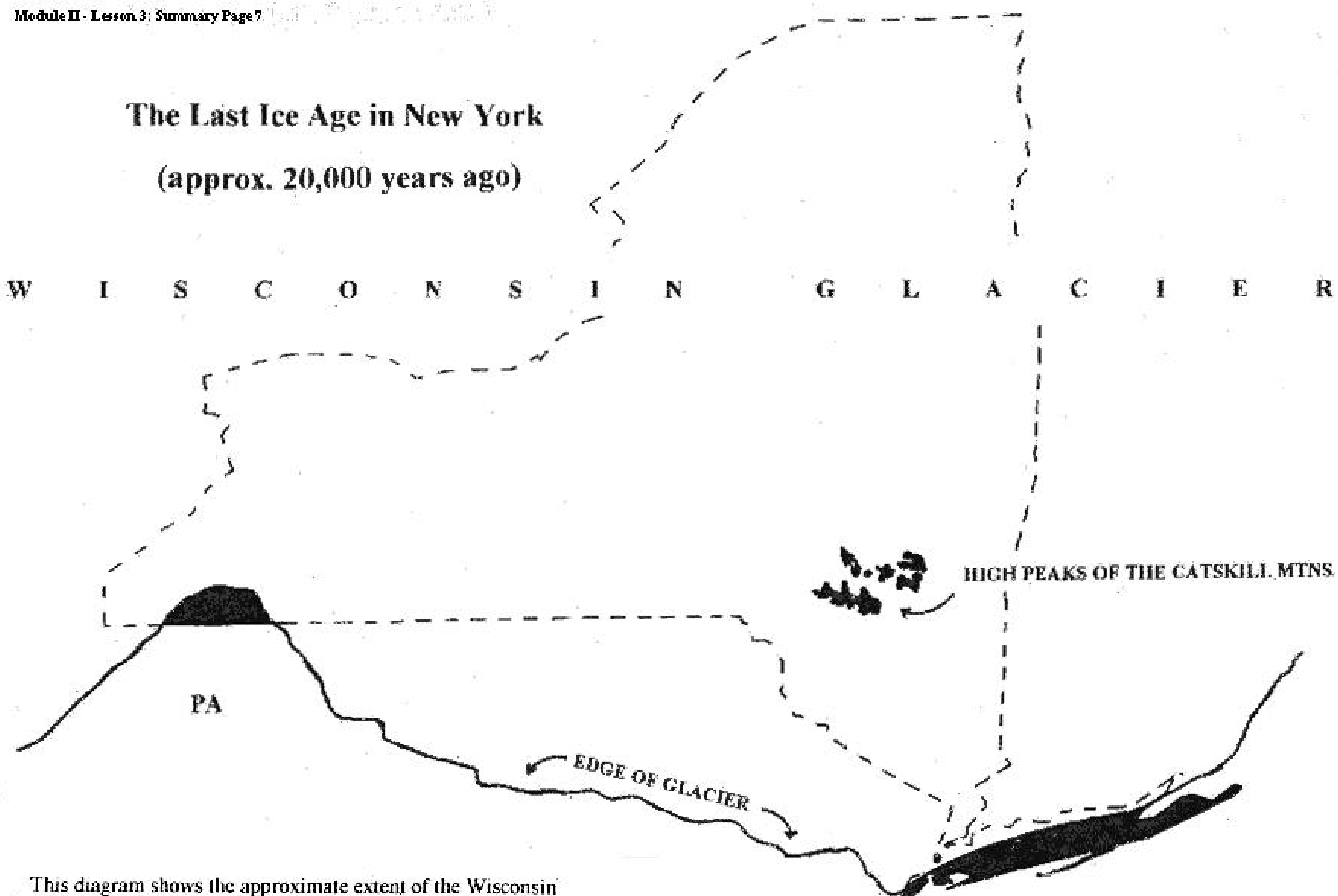
shaped, with the long axis lying parallel to the direction of the flow of ice, these intriguing formations are never found isolated, but in "fields". In fact, the largest drumlin field in North America is in New York, extending along the southern shore of lake Erie. In all, over 10,000 drumlins are located throughout the state. The southern Mohawk River valley accounts for the largest number of drumlins in the Catskills. Many of the hills along Interstate 88 from Otsego County through Schoharie County are drumlins. The lobe of the Wisconsin glacier that covered the Mohawk Valley is often called a "
the warming climate caused the hasty retreat of the ice, consequently forming the many glacial features aforementioned.

Glaciers cannot only create hills and depressions, but also huge lakes at least temporarily. A great lake of sorts once existed in what is now the Schoharie Creek valley. This lake, the Glacial Lake of Grand Gorge, occupied nearly the entire valley. Everything below 1,600' in elevation, from the present-day villages of Hunter to North Blenheim would have been covered in water. Gilboa would have been buried in 600' of water. The retreating Wisconsin glacier blocked the outlet of melt-water to the north, forcing water to collect behind the wall of ice and between the mountains. The first place the melt-water could escape was at a gap in the mountains at Grand Gorge. As the glacier retreated, more outlets for the water developed, but the majority went through the Grand Gorge Gap, down the Delaware River, and on to the ocean.

The Wisconsin glaciation ended only 14,000 years ago in our area. The Pleistocene Epoch ended around 10,000 years ago, as the current Holocene Epoch began. This marked the end of the Ice Age in New York State. The most noticeable difference between the Adirondacks and the Catskills is the abundance and the size of lakes in the Adirondacks and the lack thereof in our region. Unlike the mountains to the north, the Catskills Mountains are orientated in such a direction (southeast-northwest) that the glacier (which flowed south-southwest) had a tough time infiltrating these mountains. Due to the orientation of the Adirondacks, the glacier easily entered the valleys, and when retreating abandoned huge alpine glaciers behind, eventually forming the thousands of lakes that now exist there.

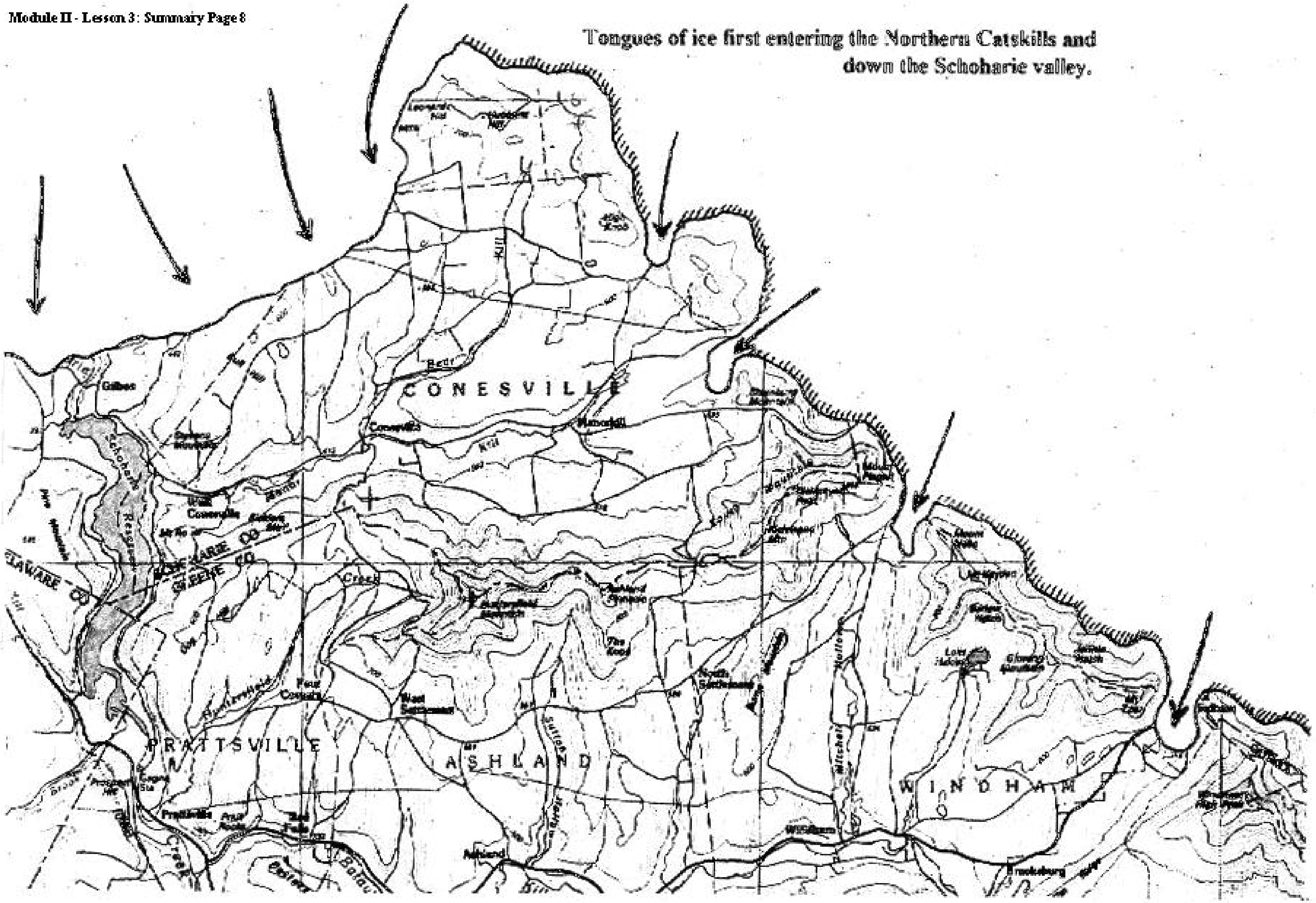
The Last Ice Age in New York

(approx. 20,000 years ago)

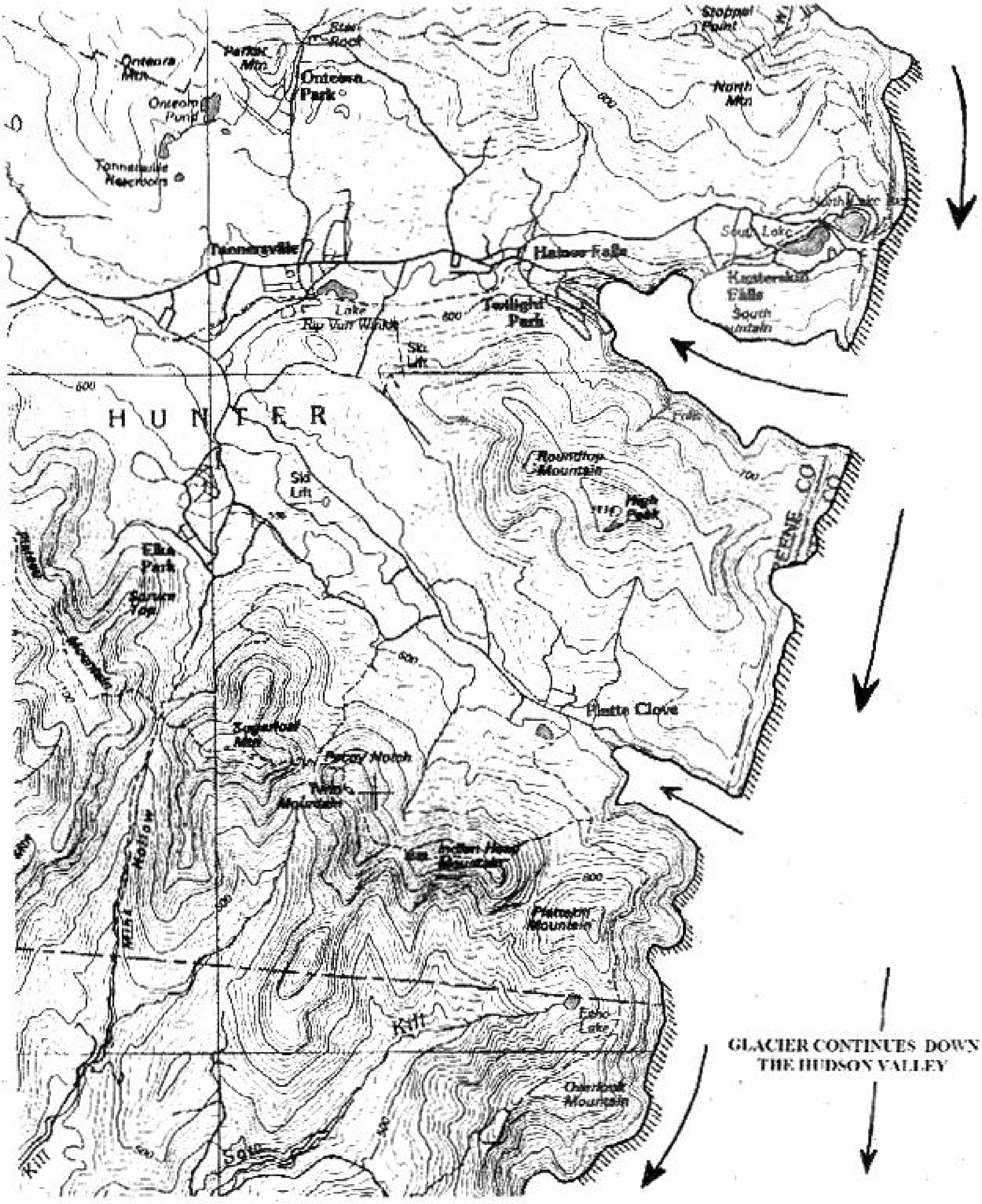


This diagram shows the approximate extent of the Wisconsin glacier before it began to melt. Notice how the high peaks of the Catskill Mountains and the southern part of Long Island were not buried by this glaciation. The Adirondack Mountains were completely covered because the ice was thicker father north.

Tongues of ice first entering the Northern Catskills and down the Schoharie valley.



Tongues of the Wisconsin glacier penetrating Kaaterskill and Platte Cloves, while the Wall of Manitou forces the rest of the ice south.



Ice Age Field Trip

Grades:

4th - 7th

Objective:

Students develop written communication skills and gain an understanding of how the various glaciations could have affected the Catskills.

Method:

Students visit an elevated viewpoint in the Catskills on two occasions. At the first visit, they describe the scene in writing or another form of creative expression. After learning in class about Catskills glaciations, students revisit the site and describe the site, as it may have appeared when the glaciers were arriving.

Materials:

Notebooks, pencils, glacier maps (see lesson summary). Each student should bring shoes, clothing, food, and water appropriate for a short hike.

Time:

Preparation time: variable, dependant upon your familiarity with the region.
Class time: two field trip sessions at least a week apart, length depending on the site you choose.

Procedure:

1. Investigate and choose a suitable site for the field trip. Hiking should be limited to a few miles, and alternative arrangements should be made for any students you feel would have trouble. Consult a topographic map, or better yet, do the hike yourself, to make sure it isn't too steep or too dangerous. Some possible locations we are familiar with are Pratt Rock (Prattsville), Sunset Rock (just south of North-South Lake), Catskill Mountain House Site (North-South Lake), Giant Ledge (Oliverea), and Overlook Mountain (Woodstock). You should be able to find a suitable location near your school. Please call The Center for more suggestions at (845) 586-2611. A Catskill Center staff member may even be able to accompany you on your hike to help point out relevant features.

2. On the first hike, you may wish to point out pertinent geologic features such as sedimentary rock layers, older rocks incorporated into conglomerate (also called puddingstone), any fossils you encounter, etc.

3. When you have reached the viewpoint, after students have had a chance to take in the view and have lunch, have them write a description of what they see. They should describe as many details as possible, such as what they see in the valley, what kind of plants are growing both on the mountain and in the valley, what the air feels like, any animals they see or would expect to see, etc. You may wish to encourage other forms of expression such as drawing instead of or in addition to writing. Students can draw tiny plants for later identification, or they can draw the whole vista. Return to classroom for the next part.

4. Teach the class about glaciers and the glacial periods that affected the Catskills. For material, see the lesson summary and other activities that comprise this lesson. If your school library has a video about glaciers, show it to your students and explain that similar glaciers once covered the Catskills.

5. Repeat the field trip. This time, have students imagine what the landscape would have looked like when glaciers were advancing into the Catskills. Bring the glacier maps (see lesson summary) to remind students which way the glaciers came from. Help students find their viewpoint on the map (if it is on the map) so they can see where the ice would have been at one point in time. Students can also use their imaginations for this. They can picture a mountain-high river of ice flowing from the north. (Point out which way is north.) Over many years, this river of ice would swell until all but the highest peaks were covered.

6. In the classroom after your hike, have students compare their description of the mountain view today to the description of how it was during the Ice Age. What is different about the scenery, living things, or other conditions? Which time would you rather live in? Do you think an ice age could ever happen again? How long would it take for the ice to advance?

Assessment:

1. Written or other materials should demonstrate comprehension of the glaciations and improved written communication skills.
2. Was the hiking place too far away or was the hike too strenuous? Is there a better place to go?
3. Did the form of expression that you chose to have them use (i.e. writing, drawing, etc.) work out as well as you had expected? If not, you should try a different form next time.
4. Use the enclosed quiz to assess students' knowledge of the presented material. Quiz answers:
    1. Answers will vary a bit dependant upon where you went. All rocks in the Catskills will be types of sedimentary rocks (sandstone, shale, limestone) or conglomerate (sandstone with quartz pebbles). Call us if you have questions about what you saw.
    2. Again, answers will vary. Generally, shale is at lower elevations, with sandstone on top in addition to conglomerate. Limestone is present in Hudson Valley and the Helderbergs.

3. A glacier is a huge ice sheet resulting from the compaction of snow. It moves under its own weight and survives from year to year.
4. Answers are dependant upon your location. Ice generally flowed from the north, and was able to penetrate the Catskills at Platte and Kaaterskill Cloves where it moved west.
5. Once again, evidence will be site specific, with the following terms all defined in the glossary. Possibilities include cirques (a great one near Echo Lake), erratics (a few huge ones near North/South Lake), striations (present in many areas where there a large area of exposed bedrock, i.e. ridges and mountaintops), and perfectly U-shaped valleys typical of the western Catskills.

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Speaking and Writing

Math, Science, and Technology
Standard 4 - Science: The Physical Setting 2, 5
Standard 4 - Science: The Living Environment 6

Social Studies
Standard 3 - Geography 1, 2

Source: This activity was developed by Nathan Chronister.

Ice Age Field Trip Quiz

Name: ________________________ **Date:** __________ **Teacher:** ____________________

Directions: Answer the questions below using the information you learned in the activity and throughout the lesson.

1. When you went on your first hike up the mountain, what types of rocks did you see?

2. Once you reached the viewpoint and had a chance to look around, did you notice if the rocks were different than at the bottom? If they were, why were they different?

3. What is a glacier?

4. When you went back up the mountain and imagined the glacier moving over the Catskills, which way was it moving?

A. North to South B. South to North C. East to West D. West to East

5. On your hikes, what real-life evidence did you see that proves glaciers were once in this area?

Glacier Formation

Grades:

4th - 7th

Objective:

Students will begin to understand how snow is compacted into ice over time, eventually forming glaciers.

Method:

This simple, in-class demonstration allows students to use marshmallows to simulate the compaction of snow. The compression of snow by the weight above leads to the formation of ice, and eventually a glacier.

Materials:

Fresh marshmallows, a tall slender glass jar with lid, cardboard, masking tape, scissors, and rocks (or other small weights that can fit into the jar).

Time:

Preparation time: 20 minutes.
Class time: initially 30-45 minutes, 15-minute wrap-up four days later.

Procedure:

1. Ask the class if they know what glaciers are, and if any are still present on Earth. You might want to discuss what an ice age is, how they begin, how they end, how many there were, etc. The background information provided in the Lesson 3 summary can guide you. Ask if they think ice can move. What might happen if ice moved over the Earth's surface? How fast would ice move?

2. Begin the activity by *loosely* filling the jar half full with marshmallows. The marshmallows represent the bottom layers of a glacier (snow that has compacted into ice).

3. Cut a cardboard circle to fit into the jar (without it touching the sides of the jar).

4. Place rocks or other appropriate weights on top of the cardboard circle. Explain that the rocks represent the hundreds of feet of snow that continuously pile up, creating a tremendous amount of weight pushing straight down on the bottom layers eventually compressing the snow into ice.

You could use this opportunity to tie-in a comparison to the formation of sedimentary rocks (grains of sand compacting into solid rock) if you have completed activities from Lesson 1.

5. Place a strip of masking tape on the outside of the jar from top to bottom. Make a mark on the tape where the cardboard is. Ask students what they think will happen over time.

6. Place the lid on the jar, and store it in a safe place. The lid is necessary so the marshmallows do not dry out.

7. For the next three or four days, check the jar and make an appropriate mark on the tape indicating the level of the cardboard. What is happening?

8. After the demonstration is complete, discuss the results and observations with the class.

9. We recommend performing the next activity soon after completing this one. Students will make a better connection between a glaciers formation, and its movement.

Assessment:

1. Could the students relate the marshmallows to an actual glacier?
2. The concept of flowing ice is a hard one to grasp. We suggest performing the next few activities as follow-ups, especially if the students seem to have a hard time picturing it.
3. If you did the activity next year, would you wait the recommended four days or was it too long or too short?

NYS Learning Standards:

Math, Science, and Technology
Standard 1 - Analysis, Inquiry, and Design: Scientific Inquiry 1
Standard 4 - Science: Physical Setting 2,5
Standard 6 - Interconnectedness: Models

Source: Activity adapted from unknown source.

Flowing Ice

Grades:

4th - 7th

Objective:

Students will be able to see how glaciers can change our landscape as they leave behind evidence of their existence; glaciers cause erosion and deposition of soil and rocks, and they can carve-up mountains.

Method:

This simple demonstration uses a solid block of ice to represent a glacier and the pebbles frozen inside act as the boulders that scour the land, and are eventually deposited as the ice melts.

Materials:

Pie tin, stones and pebbles, freezer, outdoor location with exposed soil.

Time:

Preparation time: 10 minutes.
Class time: initially 30 minutes, 45 minutes the next day.

Procedure:

1. Discuss how glaciers leave behind distinctive evidence. Use the background information we have provided in the lesson summary to give examples of glacial marks, and to discuss glaciation. You can use the provided information to discuss the Wisconsin Glaciation, the most recent in this area.

2. Explain that glaciers move over everything in their paths, and any cobbles, boulders, trees, etc. in the path of a glacier will get picked up and carried by the ice.

3. Strategically place some pebbles and stones in the pie pan halfway around the inside of the pan.

4. Place some water in the pan, enough so that only the tops of the rocks stick up above the water. (If using a larger container, you may submerge the rocks completely. If your freezer is cold enough, you can freeze large blocks of ice overnight, and you can speed the process by starting out with ice water.)

5. Place the pie pan in a freezer overnight.

6. Remove the model of the glacier from the pie pan and take it, and the class to an area of exposed soil. (If the rocks are fully embedded in the ice, you may need to let some of the ice melt, by running water on it, before proceeding.)

7. Turn the model so the protruding rocks are underneath, and place it flat on the ground. While pressing down, push the glacier along, with the stones in the front, for about two feet. Reiterate the fact that as more and more snow piles up at the source of the glacier (Northern Canada, near Hudson Bay, for the Wisconsin Glacier), the ice is forced outward due to its own weight. You may also wish to push it over a hill or over a “mountain” of rock. Try to apply the same pressure, and when finished, observe the differences.

8. After you are finished, leave the glacier in place, letting it melt. Come back a few hours (or days, for a large ice block in cool weather) later and see what happened once it melted. What has been left behind? This marks the end of the glacier’s advance, meaning a warmer climate began, resulting in the deposition of its till. Long Island is an example of glacial till left behind from the Wisconsin Glacier.

9. Ask the class: What types of evidence did the glacier leave behind as to its presence and its movement? What could stop a glacier from moving? Do you think there will be another Ice Age?

Assessment:

1. Could the students see how the block of ice was supposed to represent a glacier?
2. Could the class point out the different clues about the glacier once it melted?
3. Did you use the previous activity as preparation for this one? If not, do you think it would have helped kids understand how glaciers form?

NYS Learning Standards:

Math, Science, and Technology
Standard 1 - Analysis, Inquiry, and Design: Scientific Inquiry 1
Standard 4 - Science: Physical Setting 2,5
Standard 6 - Interconnectedness: Models

Source: Activity adapted from unknown source.

Valley Glacier

Grades:

4th - 9th

Objective:

Students will become familiar with how glaciers flow, how they pick up material, how they deposit it, and other characteristics.

Method:

By constructing a model of a glacier using a cornstarch mixture, students, working together in groups, can mimic the flow of a glacier over and around objects. For younger ages you could perform the activity as a demonstration.

Materials:

A plastic shoe box, one 16 oz. box of cornstarch, one to two cups of water, a 2 qt. mixing bowl, five wooden toothpicks, five or more large pebbles, a pencil, and a 5”x7” index card (all per group).

Time:

Preparation time: variable (1 hour, maximum)
Class time: 30 minutes

Procedure:

Decide if the students are able to perform the exercise or if you will demonstrate it.

1. Review some facts about glaciers with the class (refer to previous activities and lesson summary). Talk a little about how they form, why they move, what an ice age is, that glaciers currently exist at the poles and at very high elevations, and that most of the freshwater on Earth (79%) is found in glaciers.

2. Explain that the class will be making a glacier (cornstarch mixture) that will be flowing down a valley (the shoe box), mimicking how glaciers flowed through the Catskill valleys 20,000 years ago. Distribute materials to groups (if needed).

3. Instruct, and help students combine the cornstarch and water in the bowl until the mixture is the same consistency as toothpaste. Save a little cornstarch just in case the mixture becomes too runny. The experiment will not work properly if the consistency is not right.

4. Once the mixture is ready, place the pencil flat on one end of the table and prop one end of the shoebox on top so the box is slightly tilted. Slowly pour the mixture into the raised end of the box and observe what happens.

5. After the mixture has finished flowing through the box, scrape it up with your hand, and make a pile with it in the raised end. Place the index card in the upper end to make a "
box to prevent the glacier from moving. Lay the toothpicks across the front of the glacier so they are one inch apart and parallel to each other. Remove the dam, and as the glacier flows, focus on the way the toothpicks move.

6. After following the flow of the glacier with the toothpicks, place the pebbles on the bottom of the box, causing obstructions, and repeat the experiment. Notice the interactions when the glacier encounters an obstruction.

7. Some ideas for wrap-up questions are: What shape did the front of the glacier take as it flowed through the valley the first time? When the dam was released, what pattern did the markers (toothpicks) make? What caused this to happen? What happened when the glacier flowed over the rocks? Did you notice anything strange at the top of the glacier when it flowed over the rocks?

Assessment:

1. Was the cornstarch mixture too difficult for the students to make?
2. Did the glacier pick up the pebbles and move around the barriers the way you expected?
3. Could the class associate the glacier model with how a real glacier flows?
4. Use the enclosed quiz to assess students' knowledge of the presented material. Quiz answers:
    1. Glaciers form as a result of snowfall that doesn't melt from the previous year, and moves under its own weight once its about 70-100' thick.
    2. No, glaciers do flow uphill; accumulating snow continually pushes them forward.
    3. Yes, and the last Ice Age covered all except the few highest peaks.
    4. Once boulders get picked up, they are carried along until the ice can no longer support its weight (the ice begins melting) and deposits it. These rocks are called *erratics*.
    5. Answers will vary.

NYS Learning Standards:

Math, Science, and Technology
Standard 4 - Science: Physical Setting 2,5
Standard 6 - Interconnectedness: Models

Source: This activity adapted from PBS's *Newton's Apple* activity database.

Valley Glacier Quiz

Name: ___________________________ **Date:** __________ **Teacher:** ____________________

Directions: Answer the questions below using the information you learned from this activity and throughout the lesson.

1. In this activity we placed a pencil under the shoebox to help the glacier “flow”. In real life what causes a glacier to start “flowing”?

2. Can glaciers only flow downhill?

3. Were glaciers once moving through the Catskill Mountains?

4. When a large boulder gets picked up by a moving glacier, what do you think will eventually happen to it?

5. List three things that you have learned about glaciers that you didn’t already know before doing the activity(ies)?

Catskill Mountain Geologic Points of Interest

Grades:

4th - 12th

Objective:

Students will become familiar with the unique and interesting geology of the Catskill region by learning about five places of geologic interest in the Catskills.

Methods:

Students work as a team in five separate groups. After becoming "experts" on their point of interest (the one they chose or were assigned), each group will then creatively present its historical significance and characteristics to their classmates.

Materials:

One copy of each of the geologic points of interest sheets (enclosed).
Younger students: five copies of the required facts (enclosed).
Older students: copies of the questions (enclosed), one per student.

Time:

Preparation time: 10 minutes
Class time: 1 hour

Procedure:

Note: Please keep in mind that there are many places in the Catskills with very distinguishing geology; the five we have selected are perhaps the most recognizable. We encourage you to mention, and even explore other areas such as Vroman's Nose, Overlook Mountain, Plattekill Clove, and the Shawangunk Mountains.

1. Ask the class what a point of interest is. Ask what they think a geological point of interest would be. Ask if they can think of any points of geologic interest in the United States. (Grand Canyon, Mount St. Helen's, Death Valley - 282' below sea level is the lowest point in the US, etc.) Ask them if they can think of any in New York State (Finger Lakes - formed by glaciers, Long Island - till deposited at the front-end once glacier began to retreat). Can they think of specific places in the Catskills that may be of geologic interest? Write ideas on the board.

2. If they cannot think of any, provide them with the names of the following: the Gilboa Forest, the Glacial Lake of Grand Gorge, the Wall of Manitou, Kaaterskill Falls, and the Panther

Mountain Meteor Impact Site. Ask the class if they know anything about these places (or can guess based on the names) and why they are geologically interesting.

3. Divide the class into five groups. Assign each group (or let them choose if they have a favorite) a geologic point of interest. Provide each with the appropriate information for their topic. Explain that they will have to work together to create a presentation for the class on their assigned point of geologic interest.

4. Suggest different ways to present their project, such as: acting out a play or skit, a television news broadcast, a television or radio commercial intended to generate tourism to that area, writing and illustrating a story, creating physical props to go along with the presentation, etc. Older students could actually produce a video and have it shown on local TV or write an article for the local newspaper.

Note: The following are ideas for presentations that you may or may not want to provide depending on the ability and creativity of the class.

A. Kaaterskill Falls
Students can create a television or radio commercial describing the geology of the falls and why all should visit it. It may take place during any time period. (They can use the Laurel House and railroads as part of the ad campaign.)

B. The Wall of Manitou
Students write a story about a Native American tribe living in the Catskills and how they used this great barrier to their advantage.

C. The Gilboa Forest
Students act out a play set in the time of the discovery of the Gilboa Forest. They discover objects and describe them, or students create a television news broadcast of the discovery.

D. The Panther Mountain Meteor Impact Site
Students create a television program in which the scientists who discovered the meteor impact are interviewed.

E. The Glacial Lake of Grand Gorge
Students write a story or act a play describing how deep the lake was and how meltwater made its way from the glacier, to the lake, and into the ocean.

5. Younger students should include all of the “required facts” (enclosed) during their presentations. Older students should include all information in their presentation that will allow classmates to answer the questions about that point of geologic interest. Encourage the students to do additional research of their point of interest and include it in their presentation. After each group finishes its presentation, the rest of the class should individually answer the questions relating to that point of geologic interest.

6. Give the students a specific time frame (one month maximum) to prepare their presentation. During a week of class, you could have one group per day present its story.

7. For each of the presentations, have a map available so each group can show where the site is or was. The Catskill Center's map provided with this module should be adequate.

8. Have the groups give their presentation. Before the first group goes, explain that each student will have to answer a series of questions (as a quiz or homework, you decide) pertaining to each of these places, so they'd better pay attention.

Assessment:

1. Use the question sheets and the accuracy of the presentations as an assessment of student' s interest and understanding of material.
2. Was the time frame given long enough for students to complete their presentations?
3. There are many places of equal geological interest in the Catskills; were these five good choices for this activity, or can you think of others that would work better or are closer to the school?

NYS Learning Standards:

Arts
Standard 1 - Creating, Performing, and Participating in the Arts: Theatre, Visual Arts
Standard 2 - Knowing and Using Arts Materials and Resources: Theatre, Visual Arts

English
Standard 1 - Language for Information and Understanding: Listening and Reading, Speaking and Writing
Standard 4 - Language for Social Interaction: Listening and Speaking

Math, Science, and Technology
Standard 4 - Science: Physical Setting 2

Social Studies
Standard 1 - History of the United States and New York 2,4
Standard 3 - Geology 1,2

Source: This activity was developed by Aaron Bennett and Marie Ellenbogen.

Catskill Mountain Geologic Points of Interest

A. Kaaterskill Falls

One of the most popular landscape attractions in the Catskill Mountains is Kaaterskill Falls. The falls are easily distinguishable by their two cascading steps, where the upper step is nearly three times the height of the bottom one. At a combined 260 feet, these falls are the highest of any cascade in New York. The upper drop is 180' and the lower is an 80' drop. These impressive falls have been the focus of much artwork (painting and writing) not only by local artists, but also by Hudson River School painters known throughout the world. Kaaterskill Falls, and the clove formed by the Kaaterskill Creek, have been very popular with geologists as well.

The Kaaterskill Creek is a relatively small creek, much smaller than the Esopus or the Schoharie. It begins near Haines Falls at an elevation of 2600', and plunges through the clove until it reaches Palenville (500' above sea level). From here it winds its way north toward Catskill, where it empties into the Hudson River (at sea level). Kaaterskill Falls is located on Spruce Creek, which flows out of North/South Lake. Spruce Creek is a tributary that joins Kaaterskill Creek within the Clove. The falls are not on Kaaterskill Creek itself.

During the Wisconsin glaciation, glaciers scraped even the upper elevations of Kaaterskill Clove. The creek is now left behind to chisel away at the bottom of the clove. The less-resistant red shales of the Catskills compose most of the clove's floor, and as a result, the Kaaterskill Creek has cut deeply into the rocks. The glaciers and Kaaterskill Creek working together have given the clove a very jagged and rocky appearance.

Kaaterskill Falls shows us a perfect example of the geology in the Catskills. There is not a better place to look at the Devonian sandstone and shale of our region, in addition to viewing how powerful water is. The Falls are the result of weathering upon two different kinds of rock. The two ledges are composed of the more resistant cross-bedded river sandstones, which are underlain by less resistant floodplain deposits of red shale. The creek simply flows over the sandstone, and the underlying shale is slowly worn away, creating an overhanging ledge (*outcrop*). Presently, the water drops over the first sandstone outcrop and hits another layer of sandstone 180' below, where the creek begins to flow again. The second waterfall was formed in the same way. In addition to the shale and sandstone, some conglomerate can be found at the top of the falls.

Kaaterskill Falls is not only a very rewarding, but also an easily accessible place to spend a day. It rewards you with its natural beauty and educational value if you know what to look for. From the top of the waterfall, there are excellent views of the upper reaches of Kaaterskill Clove with Hunter Mountain as a backdrop. The Falls can be reached in two ways. From below, it is merely a ¾-mile hike along the yellow-blazed trail from the hairpin turn on Route 23A, east of Haines Falls. From here is the best place to view their geology. The top of the falls is reached via the trails around the North Lake area. The remnants of the old Laurel House that once sat very near the top of the falls can still be seen. A multitude of trails blanket Kaaterskill Clove, creating what Bob Titus called an outdoor "museum of art". The clove is arguably the most scenic area of the Catskills.

The upper portion of Kaaterskill Falls drops over 180 feet. For scale, the white dots behind the waterfall are people. The numerous layers of Devonian sandstone can be seen in the photo. Photo by Aaron Bennett.

The lower falls drop an additional 60+ feet, making the total cascade drop over 240 feet, the highest double waterfall in the state. Photo by Aaron Bennett

Catskill Mountain Geologic Points of Interest

B. The Wall of Manitou

The eastern edge of the Catskill Mountains is the only definitive boundary of the mountains. When driving along the New York State Thruway between Kingston and Catskill, or looking at a good map of the region, you can easily see how the Catskill Mountains come to an abrupt end about five miles before the Hudson River. The 3,000 foot high ridge of mountainous landscape that literally falls off nearly 2,000' to the valley floor below, has been named "The Wall of Manitou". Artists often refer to the wall and the high mountains visible beyond it as the "Catskill Mural Front". This straight, ten-mile-long *escarpment*, a long ridge with a steep face on one side, was shaped as a result of the four ice ages that inundated the Catskill Mountains from 1.6 million years ago until 10,000 years ago (the Pleistocene Epoch).

The Wall of Manitou is interrupted twice by steep notches that were gouged out by streams. These two slices, Plattekill and Kaaterskill Cloves divide the wall into three distinct ranges of mountains all part of the Catskills. The northern part of the Wall of Manitou is part of the Jewett Range, the middle is part of the Roundtop-High Peak Range, and the eastern end of the Plattekill-Sugarloaf Range forms the southern part. Overlook Mountain marks the southern end of the wall. George Chadwick, a prominent Catskill geologist from the early 1900s believed that Overlook was originally twice its current size until glaciers removed the eastern half of the mountain. The shales found at lower elevations were easily displaced or destroyed by glaciers, while the harder sandstone was scraped and carved away. Chadwick believed that almost two miles of Overlook were lost, "plucked" off by the passing ice, and the remaining sandstone ledges and outcrops (e.g. the Minister's Face) were forever scarred.

The Native Americans that once inhabited the Catskills thought of them as a fortress, an elevated place where they were isolated from the rest of the world. The Catskills are skirted on the south and north by farmland, on the west by rippling hills and smaller mountains, and on the east by the Hudson plain that abruptly changes without warning into this giant wall of sandstone. The natives believed that their fortress was built and protected by the Great Spirit Manitou. The greatest defense against any hostile spirits was the majestic barrier on the eastern side, along the Hudson. The 2000' barrier not only stretches for ten miles along the river valley but also extends northwest for another 17 miles to Mount Pisgah, near Durham. This citadel, even with its natural barricades, was not enough to keep out settlers who navigated the Catskills' ample streams, conquered their summits, and endured their perilous cloves and notches to hunt and trap game, harvest timber, and mine slate.

The Great Wall of the Catskills is still an impressive land formation to look at today. While driving over the Kingston-Rhinecliff Bridge, you almost feel above it and cannot get a feel for its size. Imagine viewing the Catskills as you were traveling up the Hudson River, at sea level, as the early settlers did. You would not be able to see much past the Wall due to its daunting size. You would be looking up, 3,000', at the blue-tinted wall of earth that often has fog or clouds concealing some, if not all of the mountains that rise from behind it.

This image shows about a seven-mile section of the Wall of Manitou. The v-shaped clove in the middle is Kaaterskill Clove. Plattekill Clove would be just off to the left. Simulated view by Nathan Chronister.

Catskill Mountain Geologic Points of Interest

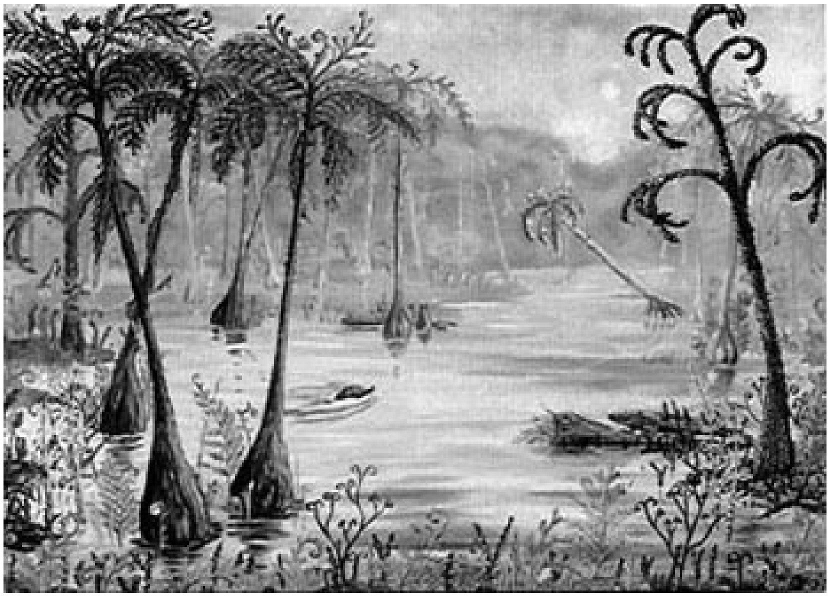
C. The Gilboa Forest

The ancient Gilboa Forest was first discovered following a major flood in 1869. However, the largest discovery didn't take place until 1920, during the construction of the Gilboa Dam, erected to create the Schoharie Reservoir. When discovered, the Gilboa Forest was the oldest known fossil forest in the world. The fossils that were found were tree stumps that had been preserved in Middle Devonian sandstone for 380 million years. Two hundred stumps were excavated and placed in various museums and colleges nationwide, and some are still on display near the original site. *Eospermatopteris*, one of the trees found in Gilboa, was unlike any tree that is common today. These 40 foot-tall trees had a conifer-like trunk with a crown that resembled a fern and produced perhaps the first seeds to ever appear on Earth. These "seed ferns" did not reproduce by spores, like ferns do or other tree ferns present in the Devonian did, but by the most primitive of seeds. Their fern-like leaves reached lengths of six to nine feet, and their trunks swelled-out near the water line, much like the trees we see today that rise out of the southern deepwater swamps. One stump that was recovered measured eleven feet in circumference! There were no seed-bearing deciduous tree or cone-bearing coniferous tree forests, meaning the forests of the Devonian were very primitive.

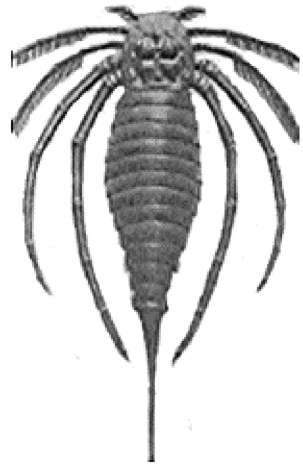
Another common species in the Gilboa Forest, and throughout the Catskills was *Archaeopteris*. This is believed to be the ancestor of modern conifers. Another group of plants, the *psilophytes*, were among the first vascular plants that were able to survive on land. These too were abundant in the Gilboa Forest. All of these plants grew in a swampy lowland area known as the Catskill Delta. The mountains did not yet exist.

With the recent arrival of land plants, terrestrial animal life soon followed. Appropriate habitats for these creatures were few and far between, with the exception of the soil. These animals including earthworms, centipedes, millipedes, spiders, and terrestrial insects, were able to survive in the soil using decaying plant material or other animals as food.

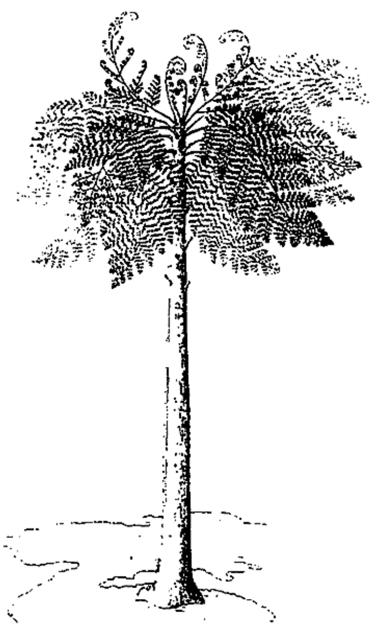
The majority of animal life of the Gilboa Forest, like the rest of the Catskill Delta, was present in its ponds and streams. The fossils of these creatures are not as common as those of terrestrial plants and animals. *Eurypterids*, or sea scorpions, up to five feet long inhabited the delta's streams. A clam, *Archanodon catskillensis*, after it had been buried by sediment from heavy floods would burrow upward through the sand to escape. Its escape route can often be seen in the sandstone that has formed over hundreds of millions of years. The Catskill Delta was thriving with fish. A primitive fish, *Cephalaspis*, had no teeth or lower jaw. Some fish, like *Dipterus*, not only had teeth and jaws, but probably lungs as well. The droughts that often plagued the late Devonian caused these creatures to burrow into the mud and forced them to breathe air until the streams refilled. Another fish, *Holoptychus*, had a different strategy for surviving droughts. It had remarkably strong front-end fins so it was able to drag itself over land in order to reach another pond or stream. These types of fish would eventually evolve into the amphibians of today. Drawings of these prehistoric creatures are on the following page and obtained from the New York State Museum.



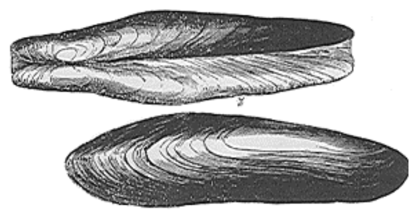
This painting of the Gilboa Forest by Kristen V.H. Wyckoff is titled "Gilboa, NY 370 Million B.C." **These fern-like Gilboa trees existed throughout the present-day Catskills during the Devonian Period.**



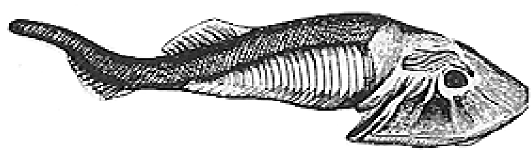
The sea scorpion *Eurypterid*.
Image courtesy New York State Museum



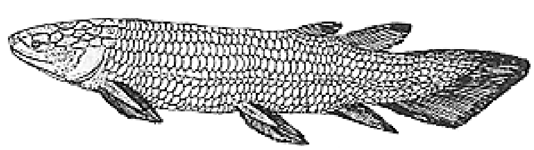
***Eospermatopteris* tree.**
Image courtesy New York State Museum.



Archanodon catskillensis
Image courtesy New York State Museum.



The jawless Devonian fish *Cephalaspis*.
Image courtesy New York State Museum.

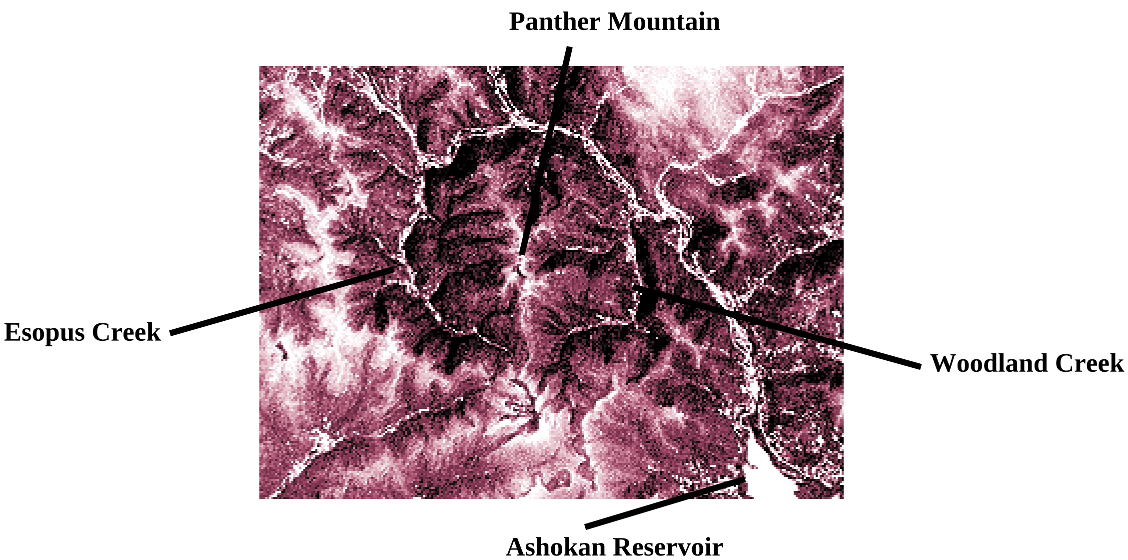


***Dipterus*, a Devonian lungfish.**
Image courtesy New York State Museum.

Catskill Mountain Geologic Points of Interest

D. Panther Mountain Meteor

If you have ever looked at a satellite image of the Catskill Mountain region, one thing jumps out at you right away - the drainage patterns of the various smaller streams flowing off of the long mountain ridges. Most of the streams in the Catskills have a “branched” drainage pattern. On a map, the streams appear to branch out like the limbs of a tree. Once you notice the branched drainage, another area will attract your attention. This is an enormous, round land mass named Panther Mountain. Here, an almost perfect circular valley has been carved around the mountain by the surrounding streams. Circular drainage patterns are not very common in New York State. What might have caused the streams to carve out a circle?



This unusual landscape intrigued three scientists, Yngvar Isachsen, Stephen Wright, and Frank Revetta, who thought a possible meteor impact millions of years ago might have caused the circular drainage. When meteorites collide with the Earth, obviously they do not build 3,720’ tall mountains. Instead, they put a dent in the Earth’s crust. Therefore, this impact must have occurred prior to the formation of the Catskill Mountains. During the late Devonian Period (375 million years ago), an inland sea was accumulating sand and mud deposits from the eroding Acadian Mountains. When the meteor hit, it would have splintered the Earth=s bedrock. This crater would eventually become buried miles deep by the sediment from the Acadian Mountains. Over millions of years, the sediment hardened into the sandstone and shale that today make up the Catskill Mountains.

The underlying crater affected the rock above the rim of the crater. As the fractured rock material in the crater settled, the overlying sedimentary rocks dropped down a little too. Joints (small fractures) formed around the edge of the circle to relieve the stress. Scientists think the nearby streams have been influenced by these small cracks that formed in the sedimentary rock.

In the upper part of the Esopus Creek, you can see these closely-spaced joints in the bedrock near the stream. In lower reaches of the stream, the bedrock is buried beneath glacial deposits. However, the scientists used a seismograph (a sensitive instrument used to study how vibrations travel through the ground, also used to study earthquakes) to infer that there are a lot of joints in other parts of the circle as well. These joints in the sandstone make it more susceptible to erosion by water. Two streams, Woodland Creek and Esopus Creek, have been carving away the vulnerable rock for over 300 million years, forming the circular stream corridor.

Perhaps the strongest evidence of an impact are the results of gravitational studies at the site. Since the fractured bedrock inside a crater has a lower density than the nearby-undisturbed bedrock, there is less gravitational pull over an impact site. Scientists have found evidence of this outside the crater at Panther Mountain.

This meteor, which may have been up to a kilometer in diameter before it struck, left a circular valley six-miles across as evidence of its impact. An impact of much greater magnitude may be connected to the extinction of the dinosaurs some 65 million years ago. On the Yucatan Peninsula in Mexico, there is a 150-mile-wide buried crater. Called the Chicxulub crater, it was tapped for fossil fuels. Scientists believe there could be a reservoir of natural gas below Panther Mountain too because the gas could collect in the areas of the fractured bedrock.

Many people live in the valley formed by the Panther Mountain circle. Route 28 follows the circle all the way from Phoenicia to Big Indian. Woodland Valley State Campground and a short day-hike to Giant Ledge make Panther Mountain a popular outdoor recreation destination. You can visit two great web sites on Panther Mountain. Nathan Chronister, The Catskill Center's Director of Education, developed the first web site, http://www.catskill.net/evolution/panther. The site is full of information and includes a fun activity for kids. The other web site can be found at http://www.catskillcenter.org/hikes.html. By visiting this site you will embark on a "virtual hike" of Panther Mountain, learning about its environment and its natural history, while enjoying some impressive views of the region. If you do not have access to the Internet in your classroom or at home, your local library is likely to have access.

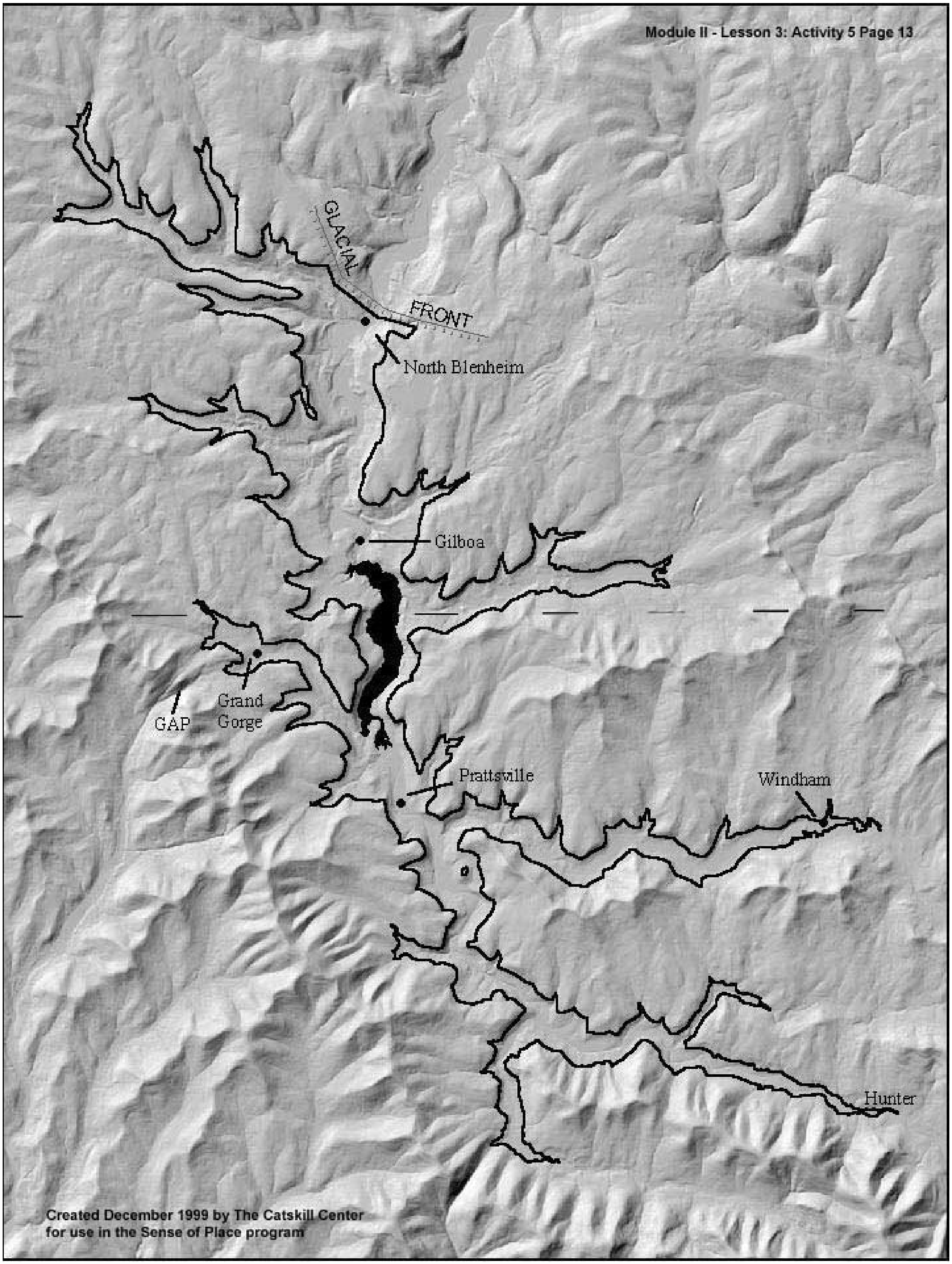
Catskill Mountain Geologic Points of Interest

E. The Glacial Lake of Grand Gorge

Imagine a 700-foot deep lake in the Catskill Mountains! 16,000 years ago, such a place existed. As the last of the Wisconsin glacier melted away, several smaller, secondary glaciers remained in the area. These were relatively small glaciers, isolated from the main continental ice sheet. They are called *valley glaciers*. Valley glaciers are usually confined to the upper reaches of a valley. Due to gravity and the accumulation of snow and ice, the glaciers begin to flow downhill, much like a continental glacier would advance. The many valleys in the Catskills were home for numerous valley glaciers left behind by the Wisconsin. When valley glaciers melt, they create lakes that are surrounded by mountains (Echo Lake, near Woodstock is an example). While valley glaciers were left behind in the Schoharie Creek valley, a much bigger lake once existed that was not created by a valley glacier, but by the retreat of the Wisconsin.

The Wisconsin glacier had entered from the north, and when the climate warmed (after thousands of years), the ice began to melt. As the ice melted, the meltwater continued to pile up behind the glacier because there was no drainage route to the north. The water was blocked by a wall of ice (the retreating glacier). Eventually the dammed-up lake would spill to the south through Grand Gorge Gap, a location that can easily be seen from afar. This tremendous flow of rushing water was "acting like a buzz saw cutting into the mountain", wrote Bob Titus; *Kaatskill Life* as it gouged out the walls of the gap. From Grand Gorge Gap, the water reached the Delaware River system and ultimately the ocean. Another outlet, near Middleburgh, came about once the retreating glacier reached the Catskill Creek, where the water flowed southeast into the Hudson River. However, most of the water flowed out the Schoharie Creek and into the Mohawk River.

At its climax, Lake Grand Gorge would have drowned everything fewer than 1,600 feet in elevation from Hunter and Windham in the east, to North Blenheim in the north, and to Grand Gorge in the west. Prattsville would have been buried in 450 feet of water, and Gilboa in 600 feet of water from the great lake. The areas surrounding Grand Gorge have almost perfect U-shaped valley floors, an ideal example of glacial erosion. The map on the next page shows the approximate extent of the Grand Gorge Lake just prior to it pushing through the Grand Gorge Gap and down the East Branch of the Delaware River. The retreating glacier is shown just above North Blenheim. Present-day villages are also shown, in addition to the Schoharie Reservoir, colored black.



Created December 1999 by The Catskill Center
for use in the Sense of Place program

REQUIRED FACTS

Kaaterskill Falls

☐ Location (include county)
☐ Height of each level and total height
☐ Beginning and end of Kaaterskill Creek
☐ Is Kaaterskill Falls on Kaaterskill Creek?
☐ The glacier that sculpted part of Kaaterskill Clove
☐ The types of rocks that make up the underlying rock where the falls flow
☐ Describe the formation of the two ledges

The Wall of Manitou

☐ Location (include counties)
☐ Size
☐ The two cloves that interrupt it
☐ The three mountain ranges formed by the cloves
☐ How did it get its name and why was it important to the Native Americans?

The Gilboa Forest

☐ Location (include county)
☐ When and how it was uncovered
☐ How old are the fossils and how were they preserved in stone?
☐ Name and describe the plants, land animals, and aquatic life that were found.
☐ Are some of the Gilboa tree fossils now in a place where anyone can see them?

Panther Mountain Meteor Impact Site

☐ Location (include county)
☐ Size
☐ The difference between the drainage patterns of the streams in the Catskills compared to the two streams around Panther Mountain
☐ About how big was the meteor?
☐ When was the crater buried by the mountains?
☐ Where did the joints form and how did they change the geology of Panther Mountain?
☐ What two creeks have been carving the rock around the edge of the crater?
☐ What two things may be under Panther Mountain?

The Glacial Lake of Grand Gorge

☐ Location (include counties)
☐ Size
☐ When did the lake exist?
☐ How it was formed and how did it disappear?
☐ How and why might have the flowing water affected the geology of the Catskills?
☐ What are some visible signs that the lake once existed?

QUESTIONS

A. The Gilboa Forest

1. The Gilboa Forest was uncovered by _______________ in 1869 and discovered in 1920 during the construction of the________________.

2. The tree stumps along the road near the Gilboa Forest site were preserved in ______________ during the _____________ _____________ period for _______ million years.

3. Name three types of land animals that were found in the Gilboa Forest that are still around today.

4. Matching:

Holoptychus	a fish with teeth, lower jaw, and lungs
Eospermatopteris	believed to be the ancestors of modern conifers
Dipterus	a sea scorpion that could be as long as 5 feet
Cephalaspis	trees with a conifer-like trunk and a spore-producing crown that resembled a fern
Archanodon catskillensis	a primitive fish with no teeth or lower jaw
Archaeopteris	a clam that could burrow to the surface after being buried by sediment by heavy floods
Eurypterids	the world's first vascular plants
Psilophytes	a fish with strong front fins to help them drag themselves over land to reach water

5. The fish that once lived in the Gilboa Forest eventually evolved into:

❒Reptiles ❒Sharks ❒Amphibians ❒Birds

B. The Glacial Lake of Grand Gorge

1. When did the Glacial Lake of Grand Gorge exist?

2. How deep was it?
   ❒70’ ❒600’ ❒700’ ❒1,600’

3. Describe how the Glacial Lake and the Grand Gorge Gap were formed.

4. After the water left the Grand Gorge Gap it flowed into the ________________River system and eventually into the____________.

5. What present-day villages would have been on the bottom of the great lake?

6. The areas surrounding Grand Gorge have an almost perfect _______shaped valley floor, an ideal example of____________erosion.

C. The “Wall of Manitou”

1. The “Wall of Manitou”
   - ❒ is on the western side of the Hudson River and can be seen when traveling from Kingston to Rhinebeck.
   - ❒ is on the eastern side of the Hudson River and can be seen when traveling from Rhinebeck to Kingston.
   - ❒ is on the western side of the Hudson River and can be seen when traveling between Catskill to Kingston.
   - ❒ is on the eastern side of the Hudson River and can be seen when traveling between Kingston and Catskill

2. The ridge of the mountains is __________feet high and drops________feet to the Hudson Valley below.

3. What two cloves interrupt the wall?

4. Which THREE mountain ranges are formed by the two cloves?
   ❒ The Jewett Range ❒ The Plattekill-Sugarloaf Range
   ❒ The Kaaterskill Clove Range ❒ The Roundtop-High Peak Range

5. Who gave the “Wall of Manitou” its name and why?

D. Kaaterskill Falls

1. Where are the falls located? What creek are they located on (look closely)?

2. How tall is the combined height of the two falls?
❒80’ ❒180’ ❒260’ ❒800’

3. The Kaaterskill Creek begins near ___________________ at an elevation of ________feet and empties into the ____________________at_______ _______.

4. What was the most recent glaciation that sculpted part of the Kaaterskill Clove?

5. Which types of rocks make-up the underlying bedrock where the falls flow?
❒ more resistant sandstone and less resistant silt
❒ less resistant sandstone and more resistant silt
❒ more resistant sandstone and less resistant shale
❒ less resistant sandstone and more resistant shale

6. Describe how the water flowing over the falls continues to sculpt the two ledges of Kaaterskill Falls.

E. The Panther Mountain Meteor

1. Where was there a possible meteor impact?

2. How did this meteor compare to the one that is believed to have caused the extinction of the dinosaurs millions of years later on the Yucatan Peninsula?

3. The Catskill Mountain streams have a ________________ drainage pattern, but the streams around Panther Mountain have a________________drainage pattern.

4. The crater was filled in with _______________from the ______________(______________), and after millions of years, hardened into ______________and______________.

5. Explain how and why the streams have been able to erode the bedrock around the mountain.

6. What TWO creeks have been eroding the rocks around the circle of joints?
❒Panther Kill ❒Woodland Valley ❒Esopus ❒Batavia Kill

7. What naturally occurring fuel resource may lie beneath Panther Mountain? How may this be possible?

How Do the Catskills Stand Out?

Distinguishing the Catskill Mountains from other landforms throughout New York State is relatively easy. These mountains literally “stand out” above the lower half of New York State. The Catskills can stand out on maps in different ways, depending on what type of map you are studying. Due to higher elevations, the Catskills may be a different color than lowlands, or they could be labeled to indicate their number of people per square mile, or maybe even distinguished by their vegetation as compared with the lower Hudson Valley.

The Catskills: A Sense of Place takes aim at separating the Catskill Mountains from the larger picture, and then celebrating their uniqueness. The Catskills cannot only be compared with the rest on New York, but with other regions throughout the world. For instance, how would the Catskills be similar to, or different from, the Himalayas in Nepal and Tibet, the Pocono Mountains, or the state of Connecticut? There are numerous reasons why our region is both similar to and different from those places. Different areas within the Catskill region stand out from one another as well. Each township and village varies from all others in the region and even the world. The goal, not only of the *Sense of Place* program, but also of this lesson, is to identify the many ways the Catskills are distinct from their surroundings.

Where Are the Boundaries?

This is an age-old question that never seems to get answered, probably because it does not have one answer. The Catskill Mountains are a large region west of the Hudson River, north of New York City, east of Binghamton, and south of Albany in the state of New York. Everyone can agree on that. However, when trying to get more specific, conflicting answers are often given. How do you determine a boundary for a region that doesn’t have a clear beginning? Do you use different ecosystems to determine the boundary? What about roads? Geology? How about political boundaries, like counties or townships? Could you use streams and their watersheds as acceptable boundaries? Some would argue you could even use population density. No matter where you decide to delineate the boundaries in your head, one conclusion is always the same; the Catskill Mountains are truly a special place because of their historical significance, their scientific uniqueness, their gorgeous vistas, and the people that inhabit their remarkable valleys.

Even the topography isn’t helpful is delineating the Catskill Mountains. To the west, the mountains decrease gradually in size so that one can hardly say where the Catskills end and the Allegheny Plateau begins. The only definitive topographic boundary of the Catskill Mountains is in the east, where the mountains abruptly drop off over 2,000 feet, down to the Hudson River valley. Complicating matters, some people think of the Shawangunks or Helderbergs as foothills of the Catskills, but they are geologically distinct.

The New York City Department of Environmental Protection (DEP) only concerns itself with the area of the Catskill Mountains that lies within its Catskill and Delaware Watersheds. The New York State Department of Environmental Conservation defines the Catskills as all land within the “blue line”, which delineates the Catskill Park. Quite often the political boundaries of the Catskills are thought to include four counties: Delaware, Greene, Sullivan, and Ulster. However, US congressional districts and state DEC district boundaries both divide the region in half. Different minds with different areas of expertise all see the Catskill region in their own way. For the people that live and recreate in the Catskills, no boundaries are visible when standing on a Catskill mountaintop.

New York State Defines the "Catskill Region"

The Catskill Center for Conservation and Development defines the Catskills very broadly: all of the land within Delaware, Greene, Otsego, Schoharie, Sullivan, and Ulster counties, in addition to the southwestern townships in Albany County. These townships include Berne, Coeymans, Knox, New Scotland, Rensselaerville, and Westerlo. This definition of the Catskill region was first adopted by the Legislature of the State of New York when it established the Temporary State Commission to Study the Catskills in1976. This extensive piece of land, 6,260 square miles, is larger than Connecticut (5,544 mi^2). Due to its size, this area includes more lowlands, cities, and infrastructure than one would generally expect to find in a "mountain region". Other organizations and agencies, such as NYCDEP, use their own definitions of the region.

The New York City Watershed

The more than eight million residents of New York City have particular interest in the Catskill Mountains. This interest is the basis for all life: water. Ninety percent (1.26 billion gallons) of their daily water supply flows from the pristine streams that meander through the Catskills. The DEP is designated by the city to oversee and protect the quality of the water in these Catskill Mountain streams. DEP is only concerned with the areas that empty into their six Catskill region reservoirs. Because the water from these reservoirs only affects New York City's water supply, the DEP has a different definition of the Catskill region than other governmental agencies and interest groups. The boundary in this case is determined by the summation of the six reservoir watersheds, Ashokan, Cannonsville, Neversink, Pepacton, Rondout, and Schoharie. When joined together, a land area of 1,581 square miles in the Catskill Mountains (larger than the state of Delaware) lies within the New York City Watershed.

The watershed boundaries spill into five counties: Delaware, Greene, Schoharie, Sullivan, and Ulster. This watershed, home to some 66,000 people, is divided into two drainage systems, the Catskill and the Delaware. The Delaware system is drained by the Delaware River, and the Catskill system is drained by the Hudson River. The drainage divide between these two systems runs north-south from the township of Jefferson down to the township of Olive.

The New York City watershed boundary zigzags following the contours of the land. This natural boundary is obviously not affected by the established political boundaries, and therefore weaves haphazardly over township, county, and Catskill Park boundaries. Whenever NYC Watershed questions arise, it involves many different levels of government. In some areas, the watershed boundary is in accordance with town lines because these political boundaries were established in accordance with natural barriers. The New York City Watershed is discussed in much more detail in the Water Resources module.

The Catskill Forest Preserve and the Catskill Park

The Catskill and Adirondack Forest Preserves were established in 1885, with the purpose of protecting these lands forever as "wild forest lands". On a map, most of the Catskill and Adirondack Forest Preserve lands fall within a *blue line.* (In the Catskills, all but 6,500 acres are within the line.) These blue lines mark the boundaries of the Catskill and Adirondack Parks. In 1892, the blue line boundary of the Adirondack Park was established and the Catskill Park was later outlined in 1904. Originally, the blue line of the Catskills encompassed 576,120 acres. The current land area within the blue line is 705,500 acres (1,102 mi^2), constituting the Catskill Park. That is an area of land larger than the state of Rhode Island (1,045 mi^2). Eight townships lie entirely within the park, and 16 others have pieces inside the blue line. Forty-one percent of all land and water within the park is publicly owned Catskill Forest Preserve and 59% is privately owned. Forest Preserve lands are divided up into three categories: Wilderness, Wild Forest, and Intensive Use areas.

Forest Preserve lands considered Wilderness areas are defined by the NYSDEC in the *Catskill Forest Preserve Public Access Plan, August 1999*, as those lands where "the earth and its community of life are untrammeled by man--where man himself is a visitor who does not remain". These five Wilderness areas are protected and managed in ways to preserve their natural conditions. By definition, wilderness areas: Appear to have only been affected by the forces of nature, with virtually no imprint of man; offer opportunity for primitive and unconfined types of recreation; have at least 10,000 acres of land and water, or are of sufficient size and character to make their preservation and use necessary; and may contain features of scientific, educational, scenic, or historic value.

Forest Preserve lands classified as Wild Forests are defined by the NYSDEC in the *Catskill Forest Preserve Public Access Plan, August 1999*, as "a section of Forest Preserve where the resource can sustain a somewhat higher degree of human use than a wilderness area. Further defined as an area which lacks the sense of remoteness of wilderness areas and which permits a wider variety of outdoor recreation". The management guidelines for wild forests are to protect the natural setting and provide a variety of certain types of recreation without impairing or changing the wild forest atmosphere. In addition, wilderness guidelines apply to any land and water over 2,700 feet in elevation within the wild forest.

Forest Preserve lands considered Intensive Use Areas are defined by the NYSDEC in the *Catskill Forest Preserve Public Access Plan, August 1999*, as "a location where the State provides facilities for highly concentrated forms of outdoor recreation including facilities designed to accommodate significant numbers of visitors such as campgrounds, ski centers, and visitor information centers". These lands are managed to provide the public with opportunities for group gathering in an outdoor setting on a scale in harmony with nature and the character of the Catskill Park and Catskill Forest Preserve.

The Catskill Forest Preserve provides the public with numerous year-round recreational opportunities such as: camping, fishing, hiking, horseback riding, hunting, snowmobiling, skiing, snowshoeing, swimming, and wildlife viewing. In 1996, an estimated 574,000 people visited Catskill Forest Preserve lands. This estimate was made by the NYSDEC, the agency responsible for maintaining and enforcing regulations on Forest Preserve lands.

FOREST PRESERVE MANAGEMENT UNITS

Type of unit (# of type)	Acres (% of Forest Preserve land)
Wilderness (5)	129,000 acres (45%)
Wild Forest (14)	150,000 acres (52%)
Intensive Use (11)	5,265 acres (2%)
Administrative (4)	816 acres (0.3%)
Conservation Easements (3)	514 acres (0.25%)

FOREST PRESERVE ACREAGE BY COUNTY

County	Acres (% of Forest Preserve land)
Ulster	152,716 acres (53%)
Greene	78,232 acres (27%)
Delaware	41,708 acres (14%)
Sullivan	18,320 acres (6%)

CATSKILL FOREST PRESERVE VISITATION (1995-1997)*

Classification	1995	1996	1997	1998
Wilderness	35,670	32,074	36,365	36,605
Wild Forest	60,654	46,439	61,985	67,146
Intensive Use	342,382	321,951	339,475	350,856

* Figures here are based upon NYSDEC trail registers, camping permits, and ticket sales.

Demographics

The Catskill Mountain region stands apart from other regions in the state not only because of its geology or its abundance of state-owned land, but also because of its people. The Catskill Mountains were once very different than they are today. Tanning, forestry, and agriculture once dominated industry in our region. Today, tourism is the foremost, while many old pastures and fields continue to turn back into hardwood forests typical of the Catskills. Due to the close proximity of New York City, the Catskills provide a weekend playground and a second home to residents of the city. Just as people can sometimes affect an area's geology (by blasting through a mountainside to make a road) and geography (for example, by having children), geology and geography affect people. Both affect the residents of the Catskill Mountain region.

In some ways, the mountains in this region limit the number of people that can live here. The valleys between the mountains are rarely very spacious, nor suitable for large populations. For example, the state of Connecticut, which covers less land area than the Catskills, has a population of 3.3 million, while the six-county Catskill region population is about 419,000, a mere 13% of Connecticut's. Obviously, geology can play an integral role in industry as well. Land suitable for agriculture is very sparse in the Catskills. The mountain slopes are very rocky and the fertile valleys quite narrow and scarce. Very often, if a region has unfavorable land for growing crops, livestock production or timber harvesting are more practical uses for the land.

New York State and New York City own vast amounts of land in the Catskill Mountains. The State continues to buy land in order to protect these pristine areas for the general public, and New York City continues to do the same, but with the purpose of protecting its drinking water supply. Because such vast amounts of land are "tied-up" by the State and the City, inhabitants of the Catskills cannot use these lands to better their economic standing. Or can they? The Forest Preserve holds great potential for attracting tourists and second homeowners to the region, and thus contributes much to the local economy. How many people can say that they live in a state park? A region so unique that it will be preserved forever so that everyone can enjoy it.

Schoharie County is the least populated of the six counties in the Catskills. According to the 1990 census, 31,859 people live there, with a per capita income of $10,595, also the lowest. Conversely, Ulster County is the most populated in the Catskills. In 1990, 165,304 lived in Ulster County with a per capita income of $14,839, the highest in the Catskills. Compare those figures to Westchester County's per capita income of $25,584 or Albany County's per capita income of $16,363. Unfortunately, the Catskill Mountains stand out in this manner as well. This lesson of the Geography and Geology module will draw attention to aspects of our local physical and human geography that make the Catskill Mountains stand out from surrounding regions.

Names on the Land

Grades:

4th - 7th

Objective:

The students will get a better understanding about the history, environment, and culture of the Catskill region as reflected in place names. They will also become more familiar with the geographic boundaries of the Catskill region. The extension of this activity allows for more in-depth research into a place's specific history.

Method:

Students are given a map of the Catskills and a corresponding list of criteria. They must look at the map and attempt to find names of villages, streams, mountains, or lakes that fulfill the assigned criteria. All of which will be located in the Catskill region.

Materials:

Several Catskill region maps (preferably the map included with this module), and the worksheet (enclosed). All maps don't have to be the same, but if possibly, it's best. Additional copies of our map can be purchased for $4 each by contacting us. A useful tool for this activity will be the Human History, the fourth module of "Sense of Place" once it is completed.

Time:

Preparation time: 10 minutes
Class time: 45 minutes – 1 hour

Procedure:

Note: For this activity, as throughout the module, the Catskills are defined as the six counties of Delaware, Greene, Otsego, Schoharie, Sullivan, and Ulster, plus the southwestern townships of Albany County.

1. Begin a discussion with the class about how names of places are often named that way for a reason. Give examples of how pets are often named because of a certain characteristics. For example, black cats are sometimes named "Shadow" or "Midnight". Dogs with spots on their fur are sometimes named "Spot" or "Patches".

2. Explain that places usually get their names in the same way. The people that first settled in a particular village had to distinguish their place from all others, so the name was often related to a

unique feature of that place (ex. Long Island, Iceland). Quite often places still have names that ethnic groups used long ago, like the Native Americans naming the Mohawk River and Lake Huron or Huguenot Street in New Paltz being named after the Huguenots. It would be useful to have a map or globe to depict these areas you are mentioning.

3. Explain that the Catskill Mountains have a long and interesting history, and that many of the place names we are familiar with were chosen for reasons, often giving us a clue to the landscape or history of each place. Explain to the class that they are to look at a map of the Catskill region and try to uncover why certain places were given their names.

4. Divide the class into groups; the number of maps you have will determine the group size (ideally four in a group). Distribute a copy of the enclosed question sheet to each student, and give the maps to each group.

5. Review the borders of the Catskills, as defined on the worksheet, perhaps having selected students point them out to the rest of the class. Begin the activity, and help point out places if they are stuck. A sample answer key is included in case no places are found for an item.

6. Have the class share their answers with the rest of the class by pointing out their places and guessing how each one got its name.

Extension:

A great follow-up activity would be to have students research the history behind some of the interesting place names they find. Other than visiting the local libraries, they could interview their parents or grandparents if they have lived in the area their entire life. Because the Catskills have such a rich and interesting history, local historians have written numerous books about many of the villages and events in the Catskills. We encourage your students to become more aware of local history. An extra-credit project could be to have them compile the information they collect into a mini research paper, and present it to the class.

Assessment:

1. Did the students all participate in group work and did they work well together?
2. Did the students recognize the importance of place names in regards to the historical, cultural, and environmental concepts identified for that particular place?
3. Did the students fully understand the activity? For example, were they successfully in delineating the defined boundaries of the region, or did they choose places outside the specified boundaries?

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading, Speaking and Writing
Standard 4 - Language for Social Interaction: Listening and Speaking

Math, Science, and Technology
Standard 4 - Science: The Living Environment 7

Social Studies
Standard 1 - History of the United States and New York 2,4
Standard 3 - Geography 1,2

Source: This activity was developed by Nathan Chronister and Aaron Bennett.

Possible Answers for "Names on the Land"

1. **City of Catskill**, **Town of Catskill**, **Catskill Creek**.

2. **South Kortright** – actually named for an Indian fighter, Captain Benjamin Kortright; **East Branch**, **North Blenheim**, **West Saugerties**.

3. **Cherry Valley**; **Grand Gorge** – named for its location in the ravine between Irish Mountain and the Moresville Range; **Platte Clove** and **Kaaterskill Clove** – a clove is a steep chasm in the wall of a mountain.

4. **Halcott Center** – named after an early settler George W. Halcott; **Livingston Manor** – named after Dr. Edward Livingston, nephew of the famous Chancellor Robert Livingston of Clermont; **Thomas Cole Mountain** – named after the famed landscape painter, and founder of the Hudson River School; **Wurtsboro** – named for two brothers (Maurice and William Wurts) who anticipated and built the Delaware & Hudson Canal.

5. **Beaverkill**, **Mosquito Point**, **Panther Mountain**.

6. **Ashokan** – an Esopus Indian chief; **Big Indian** – named after a huge Indian, Winnisook, who was either killed by wolves or by white men, his body was eventually stuffed into a hollow tree near the railroad station; **Lake Minnewaska** – name translates to "frozen waters"; **Mt. Utsayantha** – named after a make-believe Indian princess in a tale by Eugene A. Bouton; **Onteora Mountain** – name translates to "Land in the Sky".

7. **Cementon** – named for the many cement plants located there; **Dairyland**, **Tannersville** – named for the extensive tanning (hemlock bark was used to tan leather) industry in the area in the early1800s.

8. **Cairo, Ireland Corners**, **Leeds**, **Maryland,**.

9. **Balsam Mountain** – named for the balsam fir on its summit; **Fir Mountain** – named after the balsam fir trees on its slopes and summit; **Spruceton** – named for the numerous red spruce trees in the area.

10. **Kiamesha Lake** – an Indian term meaning "clear water"; **Lake Katrine**.**-** the lake was named after a lake in Scotland.

11. **Binnewater** – Dutch term for an inland pool; **Haines Falls** – the village was once called Haines Corners but since has taken the name of the second highest waterfall in the Catskills; **West Kill** – "kill" is a Dutch word meaning "creek".

12. **Indian Head Mountain** – named because it looks like the head of an Indian looking up at the heavens; **Plateau Mountian** – named because of its 2+ mile, flat summit; **Table Mountain** – the summit looks perfectly flat when seen from a distance; **Vroman's Nose** – named after a local family, and the ridge looks like a nose.

13. **Greenville**, **White Sulphur Springs**.

14. **Granite**, **Quarryville**, **Rocky Mountain**.

15. **New Berlin**, **New Kingston**.

Names on the Land

Name:__________________________ Date: ______________ Teacher: ______________________

Directions:
For each numbered item below, write the name of a place found on your map. The place may be a town, village, water body, mountain, or any other feature. You may write more than one place name for each item. However, you may not use the same place twice.

Each place must be within the Catskill region. To be considered part of the Catskills, a place must be in Delaware, Greene, Otsego, Schoharie, Sullivan, or Ulster County, or in southwestern Albany County.

1. Has the word "Catskill" in its name.

2. Has a compass direction in its name.

3. A landform is part of the name.

4. Named after a person or family.

5. Has an animal in its name.

6. Has a name that relates to or given by the Native American people.

7. Was named to indicate an activity or industry of that village.

8. Has the same name as a city, state, or country.

9. Has the name of the natural vegetation (plants, trees, etc) that is found there.

10. The village was named for a lake.

11. The village was named for a river, stream, or waterfall.

12. A landform or water body that was named for its visual characteristics (what people think it looks like; ex. Round Pond – named because of its round shape)

13. Has the name of a color in it.

14. Has a name that relates to geology.

15. Has "new" in its name.

Environmental Exchange Box

Grades:

4th - 7th

Objective:

Students will discover some of the resources, products, and other characteristics of the Catskill Mountain region, which make it so unique in addition to learning about another region in the United States.

Method:

Students prepare an “environmental exchange box” consisting of various information related to the Catskills. The box is then exchanged with that of another school in a different part of the country.

Materials:

Books about the natural history of the region, art supplies, and any various materials they wish to include in the box.

Time:

Preparation time: 1 hour (see note)
Class time: two periods

Note: To use this activity, you must mail or fax the enclosed form to Project Learning Tree (see enclosed form). Allow four weeks for the match with the other school to be made. Once you receive the name and address of your “exchange partner” you can begin the activity.

Procedure:

1. Explain that the students you are exchanging with will not know much about your local environment. It is the responsibility of your class to prepare items for the box that will teach your exchange partners about the Catskill Mountain region.

2. Brainstorm along with the students to come up with a list of items to include in the box. Then have the students divide up the responsibilities of researching, collecting, and preparing materials for the box. The students might want to consider some of the following items for their box:

- Brief descriptions of the Catskill region written by the students.
- Types of rocks found throughout the Catskills, like pieces of shale, sandstone, or conglomerate.

"Bluestone" could be used and you could provide a little bit of its history here in the region to accompany it. Be sure to include only native rocks, students should not bring in rocks they found at the beach they went to last summer.

- A collage of pictures of local ecosystem types (mountains, streams, geology, wetlands, etc.)
- A book with drawings of some interesting local plants and animals or of many different plants and animals found in the region.
- Photographs of your group and your school or meeting area.
- A video of local ecosystems, which also records the sounds of Catskill wildlife.
- Stories written by the students about their favorite things to do, or places to go.
- Samples of special regional foods or products specific to the Catskill area (ex. Florida oranges, or Georgia peaches).
- Descriptions and pictures of regional cultural events and celebrations.
- Representative natural objects from the Catskill region such as tree leaves, cones, flowers, etc.
- Recording of various sounds of the Catskill region or oral reports on various topics prepared by the students.
- A field guide, prepared by the students, to some of the trees, wildlife, flowers, or other natural things in the Catskill Mountain region.
- A description of local environmental issues and news articles on all sides of the issues (New York City Watershed, Hudson River, etc.).

3. While you are waiting for the box from the other region to arrive, ask the class what they know or have heard about the region they are exchanging with. Can they name major cities, geographical landmarks, or other features of the region? What is the climate like there? Record the students' ideas on a chalkboard.

4. When the box arrives from your exchange group, open it and examine the contents with the students. Then have students compare that region to their own. For example, how do the climates compare? What kinds of plants and animals live here that does not live there? Are there differences in the ways people live?

5. As a conclusion, have the students use the exchange box to create a representation of what they liked most about the other area or what they imagine it would be like to live there. For example, students could draw pictures that depict their favorite item from the box or that show a scene in the other region. They could also write down their impressions of items from the box in creative ways by writing stories about their imaginary adventures in their partner's region.

Extension:

1. Have all of the students in your class prepare a short thank-you note to the exchange class, describing their impression of the box and what they like about it. Have the class develop a list of questions about certain items in the box or the region the box came from.

2. Contact the local newspaper for coverage of the opening of your exchange box. Students could write a press release for the event.

Safety Note: New York has laws that protect certain "endangered species" throughout the state. It is against the law to kill the plants on this list. Contact the NYSDEC if you are unsure if a plant is protected or not. Please do not send any plant seeds that are considered "invasive" in the region that you are sending your box.

Assessment:

1. We your students able to collect materials that were practical for sending to another part of the country?
2. Was the material that your partner sent beneficial to your class? If you sent similar objects, it probably worked well for your partner. If you do this next year, would you try some other things?
3. Did you receive the box from the other region in an acceptable amount of time?

NYS Learning Standards:

English
Standard 4 - Language for Social Interaction 1,2

Math, Science, and Technology
Standard 1 - Analysis, Inquiry, and Design: Scientific Inquiry 1
Standard 4 - Science: Physical Setting 2; The Living Environment 7
Standard 6 - Interdisciplinary Problem Solving: Connections; Strategies

Social Studies
Standard 1 - History of the United States and New York 2
Standard 3 - Geography 1,2

Source: Copied with permission, American Forest Foundation, copyright 1993-1998, *Project Learning Tree Environmental Education Pre K-8 Activity Guide*. The complete Activity Guide and High School Modules can be obtained by attending a PLT workshop. For more information, call the National Project Learning Tree office at (202) 463-2462.

Environmental Exchange Box Form

Name____

School____

School Address ____

City / State / Zip ____

Telephone Number (work & home) ____

Grade Level / Age of Students ____

Preferred U.S. State or region with which you would like to exchange (if any)

____
___

RETURN THIS FORM BY MAIL OR BY FAX TO:

Project Learning Tree
American Forest Foundation
1111 19th Street, NW
Washington, D.C. 20036
FAX: (202) 463-2461

Connect the Dams

Grades:

5th - 12th

Objective:

Students will get a better understanding of the New York City Watershed and its boundaries. They will be able to delineate boundaries between different watersheds by using a map that shows only streams on it.

Method:

After becoming familiar with what a watershed is, students (using a map that has already been introduced to them) will define the boundaries of the New York City Watershed. The only information they are provided is a map of the water bodies (reservoirs and streams).

Materials:

One water body map (enclosed) per group or per student (whatever will work best), and a pencil with an eraser. You may wish to make an overhead transparency of the map so you can demonstrate the method if necessary. A completed watershed boundary map is also enclosed, for your reference.

Time:

Preparation time: 5 minutes
Class time: 45 minutes; with Extension - 1 hour

Procedure:

For your information, below are the major streams that feed each reservoir.

- Esopus Creek flows into the Ashokan Reservoir
- Rondout Creek flows into the Rondout Reservoir
- Schoharie Creek flows into the Schoharie Reservoir
- Neversink River flows into the Neversink Reservoir
- East Branch of the Delaware flows into the Pepacton Reservoir
- West Branch of the Delaware flows into the Cannonsville Reservoir

1. If students are not already familiar with what a watershed is, use Activities 5 & 6 in Lesson 1 of the Water Resources module or Activity 5 in Lesson 2 of this module to strengthen their understanding.

Explain that a “drainage divide” is a ridge that separates two streams, and that NYC gets 90% of its water from the Catskill Mountains (again this is also in the Water Resources module). Depending on the ability of students, step 2 can be omitted to make the activity more challenging. Distribute the materials.

2. For elementary grades, discuss how to recognize the direction of a stream’s flow (which might be difficult for students to visualize). Where a stream ends on the map is its source (beginning), obviously it flows in the opposite direction. Point out the six reservoirs by name. Obviously those reservoirs are inside the watershed. Ask the class if they think that the streams that flow into those reservoirs would be inside or outside the NYC Watershed. What about the streams that flow out of the reservoirs, would they be in the NYC Watershed?

Note: The Ashokan and Schoharie Reservoirs may cause some problems for students. The dams are easy to locate on the other reservoirs, but there are three on the Ashokan, and the dam on the Schoharie is at the north end. You might want to point out that the Schoharie Creek flows north; students often think streams cannot flow north.

3. Tell the class to begin by picking a starting point. The easiest place is most likely a dam on a reservoir. Once they pick a reservoir, have them locate every stream that flows into that reservoir. Once they do that, see if they can define the drainage divide between that stream and the one next to it.

4. If the next stream does not flow into another reservoir, it is not in the NYC Watershed. Once they see what a “drainage divide” looks like on this map (the space between two streams), it should be easy to follow them until they reach the dams at all six reservoirs.

5. After they have successfully played “connect the dams”, they should check their outline against the one that is provided. Since topography is not shown on this map, the lines will not all be the same, however it will be an obvious error if a line they drew crosses over a stream.

6. By using Lesson 4 in the Water Resources module, you could discuss some interesting facts about the watershed and the reservoirs, in addition to the villages that were flooded and how the water travels from one reservoir to the next and then down to New York City.

Extension:

1. For upper grades, a major drainage divide is evident on this map that was not discussed earlier. Ask the class if they know what two larger rivers all of the streams in the NYC Watershed empty into. The Delaware River can be seen on the lower left corner, and the Hudson River is just off of the map on the right.

2. After the class has drawn the NYC Watershed boundary, see if they can draw a dashed line for the Delaware-Hudson River drainage divide. A clue you could give them if needed is that it runs in a north-south direction.

3. Once finished, see if the class notices anything strange about the path of one of the streams. You may want to familiarize them with the term “branched drainage”. This is the most common type of pattern, and the one typical of the Catskills. The Esopus Creek’s drainage should stand out like a sore thumb. It forms a near-complete circle. This was the site of a meteor impact some 400 million years ago, now buried under Panther Mountain. More information on this unique area is provided in Lesson 3.

Note: If you really want to give your class a challenge, have them outline each of the six sub-watersheds (one per reservoir) within the NYC Watershed.

Assessment:

1. Do the students fully understand what a watershed is?
2. If students worked in groups, were they able to do so effectively? If they worked individually, did that work well?
3. Could the students visualize and understand drainage divides?
4. Could the students define the boundary of the NYC Watershed?
5. Use the enclosed quiz to assess students’ knowledge of the presented material. Quiz answers:
    1. A watershed is an area of land, determined by drainage divides, that collects, stores, and eventually releases its water.
    2. The New York City Watershed is a 1,800 sq. mile area located in the Catskill region that supplies 90% of the drinking water for the 8+ million people of NYC.
    3. The Ashokan, Cannonsville, Neversink, Pepacton, Rondout, and Schoharie Reservoirs.
    4. Watershed boundaries are natural features determined by mountaintops or drainage divides. Dams determine the reservoir’s location, but not the watershed’s boundary.
    5. Villages, cities, and roads are generally located near or next to watercourses.

NYS Learning Standards:

Math, Science, and Technology
Standard 4 - Science: The Living Environment 7

Social Studies
Standard 3 - Geography 1,2

Source: This activity developed by Aaron Bennett

Connect the Dams Quiz

Name: ________________________ **Date:** __________ **Teacher:** _________________

Directions: Answer the questions below using the information you learned from this activity and throughout the lesson.

1. What is a watershed?

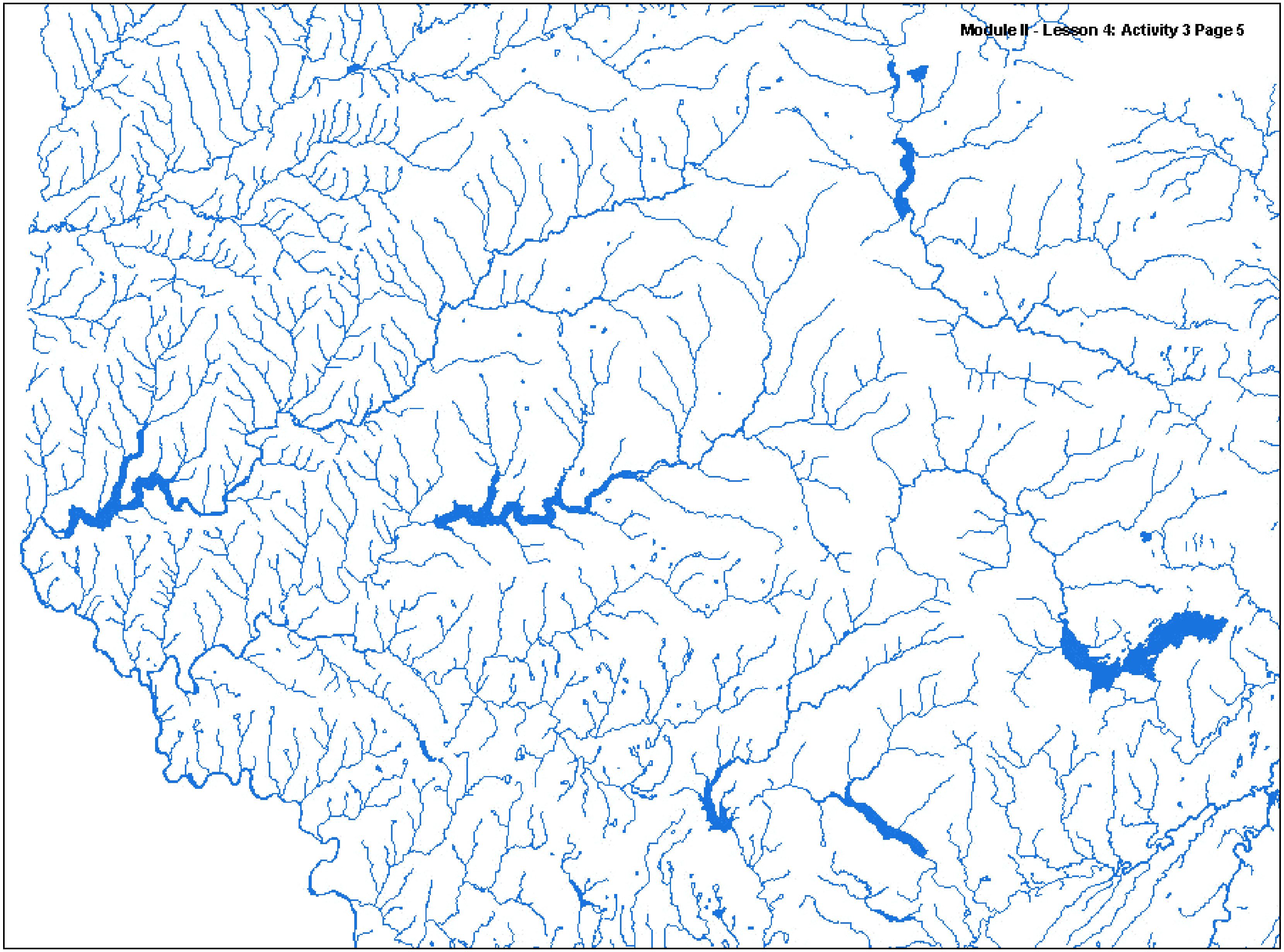
2. What is the New York City Watershed and why is it so important to keep its water clean?

3. Name three of the six reservoirs that were built in the Catskills to supply New York City with clean drinking water and of those, which is closest to your school?

4. The boundary of the NYC Watershed, the one that you drew, is determined (made) by what?

A. Dams B. Valleys C. Mountaintops D. Streams E. Town/County lines

5. If villages and roads were shown on that map, do you think they would be alongside or near the streams or away from them?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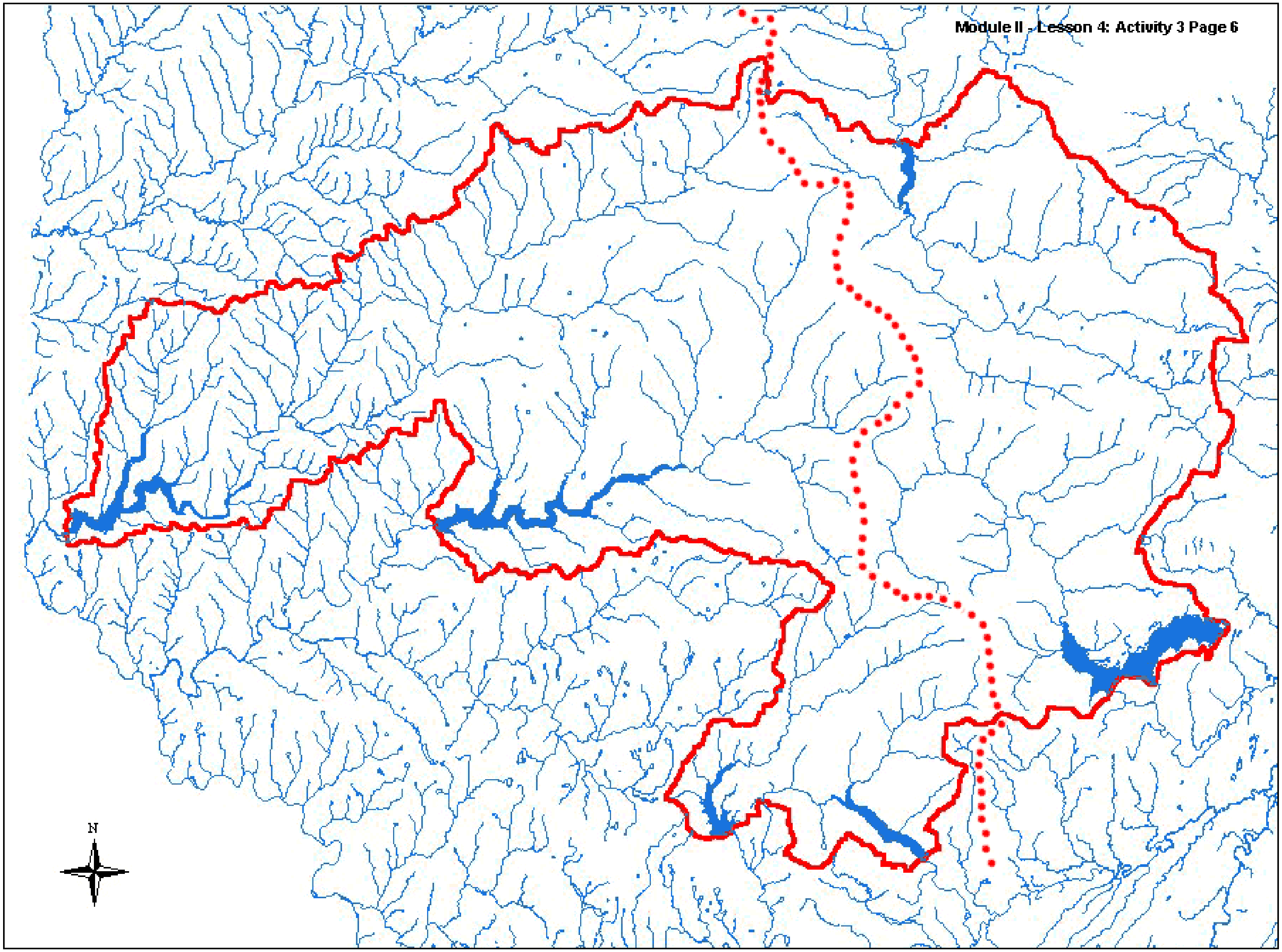


Catskill Geology Defines Human Geography

Grades:

4th - 12th

Objective:

This activity has many different objectives. Students will gain a better understanding and become more comfortable and more skilled with maps in addition to realizing how much information can be displayed on them. Also, concepts of county, township, and city (or village) boundaries will be explored. The most important objective will be exploring the relationship between geology and geography. Often students hear the word geology and they only think of different types of rocks, but geology defines where we live, what crops can grow, and what natural resources are available in a region.

Method:

The students will be provided with many different maps focusing on the central Catskill region. These maps will also be made into transparencies and used interchangeably with each other to convey different themes. As the teacher presents these overheads he/she will ask questions encouraging the students to interpret the maps.

Materials:

Make overheads of the maps (all maps are enclosed in appendix). Maps include: COUNTIES, TOWNSHIP BOUNDARIES, TOWNSHIP NAMES, MAJOR ROADS, WATER BODIES, CATSKILL PARK, NYC WATERSHED, and TOPOGRAPHY. Colored overhead pens, materials for students (whatever you decide to use), a map of the Catskill region (optional, enclosed).

Time:

Preparation time: variable (up to 45 minutes)
Class time: variable (45 minutes – 1.5 hours)

Procedure:

Note: The following procedure is one of the many ways the information provided could be manipulated. We encourage you to use the maps in different ways, as there are many options. Obviously the older the audience, the more in-depth you can be when discussing how geology influences the streams, roads, boundaries, and villages. The maps include most of the Catskill region. For adequate detail, however, we could not use a small enough scale to include the entire region. We selected enough area so that if your school is located outside the map area, students should still be able to recognize some names and places on the map.

1. Begin by asking general questions about the subject matter you will focus on.
Your geography questions could include:

What village or city do you live in (if any)? What township do you live in? What county do you live in? How are villages and cities different from townships and how are townships different from counties? (See lesson summary for definitions. A township, also called a town, is not the same thing as a village or hamlet.)

Your history or science questions could include:

What is the Catskill Park? What is the NYC Watershed? How are they different? How many NYC reservoirs are there? What is a watershed? How high are the tallest mountains in the Catskills? What is geology? (It isn't just the study of rocks!) Can streams be affected by the geology of an area? Are people affected by geology? (Again, see lesson summary for definitions, etc.)

2. Explain that throughout this activity, students should be thinking about how geology and geography are related. Make sure the class really understands how broad geology is. Geologists study the fossil record, the tectonic plates under the continents and oceans, the building of mountains, the erosion of mountains, the path of streams, the Ice Age, and more. Geology is the foundation that allows the Catskill region to be picturesque and culturally and historically unique.

3. Start by showing the students the overhead transparency with just the COUNTIES on it. Can the students accurately point to where they live? Probably not, but that is something they should know. Without any other features marked, the boundaries look arbitrary. There are two boundary lines on the map determined by geology; can they find them? (The lines between Greene and Schoharie and between Delaware and Otsego Counties) What are the geological features that determine these boundaries? (A watershed divide and the Susquehanna River, respectively)

Place the WATER BODIES overlay on top and see if they answered correctly. Do the students understand that stream location is determined by the geology? Weaker rocks erode more easily than hard rocks, influencing the course of streams.

4. Now use the TOWNSHIP BOUNDARIES overhead interchangeably with the previous two. Can the class recognize the shape of the township they live in? How are town boundaries established? Are some based on geology? Notice the town of Stamford. The western edge follows the West Branch of the Delaware, and the eastern edge follows the drainage divide (drainage divides, the opposite of streams, are geologic boundaries) between the two branches of the Delaware River.

5. Use the TOWNSHIP NAMES overlay to identify each township. Did students guess their town correctly? Do any of the township names have some historical significance? (Prattsville – named after Zadock Pratt who operated one of the largest tanneries in the Catskills, or Hardenburgh – named after Johannis Hardenburgh who along with six others were granted a patent by the English in 1708 over nearly 2 million acres in what is now Ulster, Sullivan, Greene, and Delaware Counties. The Hardenburgh Patent hampered settlement and loomed over the region for almost a century.

6. Now place the MAJOR ROADS overhead on top of the COUNTY and TOWNSHIP overlays. Have the students point out the roads they are familiar with. Please note that, to prevent clutter, only state routes and interstates are shown. See if the class notices that there are no major roads through a large chunk of western Ulster County. Why might that be? (It's all mountains) Selected hamlets, villages, and cities are also shown on the road map.

7. Now take away the COUNTY overlay, and place the WATER BODIES one on top. Do the students notice anything about the relationship between streams and roads? Almost every major road follows a stream. Do they know why? Ask the class to think of how geology and geography are linked. The class should understand that geography in this sense means where places, and subsequently people, are located, and why they are located there.

> Villages and cities form where people are. People live and work where roads take them. Roads are built in the flat valleys along streams. Location of streams and lakes (even man-made reservoirs) are determined by the geology.

8. Geology can influence an area's geography through topography. Familiarize the class with the meaning of topography. Students should already know about contour lines and how to read topographic maps. Remove the ROADS and WATER overlays, and place the TOPOGRAPHY one on top of the COUNTIES or TOWNSHIPS. The contour interval is 300 feet. Can the class point out mountaintops and valleys? Can the class recognize any distinguishing features (reservoirs, mountain ranges, or steep cliffs)? Use this overhead interchangeably with the ROADS and the WATER ones, and you might want to take off the other to avoid cluttering. Point out how streams can't flow over mountains, and how very few roads cross over mountains either. Therefore, there are no villages up on the mountains.

9. The last two overlays are the NYC WATERSHED and the CATSKILL PARK. Use these interchangeably with the other overlays. It would be a good idea to give a little bit of history behind each when introducing them (information is included in lesson summary). Students should realize that all six reservoirs are inside the NYC WATERSHED boundary, and that the boundary lines follow ridges, or drainage divides, not streams or roads. Ask the class whether these boundaries are man-made or determined by the shape of the land. (The boundary is natural, determined by topography.)

> The CATSKILL PARK overlay leads to some interesting questions. Why are some reservoirs inside the park and others outside? (NYS defined the park even before the reservoirs were built) Why are some lines perfectly straight? Why are others jagged? (Some are influenced by geology, others are arbitrary) Ask the class whether these boundaries are man-made or determined by the land. (In this case, both are true)

Assessment:

1. Could the students understand how geology influences geography?
2. Were the students able to make the assumed connections between the maps?
3. Did the class understand the differences between a city, a town, and a hamlet?
4. Could the students answer the questions asked pertaining to each overhead?
5. Did all of the overheads work well, or were some to confusing or unclear?

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading

Math, Science, and Technology
Standard 4 - Science: Physical Setting 2; The Living Environment 7

Social Studies
Standard 1 - History of the United States and New York 2
Standard 3 - Geography 1,2

Source: Activity developed by Aaron Bennett.

Population Pyramids

Grades:

6th - 12th

Objective:

To inform students about how population growth in our region compares to other regions in the world. They will also understand how geology can influence or control a nation's population.

Method:

In this activity, students will construct population pyramids for their region (or county) and compare their population growth rate to local counties or countries throughout the world.

Materials:

Population data (enclosed), blank population pyramid sheets (enclosed), population pyramid overheads (enclosed), graph paper, colored pencils (optional).

Time:

Preparation time: 15 minutes
Class time: 45 minutes – 1 hour

Procedure:

Note: Data acquired for this activity was obtained from the United States Census Bureau. County population figures are from the 1990 census data. The population figures for the different countries are based on the 1999 population, and were also acquired from the U.S. Census Bureau. If you feel there is too much data for students to graph, change the age groupings from every five years to every ten years. Then your graphs will have less detail.

1. If your class is not familiar with bar graphs, explain to them what they are and their purpose. Show examples of some that you have or those that are in books they use. Experience with bar graphs will help students construct population pyramids. You may wish to provide them with examples of various types of graphs in order to show some differences.

2. Begin the activity by asking simple questions regarding population. See if they know which county in the Catskills has the largest population. (Ulster) What state has the largest population? (California) Do they think the world's population is increasing or decreasing? (Increasing) Is the United States population increasing? (Yes)

3. Introduce population pyramids to the class. These graphs show us how many people of each age there are in a population. With this information, we can tell whether a region's population is increasing, staying the same, or decreasing. On the chalkboard you may want to draw the three shapes that indicate the population growth or decline of an area. If you decide not to construct the United States population pyramid, show it to the class and discuss what it indicates. Tell them that they will plot a pyramid for the *county* that they live in. The three graphs provided each show different population growth rates. The US's population is slightly increasing, India's is rapidly increasing, and Japan's is slightly declining.

4. Depending on the ability of the students, you can have each student set up their X and Y-axes on their graph paper, or you can provide the students with the blank population pyramid sheets that are enclosed. The information provided allows you to construct more than one pyramid if you wish to compare two counties and different countries.

5. To construct the grid system, turn the paper sideways. Draw a heavy vertical line straight down the middle of the paper for the Y-axis. Mark off ages every five years, for example 0 to 4, 5 to 9, 10 to14, etc.

6. On the X-axis, you must find a suitable scale for the population of your county or country. For counties you might use 1 box = 500 people, and for countries 1 box = 1 million people. (For India, use either 1 box = 5 million or 1 box = 10 million people.)

7. After determining the scale, label the graph accordingly. The left side of the X-axis is the number of *males*, and the right side is the number of *females*. Along the left and right margins of the page (male and female sides), label the 18 age groups (every five years), starting with "0 - 4 years" at the X-axis and ending with "85 and over".

8. Students can now begin to plot the data. Give the students an example so they can see how specific the plotting will be. For example, they will have to estimate more often than not, so show them how you would graph 2,240 females that are 19-24 years old. Students can color in the various age groups different colors based on the number of people (ex. 1000-2000 = green, 2000-3000 = red, etc.), which may make it easier for them to understand.

9. Depending on your class's ability, you can have them graph other counties' populations, or even other countries' populations. We have provided you with graphs and data from other countries to use as a comparison. **Explain that the populations from the counties in the Catskill region are in thousands and the country populations are in millions.** It is acceptable to compare the "apples and oranges" in this case because you will be looking at the *shapes* of the graphs, not the total population.

10. Compare your county's pyramid with that of the United States. Now look at other countries. See if the class knows which countries have vastly expanding populations (India, Mexico); slightly expanding populations (US, Chile); steady, declining, or shifting ones (Japan, Italy).

Assessment:

1. Did the students seem to understand bar graphs in general? What about this type of bar graph?
2. Were the students able to complete their bar graphs correctly or was the amount of information too much for them to handle?
3. Could the class pick up on the population trends of your county or counties? What about the different countries?
4. When you compared the graphs of counties to those of countries, could the students see how you were only looking at the shapes, not of the number of people?
5. Use the enclosed quiz to assess students' knowledge of presented material. Quiz answers:
    1. There are more females because they live longer than males.
    2. The other pyramids for the counties in NYS would be pretty much the same as your county. Like the US population, it will vary between slightly increasing and stable.
    3. India's population, much like Mexico's is exploding while the U.S.'s is only slightly increasing.
    4. The most common age group in the US is 35-39 years. In India it is between 0-4 years. In Japan it is between 20-24 years.
    5. The major reason why Japan's pyramid is different is because the country's population is constricted by geology. Most of Japan is very mountainous (uninhabitable) and it's an island, therefore there is not room for a huge population.

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: Listening and Reading

Math, Science, and Technology
Standard 1 - Analysis, Inquiry, and Design: Scientific Inquiry 1
Standard 3 - Mathematics: Operations
Standard 6 - Interconnectedness: Magnitude and Scale; Patterns of Change

Social Studies
Standard 1 - History of the United States and New York 2
Standard 2 - World History 1
Standard 3 - Geography 2

Source: This activity was developed by Aaron Bennett.

Population Pyramids Quiz

Name: ______________________ **Date:** __________ **Teacher:** ___________________

Directions: Answer the questions below using the information you learned in the activity and throughout the lesson. Use your population pyramids to answers these questions.

1. Look at your county's population pyramid. Are there more males or females over the age of 70? What causes this difference?

2. If you were to guess at the population pyramids of the rest of the counties in the Catskills, and in New York State, do you think they would look much different than yours? Why or why not?

3. Explain the difference between the shape of the United State's population pyramid and the shape of India's? What does it mean?

4. Looking at the other country's populations, what is the most common age group of people in the United States? In India? In Japan?

5. Why is Japan's population pyramid different than that of the United States? Hint: think about the geology.

CATSKILL REGION POPULATION BY COUNTY (1990 CENSUS)

AGE Group	DELAWARE CO.		GREENE CO.		OTSEGO CO.		SCHOHARIE CO.		SULLIVAN CO.		ULSTER CO.	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
0 - 4 yrs	1669	1502	1449	1437	1907	1844	1046	988	2648	2401	5772	5653
5 - 9 yrs	1823	1570	1528	1459	2050	1938	1250	1146	2513	2261	5548	5343
10 - 14 yrs	1602	1710	1402	1378	2145	1902	970	1020	2196	2392	5435	4860
15 - 19 yrs	2286	1818	1628	1230	2663	3190	1675	1686	2482	2214	5444	5147
20 - 24 yrs	1531	1364	1955	1245	2860	3330	1263	1120	2169	1903	6122	5909
25 - 29 yrs	1505	1492	1986	1575	1644	1913	1001	1058	2905	2582	7426	6795
30 - 34 yrs	1519	1693	2013	1743	2169	2188	1126	1283	3297	2501	7891	7157
35 - 39 yrs	1580	1652	1808	1656	2084	2369	1194	1225	3022	2578	7260	6848
40 - 44 yrs	1746	1557	1663	1431	2027	1887	1053	984	2946	2377	6195	6140
45 - 49 yrs	1359	1388	1232	1494	1627	1699	856	990	2028	1981	5111	5003
50 - 54 yrs	1063	1198	1073	932	1362	1325	772	742	1686	1553	3923	3942
55 - 59 yrs	1128	1220	996	934	1238	1305	702	739	1400	1481	3443	3865
60 - 64 yrs	1133	1260	1092	1268	1254	1467	752	708	1820	1835	3772	3743
65 - 69 yrs	1174	1225	875	1187	1351	1445	675	749	1610	1683	3107	3694
70 - 74 yrs	939	1139	931	962	919	1270	539	609	1248	1401	2357	3054
75 - 79 yrs	653	904	559	885	754	1104	365	481	796	1007	1581	2699
80 - 84 yrs	348	669	393	606	464	885	186	402	496	903	1055	1856
85 +	223	582	230	504	280	658	138	366	360	602	528	1626
TOTALS	**23,281**	**23,943**	**22,813**	**21,926**	**28,798**	**31,719**	**15,563**	**16,296**	**35,622**	**33,655**	**81,970**	**83,334**

Population (in thousands)

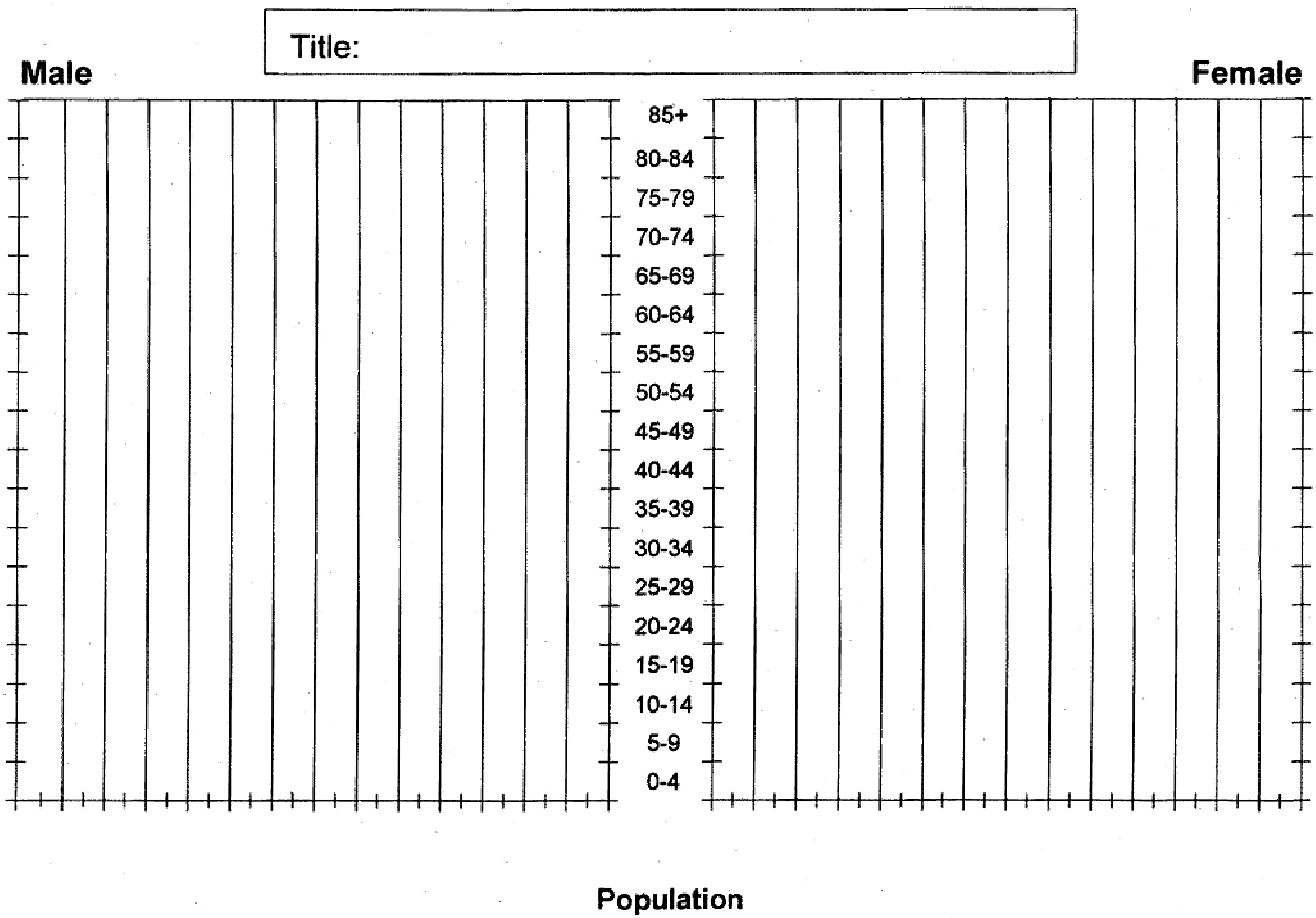
Source: United States Census Bureau.

1999 POPULATION ESTIMATES FOR USE IN BUILDING PYRAMIDS

AGE Group	Japan		India		US	
	Males	Females	Males	Females	Males	Females
0 - 4 yrs	3.2	3.1	61	58	9.6	9.5
5 - 9 yrs	3.1	2.9	58	54	10.3	9.8
10 - 14 yrs	3.4	3.3	56	53	10.1	9.7
15 - 19 yrs	3.9	3.6	52	49	10.1	9.6
20 - 24 yrs	4.5	4.4	50	42	9.0	9.0
25 - 29 yrs	5.1	4.8	43	40	9.0	9.4
30 - 34 yrs	4.5	4.4	38	38	10.0	10.0
35 - 39 yrs	4.0	3.8	33	32	11.3	11.4
40 - 44 yrs	3.9	3.9	30	27	11.	11.3
45 - 49 yrs	4.7	4.8	25	22	9.5	10.0
50 - 54 yrs	4.8	4.9	21	18	8.0	8.5
55 - 59 yrs	4.4	4.5	17	15	6.3	6.8
60 - 64 yrs	3.6	3.9	12	11	5.0	5.7
65 - 69 yrs	3.3	3.6	10	9	4.5	5.5
70 - 74 yrs	2.5	3.2	8	7	4.0	5.0
75 - 79 yrs	1.4	2.5	3	3	3.0	4.5
80 - 84 yrs	0.8	1.7	2	2	1.7	3.0
85 +	0.6	1.6	n/a	n/a	0.5	2.9
TOTALS	**61.7**	**64.9**	**519**	**480**	**132.9**	**141.6**

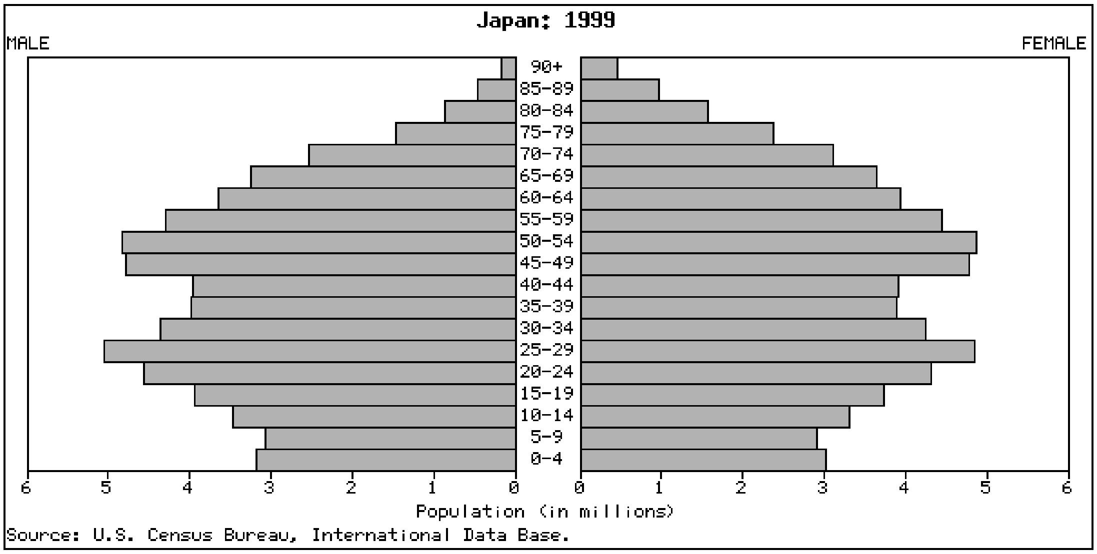
AGE Group	Italy		Mexico		Chile	
	Males	Females	Males	Females	Males	Females
0 - 4 yrs	1.3	1.2	6.1	6.0	0.7	0.65
5 - 9 yrs	1.4	1.4	6.0	5.9	0.75	0.7
10 - 14 yrs	1.4	1.4	5.8	5.7	0.7	0.65
15 - 19 yrs	1.6	1.5	5.4	5.2	0.68	0.64
20 - 24 yrs	1.9	1.8	5.0	5.0	0.6	0.6
25 - 29 yrs	2.3	2.2	4.4	4.6	0.58	0.58
30 - 34 yrs	2.4	2.4	3.5	3.9	0.59	0.6
35 - 39 yrs	2.2	2.2	2.9	3.3	0.59	0.6
40 - 44 yrs	1.9	2.0	2.2	2.8	0.7	0.7
45 - 49 yrs	1.8	1.9	2.0	2.2	0.41	0.43
50 - 54 yrs	1.8	1.9	1.6	1.9	0.35	0.38
55 - 59 yrs	1.6	1.8	1.2	1.6	0.29	0.31
60 - 64 yrs	1.5	1.8	1.0	1.2	0.21	0.25
65 - 69 yrs	1.4	1.7	0.8	1.0	0.18	0.21
70 - 74 yrs	1.1	1.5	0.5	0.7	0.13	0.18
75 - 79 yrs	0.8	1.4	0.3	0.4	0.09	0.11
80 - 84 yrs	0.4	0.7	0.2	0.4	0.06	0.11
85 +	0.4	0.8	n/a	n/a	n/a	n/a
TOTALS	**27.2**	**29.6**	**48.9**	**51.8**	**7.61**	**7.7**

Source: United States Census Bureau

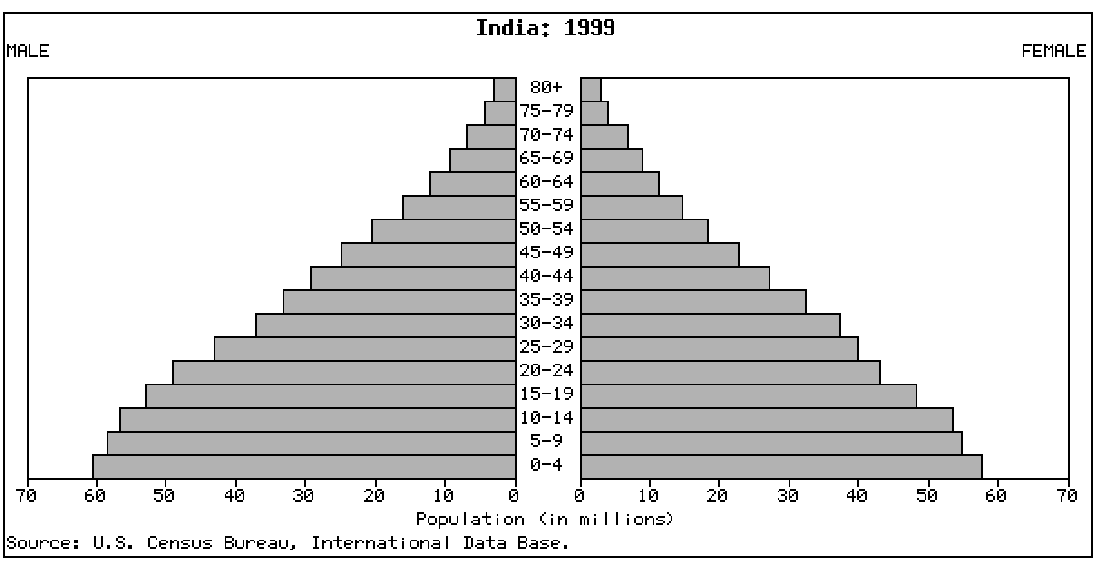

Title:
Male
Female
85+
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
0-4
Population

POPULATION PYRAMIDS BASED ON 1999 ESTIMATES

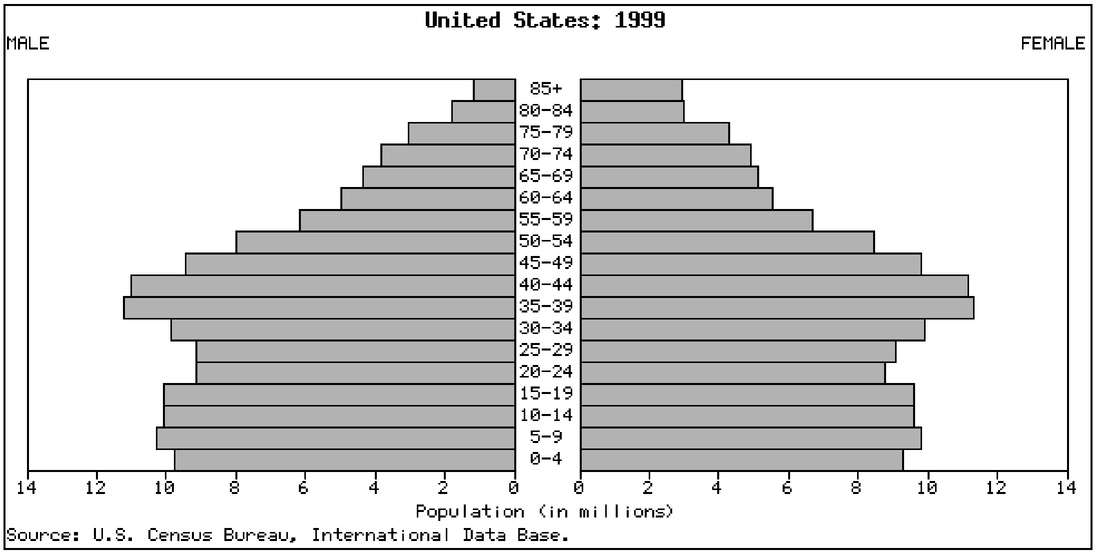
I. Slightly Declining Population



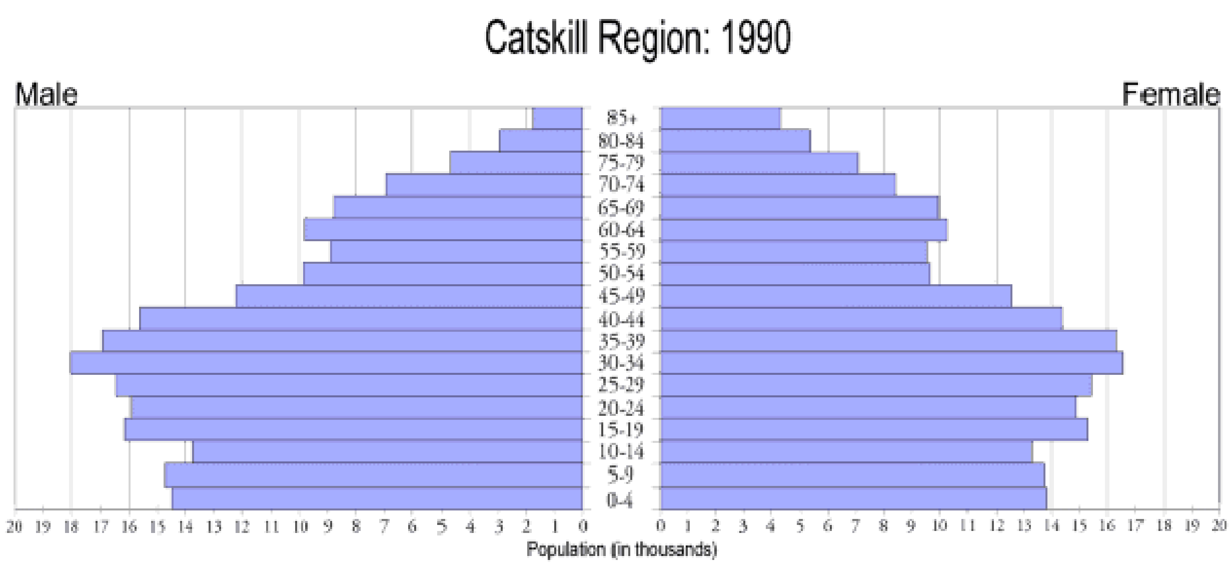
II. Exploding Population



III. Slightly Increasing Population



IV. Population Pyramid for the Catskill Region



Comparing the Catskills to Connecticut

Grades:

4th - 12th

Objective:

This two-tiered activity allows students at different ability levels to compare and contrast the Catskill Mountain region to Connecticut. The two regions are nearly the same size but have very different characteristics; giving students a greater appreciation for the distinctive geography, demography, history, and economics of the Catskills.

Method:

Younger students write creative stories about their experiences while traveling from their house to a friend's house in Connecticut. Students must incorporate facts from a fact sheet that is provided.

Older students research the Catskill Region and Connecticut. They then proceed to complete the requested information on the spreadsheet and write a report about the two areas. Students should interpret the data they find, comparing the two regions (especially geology) and explaining why the regions are so different.

Materials:

Younger Students: Spreadsheet #1 and question sheet (one per student), maps of each region.
Older Students: Spreadsheet #2 (one per student, pair, or group), maps of each region.

Time:

Preparation time: 5 minutes
Class time: variable - dependent upon ability, and the teacher's goals.

Procedure:

Note: This activity will be more beneficial and easier to understand if you perform Activities 3,4, and 5 in this lesson prior to performing this activity.

Younger students:

1. To help the students begin thinking appropriately, ask them if they know how big the Catskill region is (Over 4 million acres or 6,000 sq. miles). How many people do they think live in the Catskill region? (About 420,000) What is an urban area? A rural area? Do most people in the Catskills live in an urban area or a rural area? (Rural - 77%) Can they guess what types of

industries are in the Catskills? Which one is the most dominant? (Retail and goods) Do they know how the land is used in the Catskills? How much is owned by the state? (Over 360,000 acres) Ask if any of the students have been to Connecticut. Ask students to make educated guesses about the above questions, considering what they know about Connecticut. Write the students' responses on the board. The answers to the above questions about Connecticut can be found on the Teacher Spreadsheet (page 8).

2. Hand out the fact sheets and questions (one per student). Instruct students to answer the questions by referring to the spreadsheet. Questions can be done as homework or during class. You may wish to grade them. Discuss the answers with the students after they have been completed and/or graded.

3. Instruct the students (individuals, pairs, or groups) to write a creative story about traveling from their home to visit a friend in Connecticut. They should use the facts on the spreadsheet to help them develop creative ideas about what they might see or encounter on their visit. Encourage students to be creative. They can write journal entries, a newspaper column for the school newspaper, an adventure story, a mystery story, etc. The visit may extend over a day, weekend, a week, etc. Remind students to incorporate the information provided on the fact sheet into their story. The students can be brought to the library to look up other information about the Catskills and Connecticut to include in their writing.

Older students:

Note: Explain to students that when researching the "Catskill Region", they should only look for information from the six county area (Delaware, Greene, Otsego, Schoharie, Sullivan, and Ulster); although some towns in Albany County are considered part of the region, the data collected pertain to whole counties rather than towns.

1. Ask the class if they know how big the Catskill Region is? (Over 4 million acres or 6,000 sq. miles) How many people live in the Catskill region? (About 420,000) What types of industries are in the Catskills? Which one is most dominant (what is the largest source of income)? (Retail and goods) How is the land used in the Catskills? How much is owned by the state and what can or can't be done on state land? (Over 360,000 acres – no further development) Ask students to give the same information based on their knowledge of Connecticut. How would you go about finding the population of both areas? The economic status? Types of land use? What other information might we compare? The answers to the above questions about Connecticut can be found on the Teacher Spreadsheet (page 8).

2. Hand out the blank spreadsheets (one per student, pair, or group depending on how you want the activity to be completed). Students should fill in the blank spreadsheet or use it as a guide for finding information. Students may create their own spreadsheet as long as they are comparing the same topics (population, economy, land, etc.). Encourage the students to research other differences between the Catskill Region and Connecticut (population density, population pyramids, underlying bedrock, geologic points of interest, tourism, climate, specific types of

industry, specific types of crops, etc.). Students can also create graphs or charts to display their information.

3. After a given period of time (based upon their other workload and ability), students should hand in a report along with their spreadsheet(s) and copies of all data used in the spreadsheet.

4. The questions below geared toward an older audience. You may wish to have students answer these questions either in their report, or as a wrap-up discussion to the activity.

    1. What is the difference between an urban area and a rural one?
    2. What is population density?
    3. How does the geology of an area affect the population?
    4. How does the geology of an area determine industry and economic development?
    5. How does the geology of an area determine the types of agricultural products produced?
    6. If crops have a higher market value than livestock per acre, why don't the farms in the Catskills produce more crops instead of raising livestock?
    7. How do forest preserves affect the population and economy of an area?
    8. Can rural areas become urban?
    9. What is the difference between percent earnings and market value?

Suggested resources in addition to library materials:

- Population Information (1990) can be found on the US Census web site: www.census.gov
- Percent Earnings (1990) can be found on the following web site: http://fisher.lib.virginia.edu/ccdb/
- Market Values of Agriculture Products (1997) can be found on the following web site: www.nass.usda.gov
- Interesting facts and statistics for Connecticut (and other states) can be found at: www.50states.com

Extension:

Younger students:
Students may also work in groups or as a class to write a play. They can present it to their parents, classmates, or the school.

Older students:
Students can compare the Catskill Region to other states or countries. They can work together in groups and present the information to the class.

Assessment:

1. Did the students work best in the groups, pairs, or individually (whichever one you chose)? Should you have had them work differently?
2. Since this is a very involved activity, did you allow enough time for each group or student?
3. Were the assumptions they made based on the information they collected or were given

logical?

4. If you had them write a report or poems or stories, did they stay on the subject or did they lose focus of the objective of the activity?

NYS Learning Standards:

English

Standard 1 - Language for Information and Understanding: Listening and Reading; Speaking and Writing

Standard 4 - Language for Social Interaction: Listening and Speaking

Math, Science, and Technology

Standard 3 - Mathematics: Modeling/Multiple Representation; Measurement

Standard 4 - Science: Physical Setting 2; The Living Environment 7

Standard 5 - Technology: Computer Technology

Standard 6 - Interconnectedness: Patterns of Change

Social Studies

Standard 1 - History of the United States and New York 1,2

Standard 3 - Geography 1,2

Standard 4 - Economics 2

Source: This activity developed by Marie Ellenbogen and Aaron Bennett.

STUDENT SPREADSHEET #1

	CATSKILL REGION	CONNECTICUT
Land Area Information		
Area	5890 mi^2	5544 mi^2
Population Information		
Total Population	419,000	3,287,000
Distribution		
Urban	23%	76%
Rural	77%	21%
Economic Information		
Total Earnings of Industry	$3,978,000,000	$59,430,000,000
Farm	2.4%	0.4%
Goods	26.5%	29.8%
Retail	32.9%	6.2%
Finance, Insurance, Real Estate	3.2%	7.5%
Government	15.3%	8.2%
Other Services	19.6%	47.7%
Land Use		
State Owned Parks & Preserves	360,000 acres	over 200,000 acres
NY City Owned Land	34,079 acres	---------------
Land in Farm	677,000 acres	359,000 acres
Average Size of Farms	211 acres	91 acres
Full Time Farms	1831	1824
Market Value of Ag Prod. (1997)	$198,000,000	$422,000,000
Crop Sales	$59,000,000	$266,000,000
Livestock Sales	$139,000,000	$156,000,000

QUESTIONS

Name:__________________________ Date:___________ Teacher:________________________

1. Which has a larger area, the Catskills or Connecticut? How much larger? Show math.

2. Which is more populated, the Catskills or Connecticut? How much more? Show math.

3. Why do think it is more populated?

4. Which area has more of its people in urban areas?

5. List the industries in order, from *greatest* earnings to *least*, for the Catskills and Connecticut.

The Catskills	Connecticut
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.

6. Why is retail the largest industry in the Catskills? (*Hint:* Who else buys products from the Catskills besides the people that live here?)

7. Which area has more acres of farmland? How much more? Show math.

8. Which area makes more money from agricultural (farm) products?

9. In the Catskills, which makes more money, livestock or crops?

10. In Connecticut, which makes more money, livestock or crops?

STUDENT SPREADSHEET #2

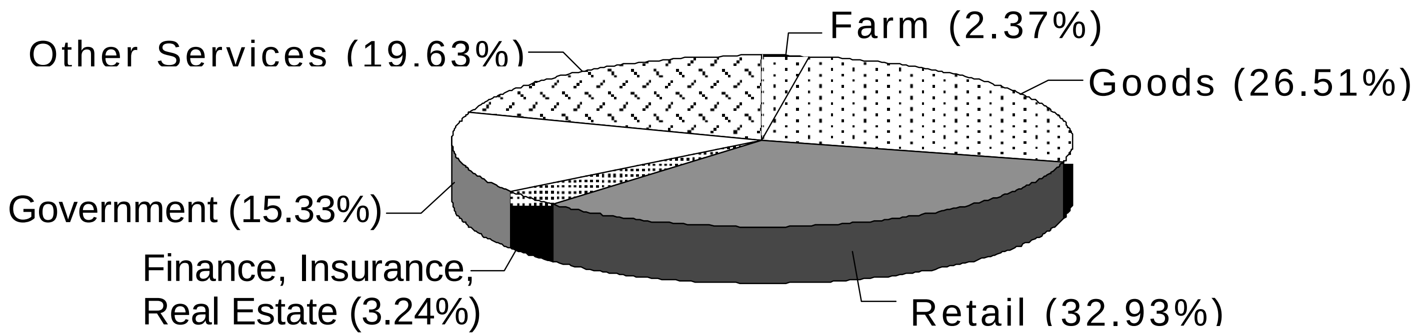
	CATSKILL REGION	CONNECTICUT
Land Area Information		
Area	mi²	mi²
Population Information		
Total Population		
Distribution		
Urban	(%)	(%)
Rural	(%)	(%)
Farm		
Non-Farm		
Density	persons per mi²	persons per mi²
Economic Information		
Per Capita Income	$12,930	$20,189
Total Earnings	$	$
Farm	$ (%)	$ (%)
Goods	$ (%)	$ (%)
Retail	$ (%)	$ (%)
Finance, Insurance, Real Estate	$ (%)	$ (%)
Government	$ (%)	$ (%)
Other Services	$ (%)	$ (%)
Land Use Information		
State Owned Parks & Preserves (Forests)		
NY City Owned Land		
Land in Farm		
Average Size of Farms		
Full Time Farms		
Market Value of Ag Prod.	$	$
Crop Sales	$ (%)	$ (%)
Livestock Sales	$ (%)	$ (%)

TEACHER SPREADSHEET

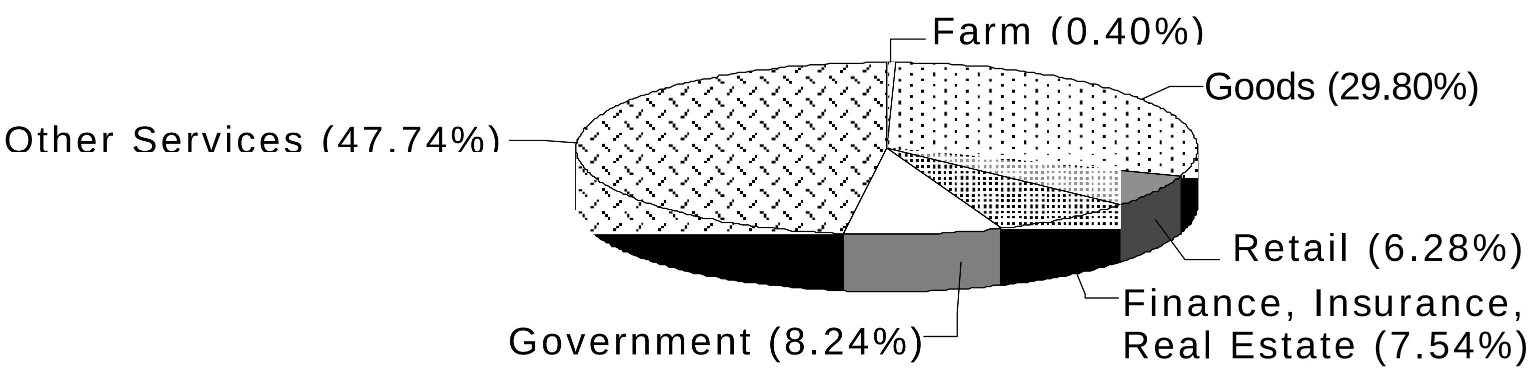
	CATSKILL REGION	CONNECTICUT
Land Area Information		
Area	5890 mi^2	5544 mi^2
Population Information		
Total Population	418,920	3,287,116
Distribution		
Urban	98,130 (23%)	2,601,534 (79%)
Rural	320,790 (77%)	685,582 (21%)
Farm	7673	5250
Non-Farm	313,117	680,332
Density	71 persons per mi^2	592 persons per mi^2
Economic Information		
Per Capita Income	$12,930	$20,189
Total Earnings	$3,978,074,000	$59,431,100,000
Farm	$94,258,000 (2.37%)	$237,724,400 (.40%)
Goods	$1,054,538,000 (26.51%)	$17,710,467,800 (29.8%)
Retail	$1,309,960,000 (32.93%)	$3,733,461,702 (6.28%)
Finance, Insurance, Real Estate	$128,743,000 (3.24%)	$4,480,154,042 (7.54%)
Government	$609,698,000 (15.33%)	$4,894,983,120 (8.24%)
Other Services	$780,877,000 (19.63%)	$28,374,308,936 (47.74%)
Land Use Information		
State Owned Parks & Preserves (Forests)	360,000 acres	over 200,000 acres
NY City Owned Land	34,079 acres	---------------
Land in Farm	677,251 acres	359,313 acres
Average Size of Farms	211 acres	91 acres
Full Time Farms	1831	1824
Market Value of Ag Prod. (1997)	$196,506,000	$421,648,000
Crop Sales	$57,832,480 (29%)	$265,638,240 (63%)
Livestock Sales	$138,673,520 (71%)	$156,009,760 (37%)

PERCENT OF TOTAL EARNINGS

CATSKILL REGION



CONNECTICUT



Source: U.S. Census Bureau (1990 Census).

Into the Mountains

Grades:

3rd - 6th

Objective:

Students will investigate the movement of people and products from one region to another. They will be able to make connections between regions, and about local, state, and national history. Students are introduced to interviewing and other methods of research.

Method:

Students research the history of how their family or ancestors came to the Catskill Mountains. They create a report or give a presentation about their findings.

Materials:

Drawing materials. The extension activity requires magazines or color newspaper inserts that can be cut.

Time:

Preparation time: none
Class time: 1 hour for students to work on projects. 1 to 2 hours for presentations.

Procedure:

1. Ask students if they know how their families came to the Catskills.

2. Tell students to research the history of their family moving to the Catskills. Students may have moved to the Catskills in their own lifetime, but they can still find out more about it. They should ask their parents or grandparents such things as:

- Where was your family before they came to the Catskills?
- What was life like there?
- Why did your parent(s) or ancestors decide to move to the Catskills?
- What form of transportation did you or your family use to get here?
- What did your family bring, and how were those items transported?
- What was life like in the Catskills?
- How was it different from where your family had been?

3. After students have done this research, have them create a written report, picture book, or oral presentation on their family moving to the Catskill Mountains. Presentations to the class will allow other students to learn about the variety of circumstances under which different families came to the area.

4. Discuss with students some of the ways in which each family's experience was different from, or similar to, others. How does the experience of moving to the Catskills vary with place of origin and how long ago the family moved here?

Extension:

Have students draw maps of their family's route moving to the Catskills.

Have students draw or cut out pictures of some items their families use, such as toys, food, wood products, etc. Then have them find out where the items come from (what country or state) by looking at the labels on similar items they have at home or in the classroom. Which items might be made in the Catskills? Of those, do you think some of them are sent to other parts of the country?

Note: See Lesson 3, Activity 1, "Names on the Land" for an activity that deals with the early settlement of the Catskills.

Assessment:

1. Were students able to collect enough useful information from the people they spoke with?
2. Use the reports generated by the students to assess their learning relative to lesson objectives and the learning standards.

NYS Learning Standards:

English
Standard 1 - Language for Information and Understanding: 1,2
Standard 4 - Language for Social Interaction: Listening and Speaking

Social Studies
Standard 1 - History of the United States and New York 1, 2
Standard 3 - Geography 1, 2

Source: This activity was developed by Nathan Chronister.

Note: All words that appear in italics are defined within this glossary.

Acadian Mountains - an ancient mountain range that existed during the Devonian Period. These mountains, which were over 20,000 feet high, eroded away, forming the *Catskill delta* over 360 million years ago.

Bedrock - continuous solid rock either exposed at the surface or overlain by unconsolidated sediments; part of the Earth's crust.

Bed - a *sedimentary* layer with more or less distinct rock-type and upper and lower boundaries.

Blue line - an imaginary line that was devised by the NYS Department of Environmental Conservation in 1904 to delineate the Catskill Park boundary. There is also a blue line for the Adirondack Park.

Catskill delta - a huge *delta* complex of middle and late Devonian *sedimentary rocks* that make up the Allegheny Plateau, of which the Catskills are part.

Cirque - an amphitheater-shaped depression on the side of a mountain caused by glacial erosion. Cirques in the Catskills were formed by small glaciers (generated by the buildup of snow on the mountain itself) either before or after the main ice sheet was present.

Clove - a V-shaped valley between two mountains, characterized by steep sides and a "young" stream. A young stream is a narrow and turbulent stream that is rapidly cutting down into the substrate. Some cloves were carved by glacial meltwater streams that no longer exist.

Conglomerate - coarse-grained *sedimentary rock* with large, rounded pebbles or boulders in a finer-grained cement-like parent material (e.g. calcium carbonate, iron oxide). Typical of the Shawangunk Mountains.

Consolidation - the process by which any loose, soft, or liquid earth materials become hard and coherent. For example, river sediments that are buried under other layers of sediment may become consolidated to form sedimentary rock.

Convergent boundary - the place where collision between two continental plates occurs; *crust* is destroyed, and mountains may be formed from the uplift of Earth's surface.

Crust - the outermost layer of the Earth, consisting of granitic continental crust and basaltic oceanic crust.

Cuesta - a long ridge with a steep face on one side and a long, gentle slope on the other. Formed by the erosion of inclined *strata* of hard *rocks*, or sometimes the result of a *fault*. See also *Escarpment*.

Delta - generally fan-shaped body of sediment formed at the mouth of a stream.

Divergent boundary - the area where plates move apart, openings are generated, and molten material moves in to form new oceanic *lithosphere*. Shallow earthquakes and mild volcanic activity are typical here.

Drumlin - an elongated hill or ridge of glacial *till* generated underneath a glacier, and later sculpted by its passage. Usually oval and shaped like half an egg, with the long axis lying parallel to the direction of the flow of ice. Very common in central New York.

Epicenter - the place on the Earth's surface directly above the *focus* of an earthquake.

Epoch - the division of geologic time shorter than a *period*.

Equator - the imaginary line at 0° *latitude* that lies midway between the North and South Poles. It is also the longest circumference of the Earth.

Era - the division of geologic time that includes several *periods*.

Erratic - boulder transported by a *glacier* that generally differs from the underlying *bedrock*.

Escarpment - a steep cliff or slope at the edge of a raised land area. Formed by the erosion of *strata* of hard *rocks*, or sometimes the result of a *fault*. See also *Cuesta*.

Esker - a long, low, sinuous ridge of sand and gravel dropped by streams that flowed on or through tunnels in a retreating *glacier*.

Fault - a fracture in the bedrock where the two sides have slid past each other.

Focus - the point within the Earth where a *fault* rupture starts and earthquakes begin.

Geography - the science of describing features on the Earth's surface.

Geographic Information Systems (GIS) - a computer program that manipulates and analyzes geographic data to generate customized maps of geographic information.

Geology - the science that studies the physical history of the Earth, the rocks of which it is made up, and the physical changes that it has undergone or is currently undergoing.

Geologic time scale - a time line of the Earth's history made up of named subdivisions whose boundaries are defined by events in the geologic record.

Glacier - a large mass of ice resulting from the compaction and recrystallation of snow. It moves slowly down slope (or outward in all directions) due to its weight, and it survives from year to year.

Global Positioning System (GPS) - a device that receives signals from a system of special satellites orbiting the Earth to determine an exact location within meters or centimeters.

Grains - the particles or crystals that make up a rock or sediment, often composed of a single mineral.

Igneous rock - a type of rock formed by solidification of molten rock (*magma*).

Kame - generally conical hill of sand and gravel deposited against a glacial ice surface that subsequently melted. It is a type of *moraine*.

Kettle lake - a bowl-shaped depression filled with trapped meltwater from a retreating *glacier*, which exhibits no surface drainage.

Latitude - the angular distance of a point on the Earth's surface north or south of the *equator*, as measured from the center of the Earth.

Lava - *magma* that reaches the surface; also the same material solidified by cooling.

Limestone - *sedimentary rock* chiefly composed of the *mineral* calcite. It is not very resistant to chemical weathering, as it dissolves readily in the presence of acid. Often forms cliffs and contains caves. Typical of the Helderberg Mountains.

Lithification - the conversion of sediment into solid *rock* through processes of compaction, cementation, and crystallization.

Lithosphere - a continuous shell of solid rock around the Earth. It includes the *crust* (both continental and oceanic) and part of the upper *mantle*.

Longitude - the angular distance of a point on the Earth's surface east or west of the *prime meridian*.

Magma - molten rock that may or may not reach the surface and forms *igneous rocks* when it cools and crystallizes.

Mantle - concentric, interior zone of the Earth below the *crust* and above the *core*, ranging from depths of about 24 to 2,088 miles.

Map - the representation on a flat surface of all or part of the Earth's surface, to show physical, political, or other features, each point on the diagram corresponding to a geographical position according to a definite *scale* or *projection*.

Metamorphic rock - rocks formed from *igneous* or *sedimentary rocks* by *metamorphism*.

Metamorphism - changes in composition, texture, or internal structure imposed on a *rock* by elevated pressure and temperature without melting.

Minerals - naturally occurring substances that have specific physical and chemical properties.

Moraine - a pile of coarse sediment (cobbles, gravel) deposited by a *glacier* often at its front end as a result of melting.

Orogeny - a long-term mountain-building event typically accompanied by intense deformation, *metamorphism,* and *igneous* activity, and caused by *convergence* of tectonic plates.

Outcrop - the portion of a distinct *rock* layer which projects above the Earth's surface, and is consequently exposed to view.

Pangaea - the super-continent in the Northern Hemisphere that broke apart some 200 million years ago, producing the present continents.

Per capita - per person.

Period - the division of geologic time that includes several *epochs* and is a subdivision of an *era*.

Plateau - an extensive, mainly level piece of elevated land. It may be intersected by streams and mountain ranges, and can be exceptionally high (the Tibetan plateau is 15,000-16,000' high) or it can be low (the Allegheny Plateau).

Prime meridian - an imaginary line at 0° *longitude* that passes through Greenwich, England and the north and south poles. It crosses the *equator* at right angles.

Projection - a method of illustrating the natural curved surface of the Earth on a flat surface *map*, so that each point of the map corresponds to one point on the Earth's natural surface.

Radioactivity - the property, shown by some elements, of changing into other elements by the release of charged particles from their nuclei.

Ring of Fire - a series of *subduction zones* around the perimeter of the Pacific Ocean where the Pacific plate collides with the Eurasian and Philippine plates, resulting in a highly active area with great potential for earthquakes and volcanoes.

Rock - a solid material made up of many smaller parts called *grains,* which consist of various *minerals*, glass, or solidified organic matter (e.g. coal). Classified as *igneous*, *metamorphic*, or *sedimentary*.

Rock cycle - the sequence of events involving the formation, alteration, destruction, and reformation of *rocks* as a result of processes such as erosion, transportation, *lithification*, *metamorphism*, and melting.

Sandstone - *sedimentary rock* composed of consolidated sand. It is often characterized by a reddish-brown color due to iron oxide staining. In the Catskills it is often gray.

Scale - the relationship between distance on a *map* and distance on the Earth's surface.

Sedimentary rock - *rock* formed by the consolidation of sediments.

Shale - *sedimentary rock* mainly composed of clay or very fine material. Often very thin-*bedded* and erodes easily. It is the most common rock in New York State.

Strata - layers of *rock*. Singular is "stratum".

Striations - the most common imprint left by a *glacier* on *bedrock*. A striation is a long, straight, and very narrow gouge carved by a cobble or boulder that was pulled across the bedrock by an advancing glacier.

Subduction zone - an area at a *convergent boundary* where one plate is driven beneath another plate. The *Ring of Fire* in the Pacific Ocean is an example. These are often the most active zones for earthquakes and volcanoes.

Terminal moraine - piles of coarse sediment (cobbles, gravel) that were deposited by the front end of a *glacier* at its climax.

Till - unsorted, unstratified glacial drift deposited directly from the ice without subsequent reworking by streams, usually containing material of a wide range of sizes.

Transform boundary - a place where plates slip by one another at *faults*; no *crust* is created or destroyed. The San Andreas *fault* is a transform boundary.

Valley glacier - a relatively small glacier, isolated from the main continental ice sheet and typically confined to the upper reaches of a valley.

Wisconsin glaciation - the last major glaciation of the Ice Age (Pleistocene Epoch).

Woodfordian advance - the climax stage of the *Wisconsin glaciation*, occurring about 21,750 years ago. This event is responsible for the formation of Long Island and Cape Cod, which are *terminal moraines*.

Books and Articles:

Books:

An Introduction to Invertebrate Fossils of New York. Educational Leaflet #19. The University of New York, the State Education Department. 1966. State Museum and Science Service, Albany, New York 12224.

This leaflet provides a great key to invertebrate fossils, the Geologic Time Scale, and in-depth descriptions of each fossil.

Catskill Forest Preserve Public Access Plan, August 1999. The New York State Department of Environmental Conservation in cooperation with The New York State Department of Transportation. 1999. The New York State Department of Environmental Conservation, 50 Wolf Road, Albany, NY 12233.

The Catskills. Longstreth, T. Morris. 1918. Reissued in 1970 by Kennikat Press, Port Washington, NY.

The Catskills - A Geological Guide. Titus, 1993 - 2nd Edition. Robert. Purple Mountain Press, Fleischmanns, NY. 123pp. 6”x9” $15.00. (845) 254-4062.

Geology is America's favorite science. As children, we commonly develop a keen interest in this science of dinosaurs and volcanoes, glaciers and earthquakes, and given a chance we never give up that fascination. Robert Titus has a guide with over 80 illustrations that will take you through the Catskills and help you learn the great geological history hidden in the region's rocks and landscapes. Here is a story of glaciers, continental collisions, lost mountain ranges, meteors from space, primitive fossil creatures from ancient sea floors, and much more.

The Catskills - An Illustrated Guide with Gazetteer. Adams, Arthur G. 1990. Fordham University Press, New York, NY.

This extensive book combines an abundance of information with a wealth of illustrations. The book's four parts include a discussion on defining the Catskill Mountains, the history of the region, Catskill legends, and an extensive gazetteer.

The Catskills - From Wilderness to Woodstock. Evers, Alf. 1972. Doubleday & Company, Inc., Garden City, NY.

The most extensive book (over 800 pages) about the Catskill Mountain region beginning with the first settlers through the Woodstock Festival, written by the legendary Catskills native and historian, Alf Evers.

The Catskills in the Ice Age. Titus, Robert. 1996. Purple Mountain Press, Fleischmanns, NY. 123pp. 6”x9” $15.00. (845) 254-4062.

To someone who knows how to read the landscape, the Catskills generate fabulous images of ice, glacial lakes and fossil rivers - the Catskill Mountains, as we know them today are the legacy of these massive forces. Virtually all Catskill Mountain villages are built where they are because glaciers made some of the land habitable; our best agricultural lands are the floors of glacial lakes; much of our recreational hiking and climbing leads to scenery carved by the passing ice. The glaciers that covered these mountains did not in themselves produce art, literature, or environmental ethics, but they created a setting that inspired all three.

Environmental Education Activity Guide: Pre K - 8. Project Learning Tree. 1993. American Forest Foundation, 1111 19th Street, NW, Washington, DC 20036.

> The complete 400-page Activity Guide and High School Modules can be obtained by attending a PLT workshop. For more information call the National Project Learning Tree office at (202) 463-2462.

Environmental Education Program: Curriculum in Science Field Studies Grades K-6. 1997. Mohonk Preserve, Inc. PO Box 715, New Paltz, NY 12561. 268 pp. 8.5”x11” $31.00 three-ring notebook. (845) 255-0919.

> This is a curriculum in Science Field Studies specifically for grades K-6 that is designed to be used with field trips throughout the Mohonk Preserve. Topics include: Discovering Animal Life, Exploring Life in a Stream, Water and Waterways, Life in the Forest, Native Americans, Geology and Earth History, and Water and Soil.

Everybody Needs A Rock. Baylor, Byrd and Parnell, Peter (Illustrator). 1974. Atheneum Books for Young Readers, 1230 Avenue of the Americas, New York, NY 10020. 32pps.

> This fabulous kids book is the basis for the “Adopt-A-Rock” activity in this module. The Catskill Center has a copy of the book that can be borrowed for use in the activity.

Fossils, Rocks, and Time. Edwards, Lucy E. and Pojeta, Jr., John. 1993. U.S. Department of the Interior / US Geological Survey, Denver, CO.

Geography for Life National Geography Standards 1994. Geography Education Standards Project. 1994. National Geographic Research and Exploration, 1145 17th Street, Washington, DC 20036-4688.

Geography of New York State. Johnson, John H. Syracuse University Press, 1966. Syracuse, NY

Geology and the Environment. Pipkin, Bernard W. West Publishing Company, 1994. 610 Opperman Drive, PO Box 64526, St. Paul, MN 55164.

Geology of New York, A Simplified Account. Second Edition - Leaflet # 28. The New York State Museum / Geological Survey. The State Education Department. The University of the State of New York. 2000. Albany, New York 12230.

> This is an excellent, thorough educational book on the geology of New York. The book comes with the “New -sided map measures 56”x22” and includes geologic cross-sections, a satellite image, geologic points of interest, field trip sites, and tectonic information of New York State.

The Gilboa Fossils. Van Aller, Linda.

Glacial Geology of the Catskills. Rich, J. L. 1935. Glacial Geology of New York #299. The New York State Museum, Albany, NY.

Minnewaska Spring Geology Program. Minnewaska State Park Preserve. PO Box 893, New Paltz, NY 12561. (845) 255-0752.

New York State Forest Preserve Centennial Fact Book. Van Valkenburgh. 1985. The New York State Department of Environmental Conservation. 50 Wolf Road, Albany, NY 12233.

Project WET: Curriculum & Activity Guide. The Council for Environmental Education. 1995. Bozeman, Montana. (406) 994-5392.

An excellent guide on teaching strategies, curriculum, and activities for all grade levels on Earth sciences. The book is only available via Project WET workshops.

Roadside Geology of New York. Van Diver, Bradford B. Mountain Press Publishing Co., 1985. Missoula, Montana. 411 pp. $15.00. (406) 728-1900.

Road by road, the author carefully points out in layman's terms the complex bedrock geology and glacial sculpture that combine to create the many landscapes of New York. Anyone interested in geology, general natural history, geography, or history of New York will find this book an indispensable and enjoyable reference at the most fundamental level.

Periodicals:

The Conservationist. January-February 1981. The New York State Department of Environmental Conservation. 50 Wolf Road, Albany, NY 12233.

The Conservationist. Special Issue: Celebrating 100 Years of the Forest Preserve. May-June 1985. The New York State Department of Environmental Conservation. 50 Wolf Road, Albany, NY 12233.

Exploring Time at North Lake. Titus, Robert. *Kaatskill Life,* Summer 1993, vol. 8, # 2. Delaware County Times, Inc., Delhi, NY 13753.

Glaciers of East Kill. Titus, Robert. *Kaatskill Life*, Winter 1994-1995, vol. 9, # 4. Delaware County Times, Inc., Delhi, NY 13753.

The Great Lake of the Catskills. Titus, Robert. *Kaatskill Life*, Winter 1995-1996, vol.10, # 4. Delaware County Times, Inc., Delhi, NY 13753.

An Island in a Sea of Ice. Titus, Robert. *Kaatskill Life*, Fall 1995, vol. 10, # 3. Delaware County Times, Inc., Delhi, NY 13753.

On the Rocks: The cirques in town! Titus, Robert. *The Woodstock Times*, June 10, 1999. Woodstock, NY 12498.

On the Rocks: A lot to Overlook. Titus, Robert. *The Woodstock Times*, February 13, 1997. Woodstock, NY 12498.

On the Rocks: Time elevator: Going doooooooowwwwwnnnnn!!! Titus, Robert. *The Woodstock Times*, April 17, 1997. Woodstock, NY 12498.

The Panther Mountain Asteroid Impact. Titus, Robert. *Kaatskill Life*, Winter 1992-1993, vol. 7, # 4. Delaware County Times, Inc., Delhi, NY 13753.

The Panther Mountain Meteor. Guterl, Fred. *Discover*, August 2000. Buena Vista Magazines, a subsidiary of Disney Publishing Worldwide.

What's Buried Under Panther Mountain? Chronister, Nathan. *Catskill Center News*, Fall 1998, vol. 27, # 4. The Catskill Center for Conservation and Development, Inc., Arkville, NY 12406.

Teaching Materials:

Posters:

New York State Geological Highway Map - Educational Leaflet #33. 1990. The University of the State of New York, State Education Department, NYS Geological Survey. New York State Museum, Cultural Education Center, Albany, NY 12230. (518) 449-1404 or www.nysm.nysed.gov/publications.html

Maps:

The Catskill Center
Route 28
Arkville, NY 12406
(845) 586-2611 or educat@catskill.net

The Center has a broad collection of USGS topographic maps that can be borrowed. We also sell the Catskill Region map enclosed with this module if additional copies are needed. Folded and rolled maps are available.

Web Sites:

ArcData Online www.esri.com/data/online/
ArcData Online is an Internet mapping and data site. The ArcData Online site contains a wide assortment of geographic information that users can access to create map images and download data.

A Back-Road Tour Through the Devonian www.stepahead.net/~schneller/devotour.htm
A Geologic Field Guide of the Eastern Catskills. This geology site includes images and descriptions as if you were on a field trip. Rick Schneller, a teacher in the Onteora Central School District, maintains the site.

Becoming a Rock Detective www.rockdetective.org
Explore our planet with mysteries about rocks, fossils, and minerals. This award winning program Exceeds National Science Education Content Standards. Includes teacher and student-friendly instructions. Its great for both science- and non-science oriented teachers, and custom designed for you by their non-profit organization of earth scientists and teachers.

The Catskills everest.hunter.cuny.edu/bight/catskill.html
The CUNY, Earth & Environmental Science, PhD Program, Department of Geography at Hunter College, and the Brooklyn College, Department of Geology, maintain this geology site. Links include: The Highlands Region of New Jersey, New York, and Connecticut, Catskill Plateau Region of New York and eastern Pennsylvania, Valley and Ridge Region of western New Jersey and Pennsylvania, and the Newark Basin and Connecticut River Basin.

The Catskill Watershed Corporation www.cwconline.org
This site contains a great deal of information relating to the NYC Watershed, including photos, watershed maps that can be downloaded, and a summary of the historic Memorandum of Agreement.

Council on Geographic Education www.ncge.org
The National Council for Geographic Education works to enhance the status and quality of geography teaching and learning. They promote the importance and value of geographic education, enhance the preparation of geographic educators with respect to their knowledge of content, techniques, and learning processes, encourage and support research on geographic education, and develops, publishes, and promotes the use of curriculum, resource, and learning materials.

EPA Maps on Demand www.epa.gov/enviro/html/mod/
Generate maps that display environmental info for the entire US.

Geospacial and Statistical Data Center http://fisher.lib.virginia.edu/ccdb/
County and City Data Books. This resource provides WWW access to the electronic versions of the 1988 and 1994 County and City Data Books. This service provides the opportunity to create custom printouts and/or customized data subsets.

The Gilboa Forest www.hartwick.edu/geology/work/VFT-so-far/gilboa_forest/gilboa.html
This web page is an article that appeared in a 1993 edition of *Kaatskill Life* magazine on the ancient Gilboa forest, written by the Catskill Geologist and Hartwick College professor, Bob Titus.

Graphic Map's World Atlas www.graphicmaps.com/aatlas/world.htm
This interesting site includes many useful tools including atlases & guides, the book of the week, country flags, the current time anywhere, answers to geography and map questions, geography quizzes, map clip art, map tests for parents and teachers, and world maps.

Interactive Mapping Gateway - Statewide Digital Orthophotography
www.nysgis.state.ny.us/gateway/index.html
This site allows you to retrieve satellite photos of local places.

Microsoft TerraServer http://terraserver.microsoft.com/
This site allows you to retrieve satellite photos of local places.

National Air and Space Museum www.nasm.edu/ceps/GAW
This is the Geography from Space home page where you can take online quizzes about planet Earth using satellite and space shuttle photographs.

National Geographic (Education) magma.nationalgeographic.com/education/index.cfm
A huge site that has an abundance of information for teachers: lesson plans, maps, activities, general information, and a listing of geography guides and books for sale. You will find something useful if you visit the site. The National Geographic homepage is at www.nationalgeographic.com.

National Mapping Information http://mapping.usgs.gov/

The National Snow and Ice Data Center www.nsidc.colorado.edu/glaciers/index.html
All you'll ever want and need to know about glaciers.

Newton's Apple ericir.syr.edu/Projects/Newton/alpha.html
This site is based on the PBS television show for kids and has over a hundred activities alphabetized by content. A complete collection of teacher's guides from season 9 through 15 is available by calling 1-800-588-NEWT.

New York City Department of Environmental Protection www.ci.nyc.ny.us/dep
Web site contains educational activities for kids, interesting info about the water supply system.

NYS GIS Clearinghouse www.nysgis.state.ny.us/

Panther Mountain Meteor Impact Site www.catskill.net/evolution/panther
Contains satellite images and a diagrammatic explanation of the origin of the Panther Mountain circular feature. There is also a physics activity for students.

Panther Mountain Project www.rpi.edu/~roecks/AppGeo/catskills/panther_home.html
This site displays the data that were collected during the recent (Spring 2000) scientific testing done by Lamont-Doherty Earth Observatory beneath the surface of Panther Mt. Also included here are names and contact numbers/emails of project partners in addition to limited background information.

Photofinder http://edcwww.cr.usgs.gov/Webglis/glisbin/finder_main.pl?dataset_name=NAPP
A quick and easy way to find and order USGS National Aerial Photography Program (NAPP) Photos.

SUNY New Paltz Geography Department www.newpaltz.edu/geography/links.html
You will find extensive links to information and activities for your classroom from this site. If you are looking for anything related to geography, you will most likely find it from here.

TIGER Mapping Service http://tiger.census.gov/
The "Coast to Coast" Digital Map Database. Welcome to the home page for the TIGER Map Service, a project sponsored by the U.S. Bureau of the Census. The goal of this service is to provide a public resource for generating high-quality, detailed maps of anywhere in the United States, using public geographic data.

TopoZone www.topozone.com
This site allows you to print out customized topographic maps of your area. In addition, you can type in any place name in the United States, and it will give you its elevation, the USGS quad name, its latitude and longitude, and show you the topographic map!

The United States Census Bureau www.census.gov
From here you have access to all kinds of people, business, and geography data for the US, other countries, each state, each county, and even cities and townships. A very useful site.

The United States Geological Survey www.usgs.gov/education/learnweb/activityIndex.html
The USGS "Learning Web" lists many Earth science activities that are categorized by subject. A great place to find new activities.

USGS Geographic Data Download http://edcwww.cr.usgs.gov/doc/edchome/ndcdb/ndcdb.html

Resource People:

Nathan Chronister, Director of Education, The Catskill Center for Conservation and Development, Route 28, Arkville, NY 12406. (845) 586-2611. educat@catskill.net Coordinates "The Catskills: A Sense of Place" program. Catskill Center educators are available for classroom visits and field trips.

Reba Laks, Director of Education, Mohonk Preserve, PO Box 715, New Paltz, NY 12561. (845) 255-0919. mpedu@idsi.net The Preserve offers environmental education workshops for teachers and over 50 guided hikes each year. In addition, they accommodate 5,000 K-6 students visitors annually.

Hatti Langsford, Park Interpreter, Minnewaska State Park Preserve, PO Box 893, New Paltz, NY 12561. (845) 255-2011 or 255-0752. minne@netstep.net Contact Hatti to arrange field trips to the park, or to get on her mailing list for upcoming teacher workshops that relate to Shawangunk Mountain and Hudson River Valley geology and ecology.

Jo Margaret Mano, Geography Professor, SUNY New Paltz, 47 Chestnut Street, New Paltz, NY 12561. (845) 257-3599. manoj@npvm.newpaltz.edu

Bob Matson, Geology Professor, Ulster County Community College, Earth and Space Sciences Department, Stone Ridge, NY 12484. (845) 687-5228.

Chris Olney, Director of Conservation, The Catskill Center for Conservation and Development, Arkville, NY 12406. (845) 586-2611. chriso@catskill.net Chris Olney has a Masters Degree in Geography from the University of Buffalo and he does GIS work (computer mapping) for the Catskill Center. He is able to generate specific, detailed display maps for a reasonable cost.

Richard Pariso, Environmental Educator, Department of Environmental Conservation, PO Box 313, Highmount, NY 12411. (845) 254-5600, ext 225. rparisio@hotmail.com Parisio is the DEC educator for the Catskill Park. His programs for children include natural history, environmental poetry writing, and more.

Robert Titus, Geology Professor, Hartwick College, Onteonta, NY 13820. (607) 431-4733. titusr@hartwick.edu Like many paleontologists, Titus began hunting for fossils as a young child. His childhood fascination with fossils and rocks led eventually to his career as a geologist. He has been sharing his enthusiasm for the geological history of the Catskills for the past 20 years. He writes for readers of *The Woodstock Times* and *Kaatskill Life* magazine.

Places To Visit:

Catskill Mountain House Site - A magnificent view of the eastern escarpment of the Catskill Mountains from 2100 feet above the Hudson River. The steep drop points to the significant gouging during the last ice age. Located at DEC's North Lake State Park. Take 23A to reach Haines Falls (just outside of Tannersville). Turn onto North Lake road from the hamlet of Haines Falls and travel three miles east to the public campsite. Look for signs for short hike to viewpoint.

Folded and Faulted Helderberg Limestones - These very large road cuts are on NY 23A a short distance west of the Interstate 87 intersection. They are important because they illustrate Acadian deformations of the early Devonian Helderberg limestone's that underlie the Catskill Delta sediments. Exposed here on both sides of the highway is a beautiful anticline (up fold).

Gilboa Fossil Trees - Take a trip back in time 400 million years and visit an ancient forest preserved in Devonian sandstone. Fossilized Gilboa tree stumps are on display about one-half mile from the overlook at the Gilboa Dam, which is along Route 990V in Gilboa. The stumps were unearthed during construction of the nearby dam.

Ice Caves Mountain – Located near of Ellenville (Ulster County). Ice Caves Mountain is now part of Sam's Point Dwarf Pine Ridge Preserve. This unique National Landmark has caves that keep ice year-round. Located off of Route 52, turn onto Cragsmoor Road, and then onto to Sam’s Point Road, proceeding 1.5 miles to the entrance. Call (845) 647-7989 for more information.

Indian Ladder Trail - Indian Ladder Trail on the face of the Helderberg scarp at John Boyd Thatcher State Park, located on Interstate 90 between exit 25 and 26. There are large cuts of Ordovician shales along the road.

Kaaterskill Clove - The Rip van Winkle Trail - Clove is the name used for most of the deep, post-glacial ravines of the Catskills. Kaaterskill Clove is the largest of two accessible cloves in the Catskill Mural Front (the eastern edge of the Catskill mountains), the other being Plattekill Clove, about 4 miles to the south. In the five miles from Palenville to Haines Falls, NY 23A, the Rip Van Winkle Trail ascends 1400 feet in a nearly straight line from the base of the clove to the top. Near the very steep roadbed there are many excellent bedrock exposures, mostly along the streambed. The lower half of the clove cuts through rock of the Hamilton group of red shales from the late Devonian Period. The upper half is in the Oneonta Formation (also of the late Devonian Period) and contains more and thicker resistant sandstones and beds separated by weathering red shales.

Kaaterskill Falls - A short but rugged trail from the Kaaterskill Clove road takes you to the falls. The trail begins at the only hairpin turn in the road. There is a parking lot nearby. The falls cascade over two sandstone steps very near the Hamilton-Oneonta contact. The supporting shale under each ledge has weathered back, leaving the sandstone overhanging. The upper falls drop 180 feet and the lower ones 80 feet so the combined drop of 260 feet is the highest of any cascade in New York. One can reach the top of the falls from the North Lake road, but the view and geology from there is less impressive.

Mohonk Preserve - Part of the northern Shawangunk Mountains (pronounced Shon-gum) in Ulster County, New York. This 38-square mile natural area is comprised of almost 25,000 acres of semi-wilderness land used by hikers, bird watchers, climbers, cross-country skiers, bicyclists, and other outdoor enthusiasts. Many geologic points of interest are located throughout the preserve. Day use fees apply. Call (845) 255-0919, write to mohonkpr@idsi.net or visit www.mohonkpreserve.org for more information.

Minnewaska State Park and Preserve – Located on the southern ridge of Shawangunk Mountains, this park offers many teacher workshops, trainings, and educational field trips for groups. The two lakes in the sky, Awosting and Minnewaska cap this unique geological formation. Call (845) 255-2011 or 255-0752 or write to minne@netstep.net for more information.

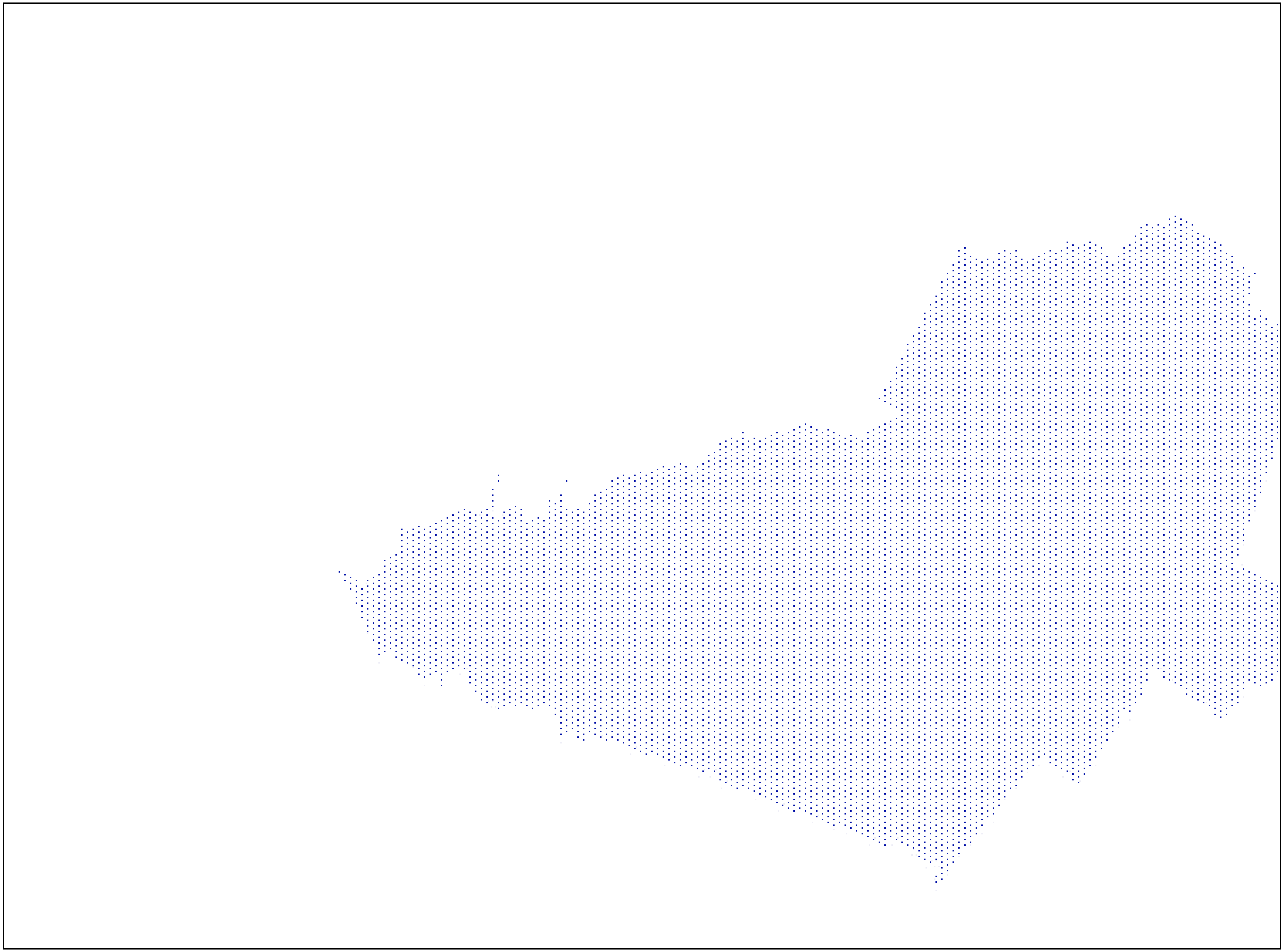
Overlook Mountain - The 2.5-mile hike up from the trailhead on Meads Mt. Road, north of Woodstock, is a gradual but very interesting one. Many glacial marks are visible, as are various rock layers. In addition, the remnants of the Overlook Mountain House provide a great rest stop on the way up. The fire tower has also recently been reopened to the public. Many rocky outcrops blanket the sides of Overlook Mountain. Overlook is the south end of the Wall of Manitou.

Plattekill Clove - Plattekill Clove is even more awesome than Kaaterskill, dropping the same vertical distance in just three miles instead of five. The same formations are exposed as in Kaaterskill Clove. The Platte Clove Road (Greene County Route 16) is very steep between the hamlets of West Saugerties and Platte Clove. The Center owns a 208-acre preserve atop the clove where you can find a great deal of geology to talk about or study.

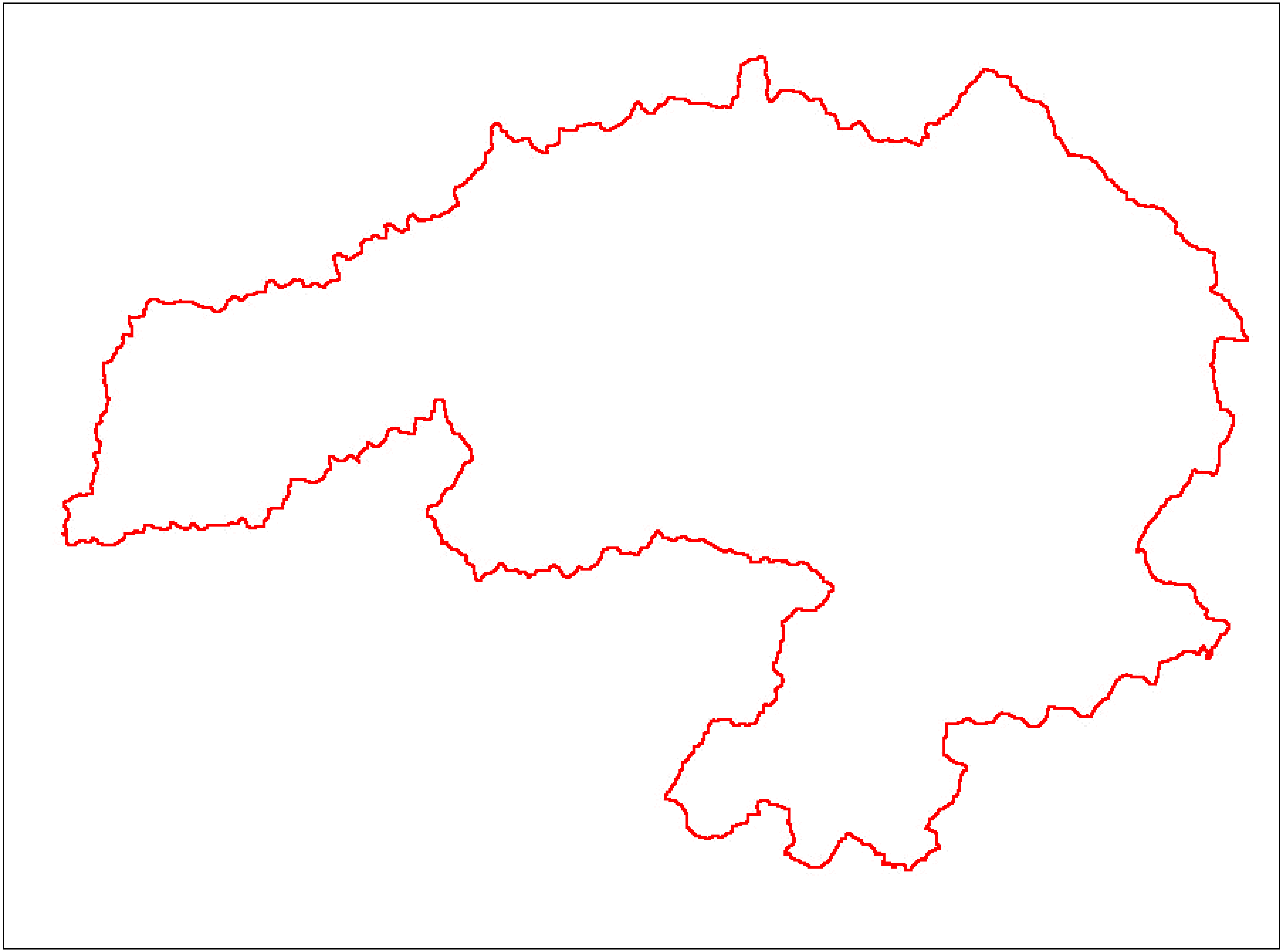
Saugerties Fossils - Take NYS Thruway (I-87) to exit 20 at Saugerties. Make a left at the light (McDonald’s). Cross over the Thruway and make the first right. Follow Route 32 for approximately 3.1 miles to the fossil dig (on the right). It is a shale road cut loaded with brachiopods and also containing a few crinoids and ammonites. Beware of the poison ivy!

Saugerties Road Cuts - West of Saugerties, at the intersection of Route 212 and 32, drive north on Route 32, noticing the light gray Onondaga limestone of the Devonian age. Continue on Route 32; there are sandstones of the Mt. Marion formation that are the sandy runoff from the ancient Acadian Mountains of Devonian times. As you continue west on Route 32 towards Palenville, the sedimentary accumulations each were once the floor of a shallow sea or the surface of the delta landscape.

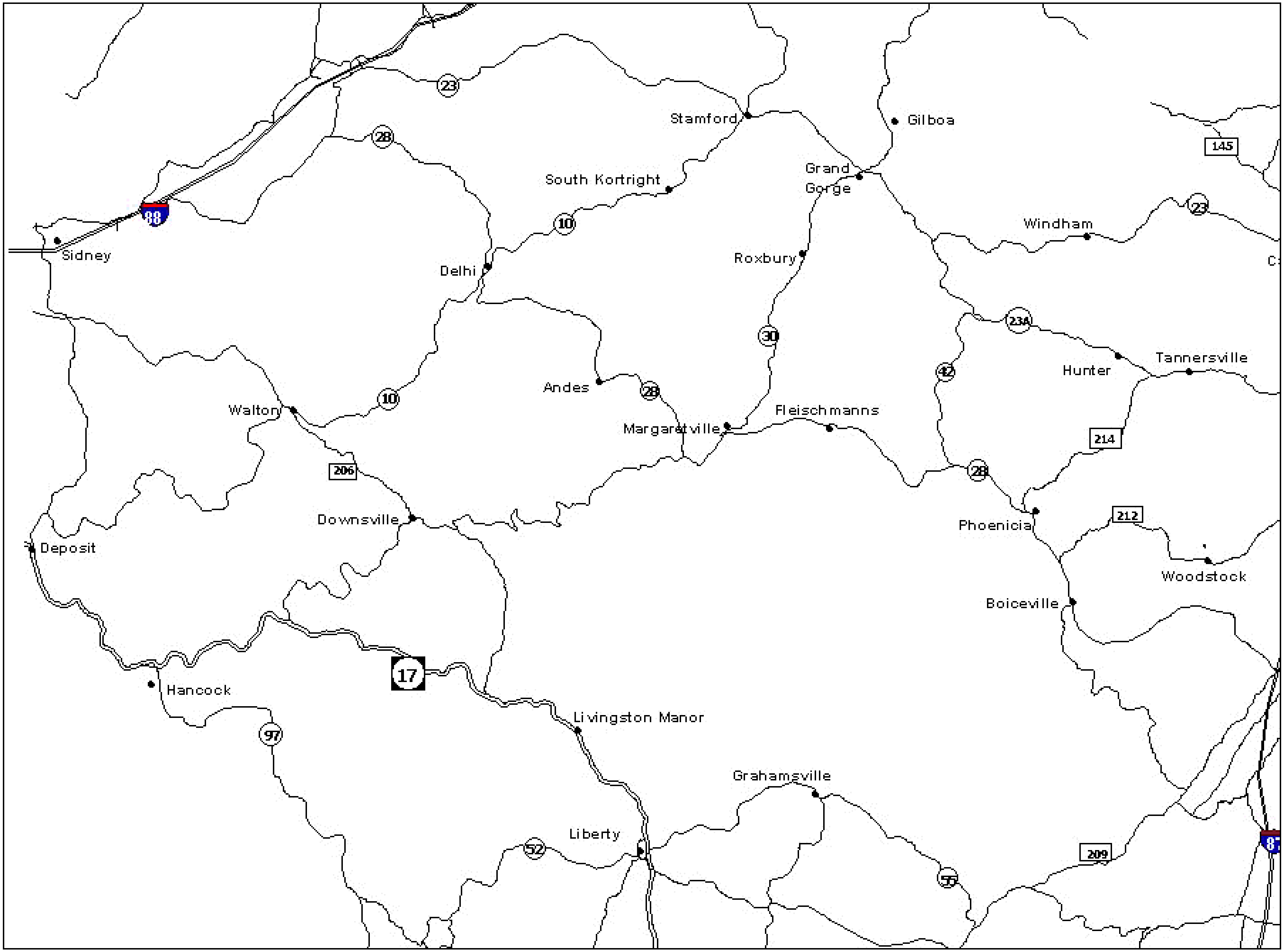
Vroman’s Nose - A very unique geological area where the bedrock juts up 600' above the ground, exposed in the shape of a nose. Hiking trails lead to the top where excellent views and evidence of glaciers are abundant. Located just south of the village of Middleburgh on Route 30 in Schoharie County. Going North, turn left after you pass Vroman’s nose and continue to the trailhead.



Catskill Park



NYC Watershed



Stamford
Gilboa
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South Kortright
Grand
Gorge
88
10
Windham
23
Sidney
Delhi
Roxbury
23A
30
Tannersville
42
Hunter
Andes
28
10
Walton
Fleischmanns
Margaretville
214
206
28
Phoenicia
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Deposit
Boiceville
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Hancock
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Grahamsville
Liberty
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209
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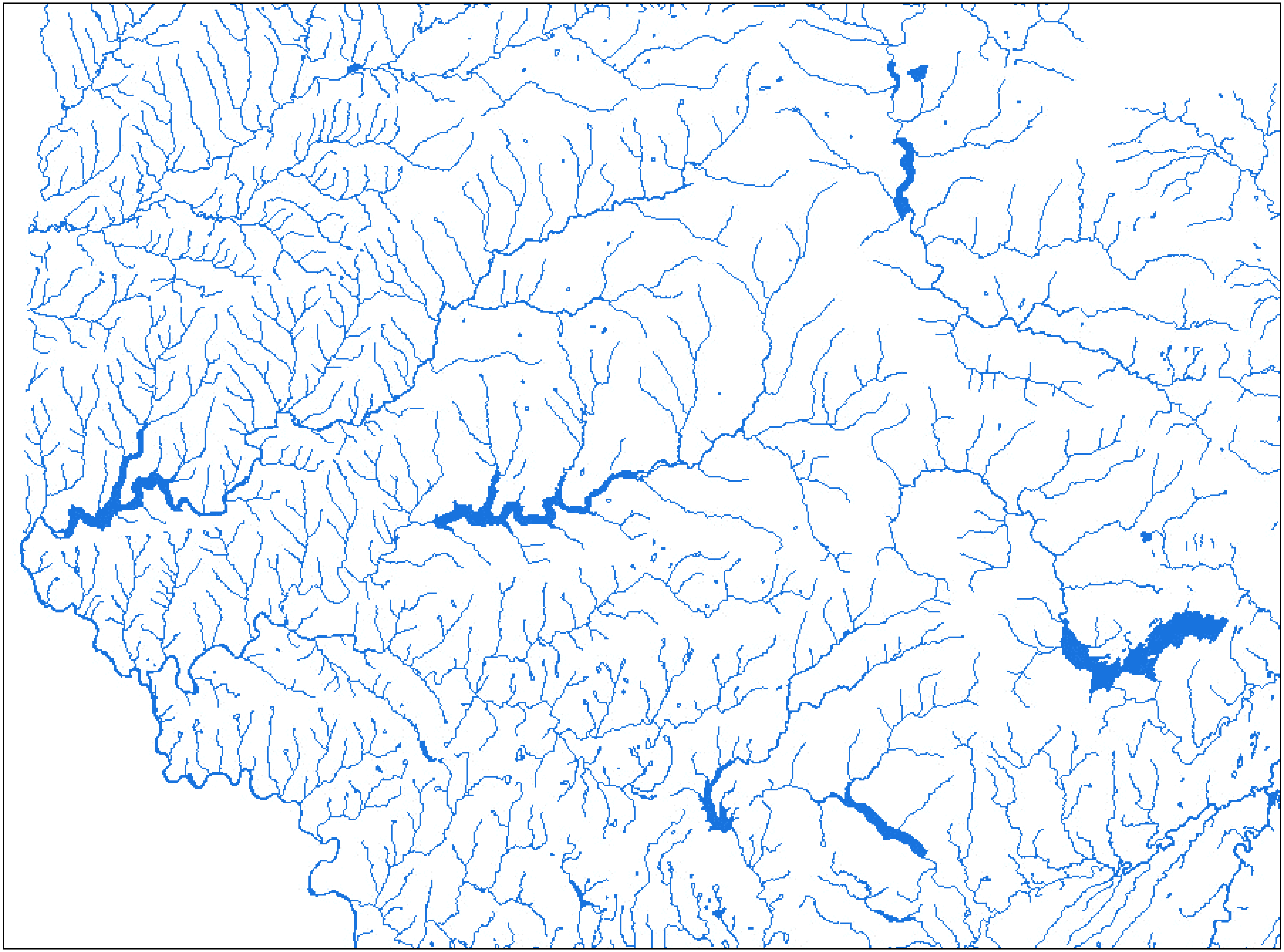
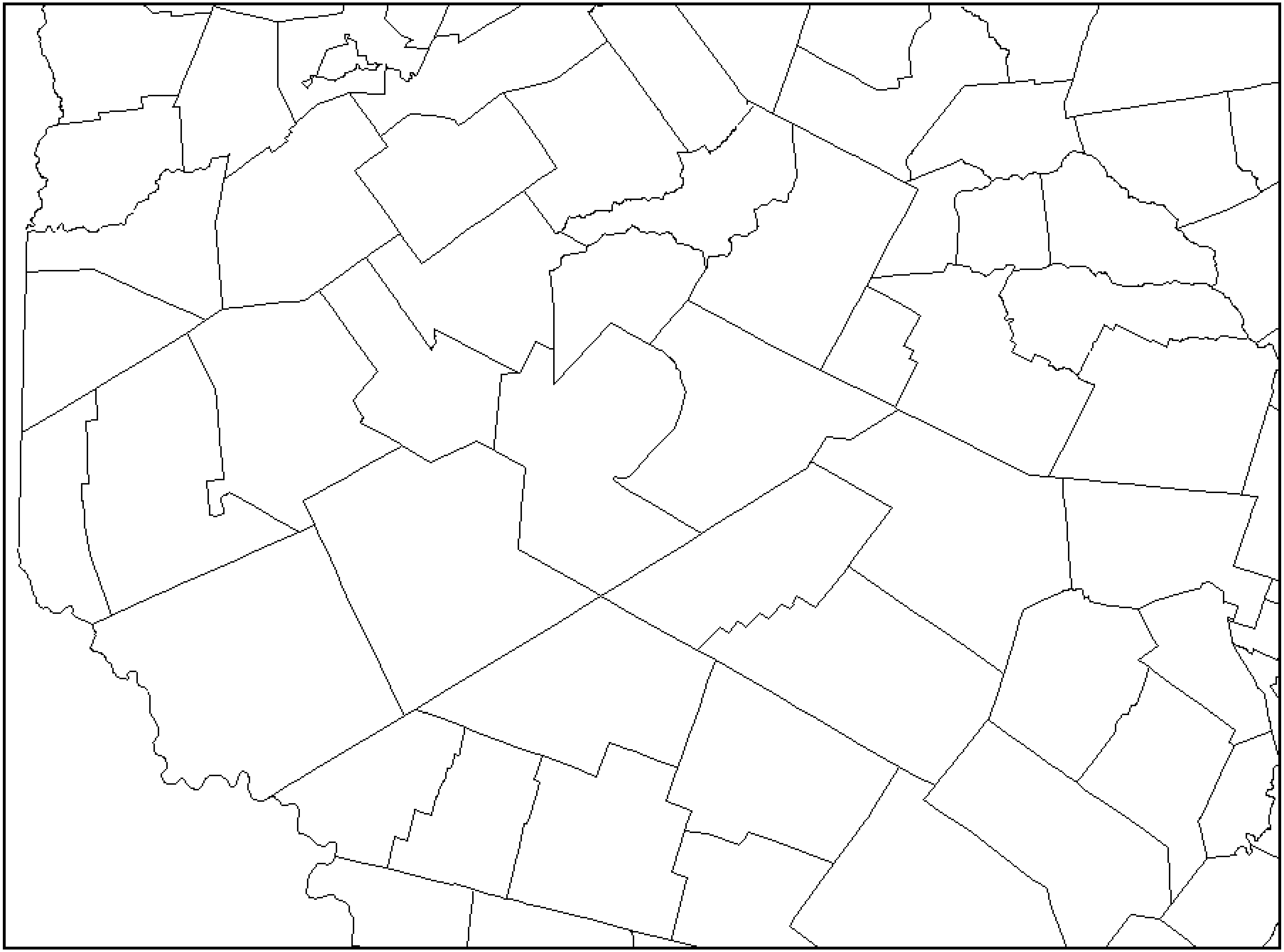
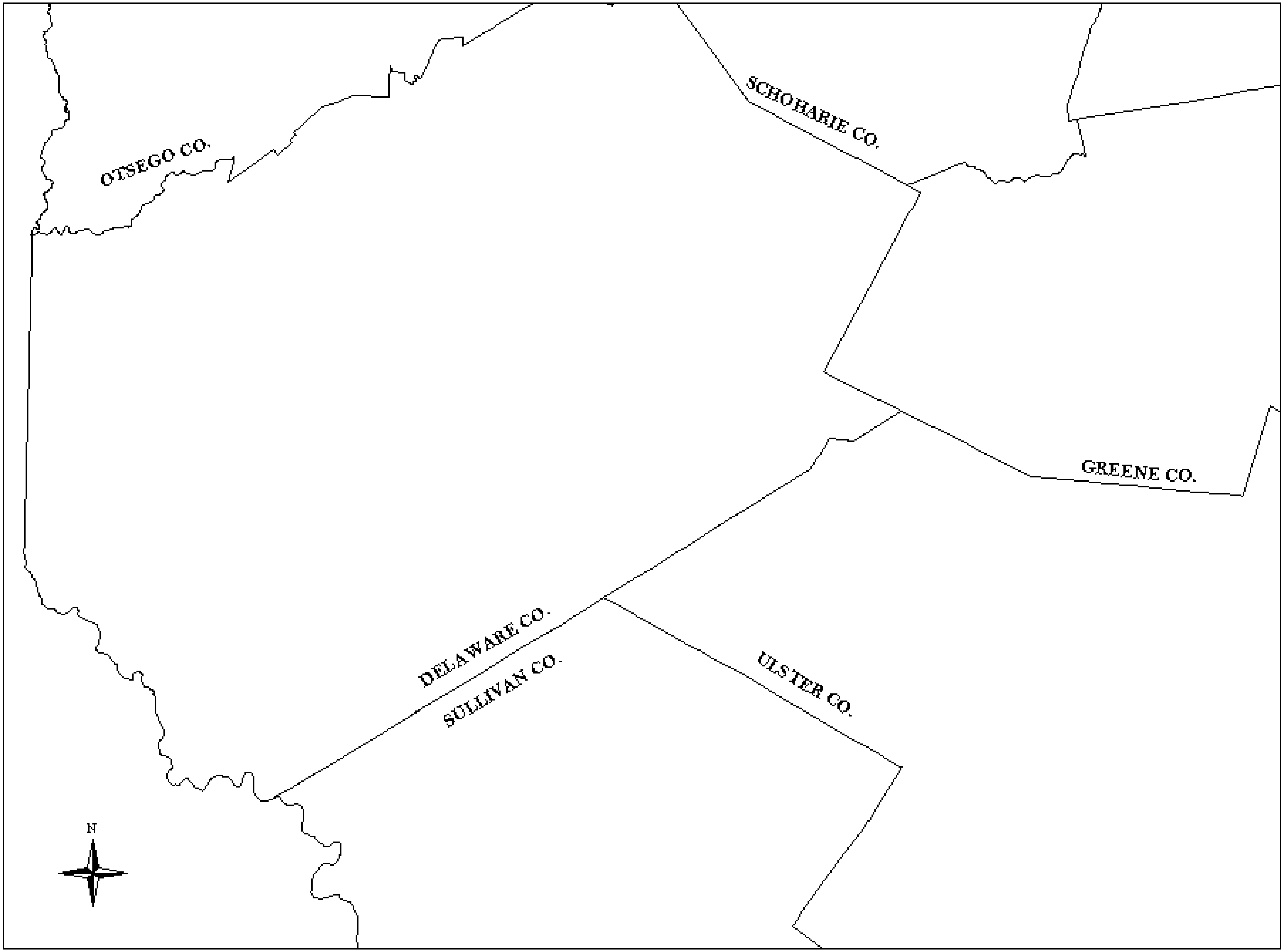
Major Roads



Water Bodies



Township Boundaries


OTSEGO CO.
SCHOHARIE CO.
GREENE CO.
DELAWARE CO.
SULLIVAN CO.
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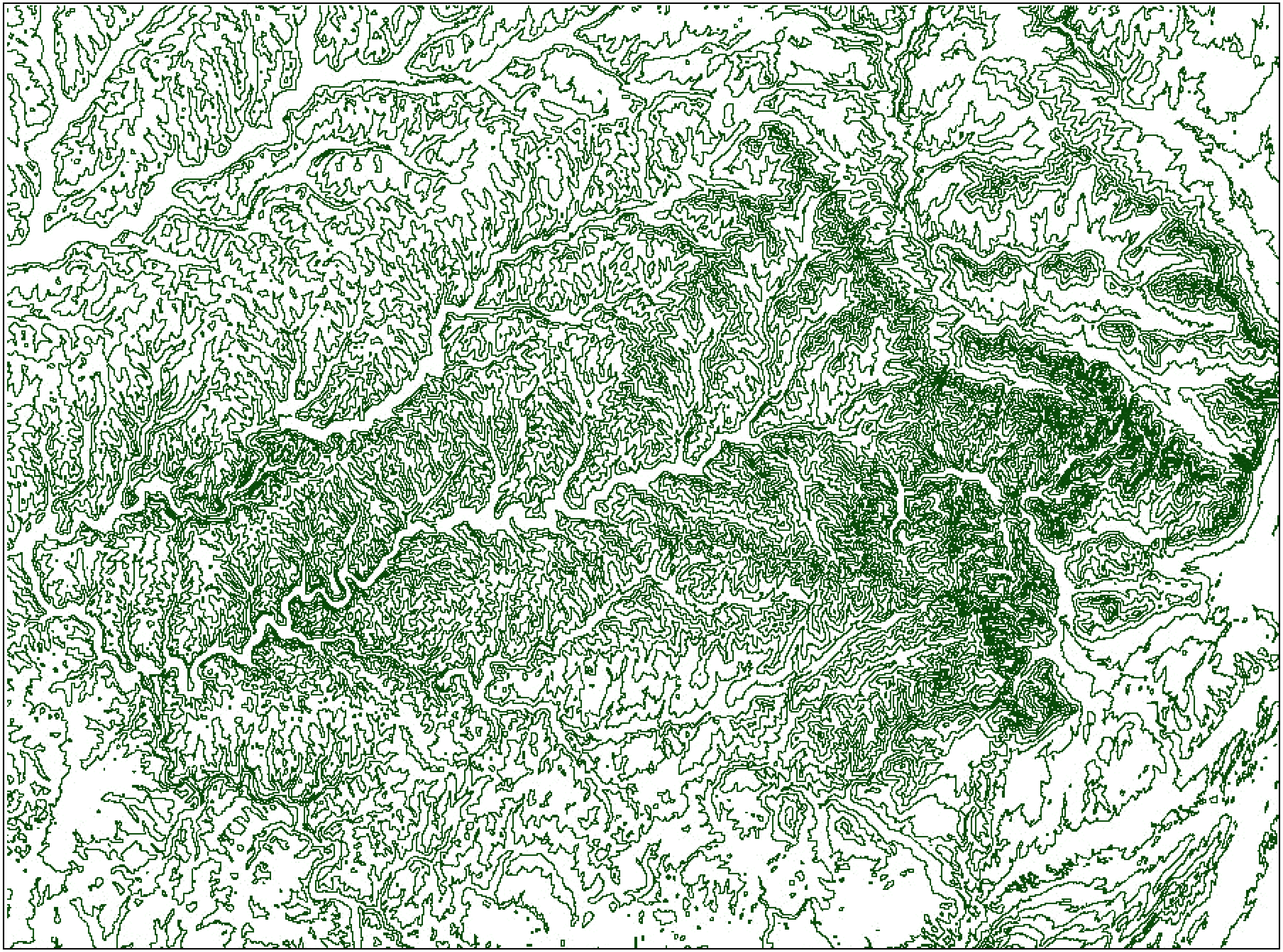
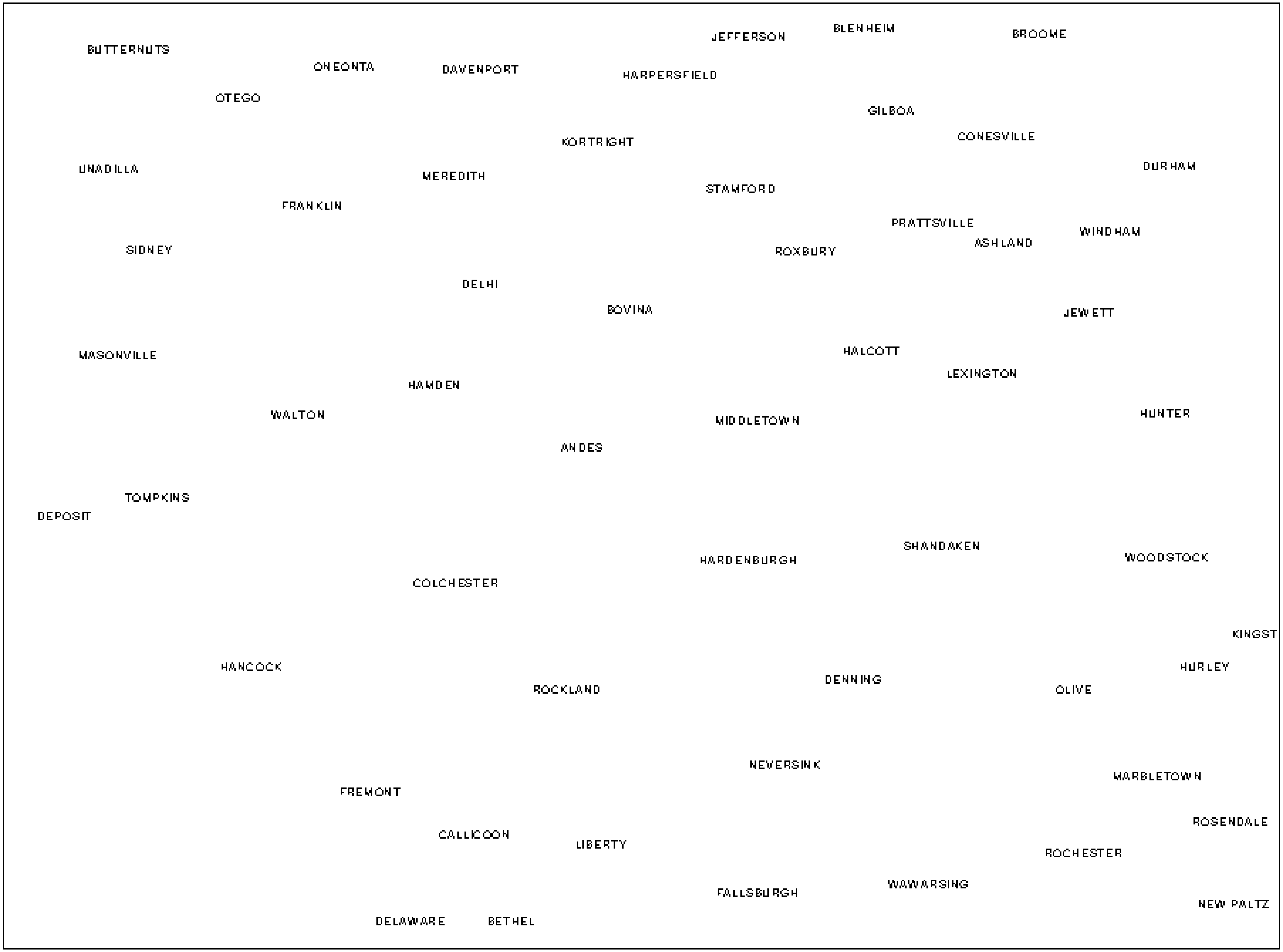
Counties



Topography



Township Names