

Lesson 4

Paleoclimate of the Hudson Valley



Paleoclimate of the Hudson Valley

NYS Intermediate Level Science

Standard 1: Analysis, Inquiry and Design/Scientific Inquiry

- S2.3b Conduct a scientific investigation.
- S2.3c Collect quantitative and qualitative data.
- S3.1a Organize results, using appropriate graphs, charts, and data tables.
- S3.2c Evaluate the original hypothesis in light of the data.
- S3.2d Formulate and defend explanations and conclusions as they relate to scientific phenomena.
- S3.2h Use and interpret graphs and data tables.

Standard 6: Interconnectedness

- 5.2 Observe patterns of change in trends or cycles and make predictions on what might happen in the future.

Standard 4: The Living Environment

- 1.1f Many plants have roots, stems, leaves, and reproductive structures. These organized groups of tissues are responsible for a plant's life activities.
- 3.2c Many thousands of layers of sedimentary rock provide evidence for the long history of Earth and for the long history of changing life forms whose remains are found in the rocks. Recently deposited rock layers are more likely to contain fossils resembling existing species.
- 7.2d Since the Industrial Revolution, human activities have resulted in major pollution of air, water, and soil. Pollution has cumulative ecological effects such as acid rain, global warming, or ozone depletion. The survival of living things on our planet depends on the conservation and protection of Earth's resources.

Standard 4: The Physical Setting

- 2.1h The process of weathering breaks down rocks to form sediment. Soil consists of sediment, organic material, water, and air.
- 2.2j Climate is the characteristic weather that prevails from season to season and year to year.
- 2.2q Hazardous weather conditions include thunderstorms, tornadoes, hurricanes, ice storms, and blizzards. Humans can prepare for and respond to these conditions if given sufficient warning.
- 2.2r Substances enter the atmosphere naturally and from human activity. Some of these are carbon dioxide, methane, and water vapor. These substances can affect weather, climate, and living things.

Next Generation Science Standards

Science and Engineering Practices

- 2. Developing and using models
- 4. Analyzing and interpreting data
- 6. Constructing explanations
- 7. Engaging in argument from evidence
- 8. Obtaining, evaluating, and communicating information



Grade 6

ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Common Core State Standards**ELA in the Content Areas - Grades 6-8**

CCSS.ELA-Literacy.RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-Literacy.RST.6-8.2

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-Literacy.RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

CCSS.ELA-Literacy.RST.6-8.8

Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

CCSS.ELA-Literacy.RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Common Core State Standards - Mathematics**Standards for Mathematical Practice**

CCSS.Math.Practice.MP2

Reason abstractly and quantitatively.

CCSS.Math.Practice.MP4

Model with mathematics.



Paleoclimate of the Hudson Valley: Historic Plant Communities

Adapted From: <http://www.caryinstitute.org/educators/teaching-materials/changing-hudson-project/pollution/day-2-paleoclimate-hudson-valley>

Introduction

This hands-on activity from the Cary Institute of Ecosystem Studies is appropriate for middle school students and can help them learn about the history of climate change in our region. The Hudson Estuary Paleoclimate is modeled by replicating fossilized pollen in marsh sediment.

Students use model “soil samples” to discover clues to the Hudson Valley’s climate history over the last 16,000 years.

Objectives

Students will be able to

- Explain how scientists use sediment cores to study past climate
- Analyze model soil samples
- Determine the climate in which model soil samples were created
- Describe climate patterns over time in the Hudson Valley.

Advanced Preparation

1. Make copies for each student of the student worksheet and Hudson Valley Paleoclimate reading.
2. Create a sample “sediment core” with visibly different layers of soil. You can build this in a graduated cylinder, tennis ball container, soda bottle, etc. Either create layers as described in the chart below, or just use different types of soil to stimulate students’ thinking.
3. Before class, prepare eight bags of soils with the mixtures of confetti described below. The ratios are approximate; feel free to use whatever colors of confetti you have on hand, pieces of paper (hole-punch construction paper or laminated colored paper) or other materials to represent the pollen. You can use visibly different soil types for each ‘layer’ with pollen, but this is not necessary.

You can also just tell the students that the soil layers might look alike now, but they look different when scientists collect them. Once you have prepared the ziplock bags with the soil and confetti, disperse the bags to your groups of students. If you can’t make eight groups, it would be advisable to give one group two layers (probably the simpler layers, ie. 2, 3, or 4). Once students have identified the ‘pollen’ based on the charts they have, they will be able to reconstruct the paleoclimate of the Hudson Valley. You can keep the ziplock bags for future use.



Color and Shape	Plant Species	Climate Characteristics
Pink Hearts	Oak	Found in warm, temperate sites with dry, warm summers
Red Hearts	Spruce	Found in cold, sub-alpine sites
Silver Circles	Fir	Prefers cold, somewhat moist soils.
Clean Stars	White Pine	Temperate, cool climate
Silver Stars	Chestnut	Prefers moist and cooler temperatures
Blue Stars	Hickory	Warm and dry, well-drained soils
Black Stars	Paper Birch	Enjoys cold, sub-alpine conditions
Gold Hearts	Hemlock	Requires moist soil, temperate conditions
Turquoise Circles	Ragweed	Native, indicator of disturbance
Red Stars	Common Reed	Invasive grass, hybrid of native and alien
Purple Stars	Sedge	Wetlands or tundra indicator
Gold Circle	Dwarf Birch	Grows in cold climates, often at high altitudes
Dark Pink Circle	Sorrel	Disturbance indicator
Blue Circles	Creeping Evergreen Shrub	Very cold climate, rocky soils, often found at high altitudes

Materials Required (for each group of about three students):

- 8 bags of soil with 14 types of confetti (or other materials) organized in the manner described below. Be sure to label each bag with Layer 1-8.
- student worksheet and reading(s)
- tweezers
- paper plates
- Student worksheets <http://www.caryinstitute.org/sites/default/files/public/downloads/less-on-plans/paleoclimate-worksheet.pdf>
- Copies of the reading on the Paleoclimate of the Hudson River Valley: <http://www.caryinstitute.org/sites/default/files/public/downloads/less-on-plans/paleoclimate-reading.pdf>

Optional Materials (for each group of about three students)

- flower
- hand lenses or microscope and slides



Layer	Soil Type	Time Period	Species Found in Soil Core	Confetti Set-up
1	Sandy	100-400 years ago	Ragweed, common reed, few oak (due to deforestation), sorrel	10 turquoise circles 10 dark pink circles 10 red stars 5 pink hearts
2		400-3,000 years ago	Oak and chestnut	10 pink hearts 10 silver stars
3	Well-drained loam or clay	3,000-5,000 years ago	Oak and hickory	10 pink hearts 10 blue stars
4	Shallow loam or silt, loam over bedrock	5,000-7,500 years ago	Oak and hemlock	10 pink hearts 10 gold hearts
5	or peat	7,500-11,000 years ago	White pine and oak	10 clear stars 10 pink hearts
6	or peat	11,500-12,700 years ago	Spruce, fir, paper birch	10 red hearts 10 silver circles 10 black stars
7	Sandy soils	12,700-15,000 years ago	Spruce, some fir, oak, white pine	10 red hearts 10 clear stars 5 silver circles 10 pink hearts
8	Rocky soils with some peat	15,000-16,000 years ago	Creeping evergreen shrub dwarf birch, sedge	10 blue circles 10 gold circles 10 purple stars

Engage

Show students the sediment core you created. Ask them to make some observations of the core.

- How are the layers similar? Different?
- Why do you think this is the case?

Note that the core is a model of cores the scientists can take of real soil.

Show students some photographs of real sediment cores, e.g.:

http://www.windows2universe.org/earth/climate/images/sediment_core_sm.jpg



Cornell University

- Why do you think scientists take sediment cores like these?
- Have you ever seen rock layers? What did you observe?
- Where are the oldest layers? The newest?

Explain to students that when we collect a sediment core, we are getting a slice of the soil's layers. There are many differences between layers, including the tiny, fossilized pollen grains found within them.

Ask

- What is pollen? A powdery substance produced by the male part of a flower that can fertilize the ovules (eggs) in the female part of the flower.
- How is pollen transported? By wind, insects, birds, etc.
- Is all pollen the same? Why or why not? No, pollen for different types of plants has different characteristics.
- How might pollen give scientists a clue about climate? Different plants grow in different climates, so seeing certain types of pollen could indicate what the climate conditions under which the plants grew. [If possible, have students observe pollen from flowers with hand lenses or under a microscope.]

Discuss

- How can scientists tell what kind of pollen is in a sediment core? Take the pollen from the core and observe it under a microscope, then compare it to a key or other known sample.

Explore

1. Note that by analyzing fossilized pollen grains in sediment cores, scientists are able to learn about ancient climates, paleoclimates. Explain to students that they will become 'scientists' to discover the paleoclimate of the Hudson Valley. Tell students to imagine that scientists have collected a sediment core from Hudson Estuary marsh sediment.
2. Explain that each group will get a sample of "soil" that represents one section of the soil. The layers are numbered, with the newest layers as Layer 1. They will analyze the "pollen" inside and compare the pollen they find to the reference chart. The goal is to predict the type of climate that might have existed during the period represented by their soil sample.
3. Show students how to use the student worksheet. If necessary, review with students how to calculate percentages so that they may determine the percentage of each type of pollen in their soil sample. Note that they should do this step after analyzing all of their soil.
4. Distribute the materials to each group of students: one layer (bag with 'pollen'), tweezers, and a paper plate. Students should sift through their sediment layers and separate out each of the different pollen types. Allow enough time to discover what layer they have and what type of climate may have existed during this period, using the information on their student worksheet.
5. As students work, create a class chart on the board (see student worksheet), in which groups can record their findings.
6. Students should then read Paleoclimate of the Hudson Valley and try to determine the time period from which their soil sample originated.



Explain

- Explain that scientists are interested in studying the history of climate change in order to understand patterns of change over time. Since each type of pollen has a distinct shape, scientists can find out what plant produced the pollen. By discovering what types of plants lived during each time period, scientists can infer what the climate was like during that time, and even how many of each type of plant lived during that period.
- They can also draw conclusions about how long it took for different changes to take place. For instance, how long did it take from the last Ice Age until the appearance of marsh plants? The speed that plant communities migrate into an area can help scientists understand how plants are currently migrating around the world, and what might happen when the temperatures increase in the future. Scientists from Columbia University's Lamont-Doherty Earth Observatory have collected pollen samples throughout the Hudson River area, and are continuing to collect samples to create a more complete picture.
- As a class, create a rough graph of the general temperature changes (put 'temp' on the y-axis as warm, cool, and cold and time on the x-axis). Discuss:
 - What do you observe?
 - What trends do you see?
- This should allow a discussion of the history of climate change in the Valley. Then, show students the two graphs of climate change over the last 14,000 years and the last 400 years. For each graph, be sure students understand the scale and specific data they are viewing. Discuss:
 - What observations can you make about the first graph?
 - Why do the lines go up and down constantly?
 - What overall trend do you see?
 - What observations can you make about the second graph?
 - How and why is it different from the first graph?
 - What overall trend do you see?
 - How do these graphs relate to our class graph?
- When discussing the pattern of climate change over the last 16,000 years, it might be helpful to give students background on climate change. There are a number of things that can alter the global temperature: changes in the sun's activity, distance of the sun's orbit from earth, volcanic eruptions, greenhouse gas emissions (including aerosols, which can provide a cooling effect). However, we know from data that the sun (solar radiation) has been relatively constant in the 20th century, and that greenhouse gases are higher now than at anytime during the last 600,000 years.
- Direct students to complete the questions on their worksheet. Review them as a class.

Elaborate

For homework, have students investigate other regions of the world to determine the paleoclimate data. Information can be found at: Climates of the Past (<http://bit.ly/11a4PsU>).

Another option is to bring students on a guided walk and discuss what a current 'layer' would look like.



Evaluate

Have students write an essay or story about one layer of the model soil. In their story, they should:

- Accurately describe the climate and plant life of the time of the layer
- Refer to information from the chart and graph on the student handouts
- Incorporate additional research (including information about the animals that have lived in the area).
- Illustrate their story appropriately

Rubric for Evaluate

Component/Score	3 (Exemplary)	2 (Satisfactory)	1 (Needs improvement)
Description	Vividly and accurately describes the climate and foliage of the selected soil layer	Describes the climate and foliage of the selected soil layer	Describes either the climate or the foliage of the selected soil layer
Use of data	Accurately and appropriately supports description with multiple pieces of data.	Accurately and appropriately supports description with data.	Refers to data, but data may be inappropriate or inaccurate.
Incorporate Research	Incorporates several appropriate factual details from outside sources.	Incorporates factual details from outside sources.	Details from outside sources are not factual or inappropriate.
Illustration	Illustration closely matches with description and other details and enhances writing.	Illustration matches description and other details	Illustration is not linked with description and other details



Name _____

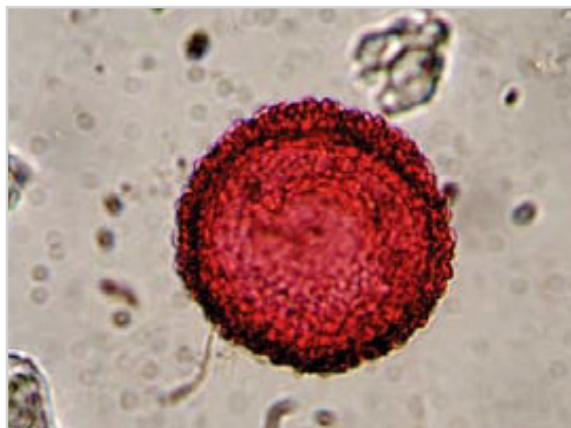
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Student Worksheet Paleoclimate of the Hudson River Valley

This activity is based on actual pollen data collected by pollen researchers since the 1950's and most recently scientists from Lamont-Doherty Earth Observatory in and around the Hudson River. Based on the soil samples that you analyze during class, you will determine the amount and type of 'pollen' in each sample. From this information, you will determine the type of vegetation and age of the samples and will draw conclusions about the climate when the pollen was dispersed from its host plant.



Sedge Pollen



Eastern Hemlock Pollen

Materials

- Pie pan or paper plate
- Tweezers (optional)
- Soil samples with confetti representing pollen grains

Procedure

1. Each group of students will receive a sediment sample, paper plate, and tweezers. Each sample contains 'pollen', with each color representing pollen from a different species of plant.
2. Separate the pollen from the sediment. Look carefully through the entire soil sample; some of the pollen grains are hard to find!
3. Use the pollen key below to determine what species of plants are represented in your sample. Calculate the percentage of the total pollen that comes from each species. Fill in the data table for the soil layer you are working on. Share your observations with the class.
4. Use the information given with each species description to decide what the climate was like when your layer was deposited.

Modified from a Windows to the Universe® (<http://windows2universe.org>) © 2010, National Earth Science Teachers Association (supported by UCAR) lesson plan, using data from Lamont-Doherty Earth Observatory, for the Changing Hudson Project, Institute of Ecosystem Studies, 2007. Last revision: Cary IES, January 2013.



Pollen Key

Color and Shape	Plant Species	Climate Characteristics
Pink Hearts	Oak	Found in warm, temperate sites with dry, warm summers
Red Hearts	Spruce	Found in cold, sub-alpine sites
Silver Circles	Fir	Prefers cold, somewhat moist soils.
Clear Stars	White Pine	Cool, temperate
Silver Stars	Chestnut	Prefers moist and cooler temperatures
Blue Stars	Hickory	Warm and dry, well-drained soils
Black Stars	Paper Birch	Enjoys cold, sub-alpine conditions
Gold Hearts	Hemlock	Requires moist soil, temperate conditions
Turquoise Circles	Ragweed	Native weedy plant that expands with disturbance
Red Stars	Common Reed	Invasive grass, hybrid of native & alien
Purple Stars	Sedge	Wetland or tundra indicator
Gold Circle	Dwarf Birch	Grows in cold climates, often at high altitudes
Dark Pink Circle	Sorrel	A shrub, used to indicate disturbance
Blue Circles	Creeping Evergreen Shrub	Very cold climate, rocky soils, often found at high altitudes

Data: Write down the type and number of pollen you found:

"Pollen"	# Found	Plant Species	Climate



Class observation data: Write down the percentage of each plant species found in each layer.

Plant Species	Sediment Layer							
	8	7	6	5	4	3	2	1
Oak								
Spruce								
Fir								
White Pine								
Chestnut								
Hickory								
Paper Birch								
Hemlock								
Ragweed								
Common Reed								
Sedge								
Dwarf Birch								
Sorrel								
Creeping Evergreen Shrub								

Questions

1. Based on your observations, what was the climate like during the time when your pollen was shed?
2. Your teacher will give you some background reading. Based on this information, what time period do you think your layer corresponds to?
3. Using everyone's data, graph the temperature shifts through time on the board, with 'time' on the x-axis and 'temperature' (warm, cool, cold) on the y-axis. Discuss the results.
4. What was the overall pattern of climate change during the last 16,000 years?
What might have caused these changes?
5. Using the graph shown by your teacher, what is currently happening with the climate in relation to the past?
6. When looking at the cumulative data collected by your class, what trends do you notice?



Hudson River Estuary Climate Change Lesson Project

www.nyseagrant.org
<http://www.dec.ny.gov/lands/>



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Water Resources Institute



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