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| **Kim Schutsky** | **Fortune Telling for Future Fossils** |
| **Ferry Beach Ecology School** | |
| **Saco, Maine** | **Ecology, Creative Presentation, Math, Geology, Climate Change** |
| **2004** | **Grades 5-6** |
| **Mexican Megafauna** | **2-hour block OR three or four 45-minute class periods** |

The lessons taught at the Ferry Beach Ecology School are taught outside and are experiential in nature. We strive to develop innovative activities that teach concepts, and that integrate magic and mystery into learning. We regularly return to the ideas contained within The ABCs of Ecology TM - that is, the basic ecological concepts of Abiotic factors, Biotic factors, Cycles, and Change. While in Mexico, my thoughts continued to focus on the abiotic factors and change that contributed to the story of the past 4.8 million years of central Mexico's natural history.

The following lesson focuses on abiotic factors and their contribution to stories that can be discovered years in the future. It follows FBES's format of a two-hour outdoor lesson, but could easily be adapted to fit three or four 45-minute class periods.

**Abstract:** This lesson actively engages students in discovering how factors such as soil, decomposition, nutrient levels, disturbance, climate change, and the atmosphere help to determine the make-up of an ecosystem and the rate at which that ecosystem might change. Students will act as fortune tellers who, by the end of the lesson, will tell the future of the area and the likelihood of there being fossils to find millions of years in the future.

**Goal:** Students will recognize that the happenings of the here and now on earth ultimately paint the background for the stories the land will have to tell thousands and millions of years in the future.

**Performance Indicators:**

*Based on the Goals of the State of Maine Learning Results.*

B2. Analyze how the finite resources in an ecosystem limit the types and populations of organisms within it.

B4. Investigate the connections between major living and non-living components of a local ecosystem.

F2. Describe how soils are formed and why soils differ from one place to another.

F4. Describe factors that can cause short-term and long-term changes to the earth.

M6. Give examples of actions which may have expected or unexpected consequences that may be positive, negative, or both.

**Background Information:** The activities of this lesson are meant to introduce different concepts. Any previous background the students have on the following topics will enhance what they are able to take from this lesson. Concepts and skills involved in this lesson include: data collection, graphing skills, drawing conclusions from a graph, greenhouse gases, climatic change and how it has affected the geology of a particular area (for example, the glaciations of New England or the exposure of the Panamanian land bridge millions of years ago), and how fossils are formed.

**Materials:** Please refer to individual activity write-ups for material lists.

**Technology:** None needed.

**Instructional Procedure:** Unless otherwise noted, the following activity write-ups are credited to Kim Schutsky or the Ferry Beach Ecology School in general.

Begin this lesson with a story about your summer adventure doing field research digging fossils in central Mexico. The experience was incredible, finding bones and teeth that were millions of years old was unforgettable. Your mind grappled with the concepts of millions of years - our lifetimes rarely reach a mere 100 years - and you wondered if any animals that roamed the land at that time had any idea that their fossils would uncovered by a small group of research volunteers and scientists. You return to your "normal" life here on the coast of southern Maine and, while walking the sandy beach, come upon an old bottle with a piece of paper crumpled up inside. Have the bottle with its message inside your bag and carefully pull it out at this time. Explain that you were so excited to have found a message in a bottle that you didn't even open it. Ask for help from your students - will they read the message for you?

The message is actually a letter from two "mad" paleontologists. Their passion in life is to discover hundreds and thousands of fossils, but they are having trouble in this area. They think the lack of fossils more than a million years old has something to do with the glaciers of a few thousand years ago. They have decided to focus their attention on speeding up the process of fossilization, but unfortunately to no avail. Instead they are beginning to develop the technology to freeze themselves for a million or more years, and then thaw themselves out millions of years in the future so they can look for fossils from the present day. They are asking for help and advice. Are their efforts worth their while in New England? Does this area have the potential for present day biotic factors to become fossilized for people in the future to find?

Before the students can provide a response to these paleontologists, they have a lot to learn so they can give an educated answer.

Their missions are as follows:

» Discover the science of soil (since that's where many fossils are found).
» Compare different area ecosystems to discover those where there is the greatest diversity.
» Is another glacier coming???
» Tell us what we should do!

## Recipe for Soil

***Goal:*** To show how topsoil is created and how long the process takes.

***Materials:*** soil recipe cards with the below ingredients, a medium-sized bowl, watch, chef's hat (optional).

Start off by telling the students you have an old family recipe for soil, which you are all going to follow today. You'll be greeted with curious stares and comments but try to head off any questions about whether or not you are actually going to eat dirt by telling them to wait and see. Divide the class into 5 groups and give each group of students a card with a different ingredient to get from the schoolyard. The ingredients are:

1 handful of decaying leaves  1 handful of small rocks (not sand)
1 green plant (not picked)  1 Tbsp. of water
1 cup of air

Another student can find a good stirring stick and still another can be the chef. Have each student add their ingredient one at a time and stir well. With a look of confusion, inform the students that the mixture doesn't look quite right to you. Let them try to figure out what the problem is and add more ingredients as they see fit. After a couple of minutes of this, "remember" that you forgot the most important part of the recipe ... time. Hand someone your watch and ask them to set the timer for 1000 years. Looks of shock will abound. Explain that you won't be able to eat the soil today because you forgot that it often takes 1000 years for one inch of topsoil to form.

***Note:*** The timeline for soil formation is different in different ecosystems and areas of the country. The rate of soil formation is dependent on the rate of weathering, and also if the weathered material is residual and remains in an area or is transported to another area. Five specific factors affect the rate of weathering and, in turn, the rate of soil formation in an area: climate, topography, parent material, plant and animal activity, and time.

***Connections:*** Take a soil core from a nearby area and have students count the number of inches of topsoil they see. They can then figure out how many years it took for the topsoil to develop. Why is soil so important in the forest? *Soil is the medium through which the plants of a forest get many of their trace nutrients. It also acts as a stable substrate in which plants anchor their roots, and is a sink for nutrients in the forest.* What effects might soil erosion have on a forest? *Soil erodes most quickly from a forest where the trees have been removed. Without tree roots anchoring the soil in place, wind and water speedily erode the nutrient-rich soil.* What types of soil might best hold fossils?

***Credit:*** This activity is adapted from an activity originally published in *Project Seasons* by Deborah Parrella. Published in Vermont by Shelburne Farms, 1995.

## Forest to Field Pattern Survey

***Goal:*** Students fill out a comprehensive graph to give an overall picture of the patterns observed between different ecosystems.

***Materials:*** a pre-printed "Forest to Field Pattern" worksheet, colored markers, long rope or stakes to mark where the transition zones are, an area where forest gradually, or abruptly, turns into a field or meadow or yard.

After you have chosen an area that is suitable for this activity, have your students decide where the beginning field area is and where the survey will end in the forest. Have students lay a length of rope across the ground connecting the field to the forest. If rope of that length is not available, simply have the students mark the field and the forest with stakes. After the transect has been laid out, assign half of the class to decide where transition zone 1 is and mark it with a stake or along the rope, while the other half of the class decides where transition zone 2 is located. There is no exact science to where the transition zones are located, but ask the students to keep in mind that transition zone 1 should be more forest than field, and transition zone 2 should be closer to a field than a forest.

To compare the different areas of this transect, students will fill out each section of the graph for different areas of the forest and field. In each area (the forest, transition zone 1, transition zone 2, and field), students will rank the **nutrient level**, **human disturbance**, **productivity**, and **diversity**. Each of those four categories is assigned a different symbol to be used in all the areas of the transect.

In order to keep all the students engaged, break them up into four "research teams" and have each student perform a different task in each ecosystem. Here's how to go about analyzing these factors:

**Nutrient level** is determined by taking a soil sample using a soil corer (if possible), making a soil smudge, and looking at how dark the soil is-- the darker the soil, the more nutrient-rich.

**Diversity** is found by determining the number of different biotic factors in an area and can be measured in a number of ways-- small groups can do a diversity count - or each student can make a rough estimate and the group can share the results.

**Productivity** is estimated by looking around at how many plants are in an area and how big they are. It is a measure of the amount of living mass the producers in an area can generate in a given amount of time.

**Disturbance** is estimated by using the human disturbance checklist. The more signs of human disturbance in the area, the more disturbance there is in that area. Students can also look for signs of natural disturbance such as a tree that has blown over, evidence that lightning has struck a tree, or evidence of a previous fire.

***Connections:*** At the end of the activity, have the students connect the different symbols with four different colored markers. Encourage students to look for relationships between nutrient level and diversity, disturbance, and diversity. How do factors such as nutrient level and human disturbance affect the diversity of an area? *Your students may find that as the nutrient level of the soil goes up, there is greater plant diversity. Conversely, as the human disturbance in an area increases, the plant (and animal) diversity goes down.* Look for patterns within and between the areas. What do students imagine the field looked like before there was human disturbance?

## Syringe Demo

***Goal:*** To show that air is indeed "something".

***Materials:*** large plastic syringe.

Ask students to tell you what air is comprised of. Can you feel air? Does it have weight? To prove that air has weight, have the students blow on their hands. Although you can't see anything, you do feel something. What you are feeling is millions of atoms and molecules colliding with the skin on your hand! When you constrict your lungs to blow out, the molecules in your lungs are pushed out of your mouth and you feel them hitting your hand!

Use the large syringe to *catch* some of the air. Place your finger over the end of the syringe and depress the plunger as far as you can. Ask your students why you can't press it further? The air inside the syringe is now compressed. When you release your finger you will hear a hissing sound and hopefully see a tiny wisp of a cloud form at the end of the syringe. These are the compressed water molecules that were in the trapped air.

***Connections:*** What are some of the particles that make up air? *Air is made up of molecules of nitrogen, oxygen, carbon dioxide, water vapor, other trace elements, and dust particles.* If air isn't made up of anything, how can it knock someone over in a hurricane or tornado? How do clouds form in our atmosphere? *Clouds form when air masses cool and water vapor condenses around condensation nuclei such as pollen grains, dust, or ash, thus forming microscopic water droplets. These droplets are so small that you would have to collect one million cloud droplets to create one raindrop! Once a cloud is saturated with raindrops, the cloud is unable to hold the weight and the drops fall to the ground as some sort of precipitation.* Which substrates from the Forest to Field Pattern Survey will blow away easiest with wind? Will that help to cover organic remains which might eventually turn into fossils?

## Carbon Dioxide Game

***Goals:*** To demonstrate the greenhouse effect— how $CO_2$ in the atmosphere traps heat and insulates the Earth. To show how increasing the amount of atmospheric $CO_2$ causes global warming.

***Materials:*** an open area, chalk, a small bag with the words "what did humans do?" or "bag of fate" written on them. Fate cards to put in bag.

Draw two concentric circles on the ground, one about 2 feet in diameter, and the other about 15 feet in diameter. The smaller circle represents the Earth, and the larger one represents the planet's atmosphere.

Ask the students what gases make up the atmosphere. Tell them that this activity focuses on the role of carbon dioxide, but be careful to not reveal what it is the $CO_2$ does; allow the activity to teach the concept.

Pick two students to be $CO_2$ molecules, and place them in the earth's "atmosphere". The rest of the students are Sunbeams, each representing energy from the sun. The "sun" is located about 30-40 feet from the atmosphere and is represented by a third circle.

The object of the game is for the Sunbeams to leave the sun, enter the atmosphere, tag the Earth, and then escape back into space without getting tagged by a $CO_2$ molecule. ($CO_2$ molecules can pivot on one foot, but may not run around within the atmosphere.) If a Sunbeam is tagged by a $CO_2$ molecule, it stays standing still in the atmosphere. If not, it bounces back out of the atmosphere.

This simulation recreates the greenhouse effect where energy from the sun is trapped as heat by $CO_2$ and other gaseous particles in the atmosphere. After the first round, have students form a circle around the atmosphere to check out how much energy has been trapped. How will this affect the temperature of the planet? During this first round, most of the energy will escape the atmosphere because $CO_2$ levels are low. Make sure to mention that a certain amount of heat *must* be trapped to keep the planet warm enough to sustain life.

For the second round, increase the number of $CO_2$ molecules in the atmosphere from two to four. Do this by reaching into the *Bag of Fate* and pulling out a fate card. The cards should say things like "humans drive cars" or "factories are built" or "trees are cut down". Each of the cards represents a human action that might or might not increase the amount of $CO_2$ in the atmosphere. After a student reads a card you can increase the $CO_2$ in your game and play again. Try a third round with seven $CO_2$ molecules. What happens? The game should demonstrate that when you increase the amount of $CO_2$, more heat gets trapped and the Earth's temperature increases.

***Note:*** While some aspects of this game are fictitious, such as carbon dioxide molecules not being able to move about the atmosphere, the game does illustrate concrete concepts regarding the greenhouse effect.

***Connections:*** Review how the energy from the sun gets trapped within the Earth's atmosphere. Discuss with the students how humans can influence the greenhouse effect and global warming— how burning fossil fuels puts more $CO_2$ into the atmosphere. What predictions can the students make as for the future of the area's climate? Wrap-up by discussing/researching alternative energy sources.

## Be a Fortune Teller!

***Goal:*** To use the concepts learned during this lesson to develop an educated answer as to what luck the mad paleontologists will have finding fossils in the future.

***Materials:*** paper and pencils for the students to take notes, costumes (hats, glasses, funny shirts) for the students to wear for their presentations, a mad paleontologist outfit for yourself.

Reread the message in the bottle to remind the group of what the missions for the lesson had been. Students should now have a good sense of the abiotic factors in the area and the changes that might potentially occur in the future. Divide the class into smaller groups, each needing to develop a response for the mad paleontologist. Groups need to take into consideration the different soils of the area, which ecosystems have the most stable substrate for fossils to form in, will the climate remain stable (in other words, no pending glaciations). Give each group a selection of costumes to choose from so they can be in character when they deliver their response to the mad paleontologist. While the students are developing their response, secretively slip behind a corner and change into your mad paleontologist outfit. Return to the group ready to hear the students' responses.

***Connections:*** How do the abiotic factors of an area influence what lives there and the stability of that area? How will the current climate change tendencies change the local landscapes?

**Assessment:** Unfortunately I do not have practice in the writing of rubrics, thus I am unable to supply these for this lesson.

**Connections:** This lesson has the potential to be incorporated with other disciplines within a school. The lesson could be paired with Language Arts, Social Studies, Math, and there are Research Project potentials. Here at the Ferry Beach Ecology School, I would relate this lesson to other lessons throughout the week such as *ABCs of Ecology*, *Forest*, *Beach and Dunes*, and our *Coastal Watersheds*.

**Extensions:** Additional studies or research topics that could help the students expand the outcomes of this lesson include:

- experiments on decomposition rates
- glaciation
- rock type and formation
- fossil formation
- climate change
- alternative energy sources
- Panama land bridge
- oceanic current and the change that was encountered when the land bridge was formed
- Great American Faunal Interchange

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**Contact Information:** kim@fbes.org