Activities 7 and 8
Introducing Carbon Presentation: Teacher Notes

Slide	Notes
1	This presentation provides a short introduction to carbon and the carbon cycle. It can be used with either Activity 7 or Activity 8. Slides 8, 9, and 10 are particularly relevant for Activity 8.
2	By mass, carbon is the fourth most abundant element in the universe. Carbon is found many places on Earth including the atmosphere, water bodies, and the biosphere.
3	Many things contain carbon including soil, trees, plants, animals, coal, oil, and diamonds. Can you think of more places where carbon is found? Because carbon is a part of most organic molecules, such as cellulose, sugar, fats, proteins, and enzymes, carbon is in all living things.
4	Carbon is found within different pools, such as plants and the atmosphere, and carbon also moves between pools. For example, carbon moves from the atmosphere to plants through the process of photosynthesis. This diagram shows the natural carbon cycle with human changes, such as fossil fuel combustion and land conversion. In land conversion, trees are removed from a landscape for development, agriculture, or other reasons without replanting them. This process is called "deforestation." The Exploring the Carbon Cycle video on the Activity 7 webpage explains this diagram. You can either click the diagram to access the video, or go to the following link: http://www.youtube.com/watch?v=PV1ac6gFyRY&list=PLgM-uU3vOAbIVCkFxqkwGNQPkRL0Rs7gl&index=7.
5	Most carbon in the atmosphere is in the form of carbon dioxide, CO_2. (Methane, another importance greenhouse gas, also contains carbon.) Since the 1960s, scientists have taken consistent measurements from a mountaintop in Hawaii and noted a steady increase in atmospheric carbon dioxide at that location. Scientific researchers and agencies also measure (and average) CO_2 at other locations as well to determine average global concentrations. The annual ups and downs show the work of plants in the northern hemisphere, which sequester carbon every summer and release it every winter.
6	Earth's natural carbon cycle is in balance. Some processes add carbon to the atmosphere, and others remove carbon from the atmosphere. Carbon dioxide in the atmosphere captures long-wave radiation that is re-radiated from Earth after it is heated by the shortwave radiation from the sun. This keeps Earth at the appropriate temperature to support current life forms. Humans have changed this balance so that there is now more carbon in the atmosphere than there has been in past 800,000 years. As a result, more heat is trapped in the atmosphere, and Earth's global average temperature is increasing.
7	Here is a simple model of the carbon cycle with round numbers for the amount of carbon in major carbon pools and the amount of the carbon that moves among these pools every year. The major pools are the atmosphere, plants and soil, the oceans, and fossil fuels. The amount of carbon in the pools is shown in petagrams (a petagram is one quadrillion grams or one trillion kilograms), and the carbon moving between the pools is shown in petagrams per year.

	The unit "petagram" is used here because of the size of these global stocks of carbon. Both blue boxes represent the ocean, with the top box representing the surface ocean and the bottom box representing the deep ocean. Notice that the amount of carbon going into the atmosphere from the plants and soil box is 1 to 2 petagrams more than the amount of carbon going from the atmosphere to plants and soil. This is the result of deforestation. Also notice that 6.5 petagrams of carbon per year move from the fossil fuel pool to the atmosphere. This occurs through the combustion of fossil fuels and adds carbon to the atmosphere, indicated by the plus sign (+) in the atmosphere box. This makes for a total increase of 7.5 to 8.5 petagrams of carbon in the atmosphere every year. This may not seem like a lot, so it might help to put this measurement into more familiar units. A petagram is equal to one billion metric tons. A metric ton equals 1,000 kilograms. One kilogram equals 2.205 pounds. This means that 1 petagram equals 2.2 trillion pounds, and 7.5 petagrams equals 16.5 trillion pounds!
8	If we want to reduce carbon dioxide in the atmosphere, we could make the inputs smaller or the outputs bigger. Both of these actions have costs and potential consequences.
9	In what areas should scientists and engineers be working to most effectively and efficiently reduce carbon emissions or increase carbon storage? • Although the ocean is a huge carbon sink, increased carbon in the sea causes a chemical reaction that converts this carbon to carbonic acid and changes the pH of the ocean, which isn't so good for the coral and shellfish. We probably don't want to increase the >100 in the blue circle. • While planting more trees is certainly helpful, it requires a lot of land. Wildfire, hurricanes, and other events that can damage or destroy trees are hard to control, so it is difficult to reduce the amount of carbon "exhaled" from forests under these circumstances. Changes in the marketplace affect when landowners harvest trees and for which markets. People are working on adding to the 100 in the other blue circle, and to reducing the >100 in the red circle. These are areas of current research and technology and can lead to additional benefits like habitat for wildlife, improved water quantity and quality, and reduced noise. • Finally, we can reduce emissions from fossil fuels (6.5 in red) though finding adequate energy substitutes for fossil fuels can be difficult and costly.
10	Carbon sequestration is the process of transferring atmospheric carbon dioxide into other pools. For example, the process of photosynthesis transfers carbon dioxide from the atmosphere to plant biomass, and decaying plant and animal matter transfers carbon into soils. During photosynthesis, plants convert carbon dioxide and water into sugar in the presence of sunlight. Some of the sugars are used as building blocks to form plant biomass, such as cellulose, lignin, bark, and leaves. Through this process, carbon moves from the atmosphere and is stored in plant cells. Building and maintaining these complex structures requires energy, which the plants create by converting some of the sugars made during photosynthesis into ATP (adenosine triphosphate). ATP is created through the process of respiration, which releases some carbon dioxide back

	into the atmosphere.