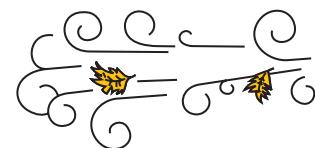


Carbon Footprint

Levels V-VI



Grades 9-12

Overview:

Students calculate their carbon footprint and then determine how they can reduce it. (NOTE: This lesson may require more than one class period.)

Objectives:

The student will:

- calculate their relative carbon footprint;
- read about the connection between carbon output and global warming; and
- research ways to mitigate climate change impacts.

GLEs Addressed:

Science

- [9] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating.
- [10-11] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, analyzing data, developing models, inferring, and communicating.
- [10-11] SC3.1 The student demonstrates an understanding that all organisms are linked to each other and their physical environments through the transfer and transformation of matter and energy by relating the carbon cycle to global climate change.
- [10] SD3.1 The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by describing causes, effects, preventions, and mitigations of human impact on climate.
- [10-11] SE3.1 The student demonstrates an understanding of how scientific discoveries and technological innovations affect our lives and society by researching a current problem, identifying possible solutions, and evaluating the impact of each solution.

Materials:

- Computer with Internet access (optional)
- OVERHEAD: "Carbon Emissions, CO₂ Concentrations, and Temperature"
- STUDENT INFORMATION SHEET: "Growing California Glaciers and Carbon Calculations"
- STUDENT WORKSHEET: "Carbon Footprint"
- STUDENT WORKSHEET: "Climate Change Mitigation and Adaptation"

Activity Procedure:

1. Ask students if they know the meaning of the phrase "carbon footprint." If necessary, explain that a carbon footprint is the amount of carbon a person uses on average. Since carbon is one of Earth's natural resources, a carbon footprint indicates how much of Earth's natural resources an individual uses. Explain that every time Earth's natural fuel reserves are used, carbon dioxide is emitted into the atmosphere.
2. Ask students if they know why someone would want to know their carbon footprint. Explain the more we consume, the bigger our footprint. Each time we consume, for example, purchase something at the store or drive a vehicle, we use Earth's natural resources directly or indirectly. Knowing a person's carbon footprint and how it compares to the carbon footprint of others can help students to identify how Earth is impacted by their actions.

3. Distribute the STUDENT WORKSHEET: "Carbon Footprint" and ask students to complete the worksheet.
4. As a class, create a chart of student results, graph the values, and then find the average "carbon footprint" of the class. Discuss why results may be similar or different (*similar or varied socioeconomic status in the community may result in a different balance of resources used*).

Critical Thinking Question: Think-Pair-Share Method. Divide students into pairs and assign each pair one item on the STUDENT WORKSHEET. Instruct pairs to explain how carbon dioxide is emitted through use of the item, directly or indirectly. Encourage students to use classroom resources (books, Internet, other students) to find the answer. Once students have explored the question, ask them to share their ideas with the class. If needed, explain that carbon dioxide is emitted into the air every time Earth's natural carbon reserves are used through the burning of fossil fuels: wood, natural gas, fuel oil, etc. When products, such as soda, are created and distributed, fuel, such as gasoline, is used to produce and transport the product. In this instance, the burning of gasoline, a fossil fuel, results in carbon dioxide emissions.

5. Ask students why it is important to know how much carbon we use. Distribute the STUDENT INFORMATION SHEET: "Growing California Glaciers and Carbon Calculations" and instruct students to read the article. Suggest that students keep notes by creating a "mind map." To create a mind map write the main idea in the center, and add branches of details that relate to the main idea.
6. As a class, discuss the article. Show students OVERHEAD: "Carbon Emissions, CO₂ Concentrations, and Temperature." Ask students to interpret the graph by answering the following question orally or in writing: "As carbon dioxide rises, what happens to atmospheric temperature?" Make sure students understand that scientists have linked rising atmospheric carbon dioxide levels with rising global temperatures. Human activities, primarily the burning of fossil fuels, and natural carbon dioxide emissions from sources such as volcanic eruptions, have been contributing to an increase in carbon dioxide in the atmosphere, which correlates to global temperature. In other words, as atmospheric carbon dioxide levels rise so does atmospheric temperature.
7. Explain that *Impacts of a Warming Arctic: Arctic Climate Impact Assessment* (2004) states, "the science suggests that responding to this challenge will require two sets of actions: one, called mitigation, to slow the speed and amount of future climate change by reducing greenhouse gas emissions; and the other, called adaptation, to attempt to limit adverse impacts by becoming more resilient to the climate changes that will occur while society pursues the first set of actions" (ACIA, p. 3).
8. Distribute the STUDENT WORKSHEET: "Climate Change Mitigation and Adaptation." Instruct students to research ways that individuals can contribute to climate change mitigation or adaptation and complete the worksheet. Suggest the following resources as a starting point. (NOTE: This can be done in small groups or as an individual assignment.)

United States Environmental Protection Agency: Climate Change Kids Site
<http://epa.gov/climatechange/kids/difference.html>

Pew Center: Global Climate Change: Global Warming –Kids Page
<http://www.pewclimate.org/global-warming-basics/kidspage.cfm>

Ben & Jerry's Canada Lick Global Warming: Learn More
http://www.benjerry.ca/about_us/lickglobalwarming/learn.cfm

9. When students have completed the worksheet, ask them to report their findings to the class.

Extension Idea: Visit www.zerofootprintkids.com to explore a "carbon footprint" calculator. As a class, or in small groups, calculate a carbon footprint. After answering all the questions on the form, compare the class or group carbon footprint to that of other countries (a built-in feature of the website). Discuss why other countries have different average carbon footprints.

Answers:

STUDENT WORKSHEET: “Carbon Footprint”

- 1-12. Answers will vary
13. Answers will vary, but should be tabulated correctly.

STUDENT WORKSHEET: “Climate Change Mitigation and Adaptation”

1. C. Carbon dioxide
2. B. CO₂ causes an increase in temperature
3. Answers will vary, but should express an understanding of activities that increase carbon usage.

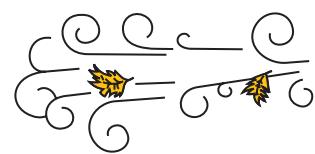
Growing California Glaciers and Carbon Calculations

Alaska Science Forum Article #1678, December 25, 2003

by Ned Rozell

Student Information Sheet

Levels V-VI



This column is provided as a public service by the Geophysical Institute, University of Alaska Fairbanks, in cooperation with the UAF research community. Ned Rozell is a science writer at the institute.

Believe it or not, California has glaciers and they're growing. These were two facts I learned at the recent meeting of the American Geophysical Union in San Francisco, when about 10,000 scientists gathered to present their work and catch up on the research of others.

During the last 50 years, glaciers on the summit of Mt. Shasta in northern California have bulked up, according to Ian Howat of the University of California, Santa Cruz. Howat and a team of earth scientists from UCSC traveled to the summit of Mt. Shasta a few years ago to predict the expiration date of small glaciers on Mt. Shasta. Instead, they found the glaciers had grown since 1951, and the largest, Whitney Glacier, had advanced about one kilometer during that time.

Since most (but not all) Alaska glaciers are melting at a rapid rate, one might expect California glaciers to have disappeared long ago, but Howat explained that the state holds many small cirque glaciers in its high mountains. The seven glaciers extending like pudgy fingers from the summit of Mt. Shasta have grown in the last 50 years because of weather patterns that have resulted in lots of snow up high, enough to offset melting losses below.

"In some areas, global warming can result in the increase of snow at high elevations," Howat said.

To get a perspective on the size of Mt. Shasta's glaciers, an Alaska scientist at the meeting figured all the ice on Mt. Shasta equals about what Alaska's Columbia Glacier calves into the ocean every two or three days.

In a press conference held during the San Francisco meeting, scientists argued that mankind had elevated the levels of carbon dioxide in Earth's atmosphere, one suspected cause of global warming, long before the industrial revolution of the 1700s and 1800s. William Ruddiman, an emeritus professor at the University of Virginia said that people had deforested much of Eurasia by the time of Christ's birth, and widespread cutting down of forests caused elevated levels of carbon dioxide. Ice cores show drops in CO₂ levels during times of great human die-offs, such as the Roman plague and the Black Death.

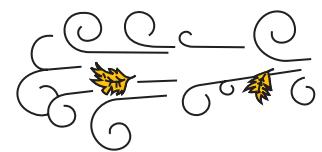
Carbon was also the topic of a presentation by Paul Higgins of Stanford University, who studies how ecological systems respond to climate change. Higgins calculated that if all Americans under the age of 64 walked or biked to work instead of driving, the U.S. could save more oil each year than the total amount of oil expected to be in Alaska's Arctic National Wildlife Refuge. Furthermore, the walking and biking could take care of America's obesity problem, Higgins said.

In a more reality-based study, Lawrence Plug tallied up the mileage traveled by the 10,000 scientists who attended the San Francisco meeting and added in the carbon dioxide released by their airplane travel. Plug, who studies permafrost at Dalhousie University in Halifax, Nova Scotia, estimated that each attendee had traveled an average of 4,900 miles round-trip to reach the conference, and had released 1,745 pounds of carbon into the atmosphere by attending. He concluded that holding the conference in Denver, a more central location, would reduce carbon dioxide emissions by 7.7 percent.

In other oil and carbon-based news, my own informal poll showed that hybrid gas/electric vehicles are catching on in San Francisco. I counted more than two dozen hybrid cars on the roads, most of them Toyota Prius sedans, Honda Civics and Honda Insights. While roaming the streets of San Francisco last year, I counted half as many.

Name: _____

Levels V-VI



Carbon Footprint Student Worksheet

Directions: Answer the following questions and then use the Scoring Instructions at the bottom to calculate your "carbon footprint."

- ____ 1. How do you get to school?
A. Walk or ride bike C. Car
B. Snow machine or four wheeler D. Bus or Van
- ____ 2. What kind of vehicle does your family drive? (If more than one, choose the largest.)
A. None C. Car
B. Snow machine/4-wheeler only D. SUV, Van or Truck
- ____ 3. How often does your family fly in a plane?
A. Less than once per month C. 2-4 times per month
B. Once per month D. Once per week or more
- ____ 4. What kind of food does your family eat?
A. Subsistence C. Store bought
B. Combination of store bought and subsistence
- ____ 5. How often does your family eat out or order food from a restaurant?
A. Never C. Once a week
B. Once a month D. Twice a week or more
- ____ 6. How much soda do you drink?
A. None C. 2 cans a day
B. 1 can a day D. 3 cans a day or more
- ____ 7. How often does your family do laundry?
A. Once per month C. Once per week
B. Twice per month D. Twice per week or more
- ____ 8. Do you get a newspaper or magazine at home A. No B. Yes
- ____ 9. Do you turn off the lights when you leave a room? A. Yes B. No
- ____ 10. Do you turn off your computer and other electronics when they are not in use? A. Yes B. No
- ____ 11. What type of fuel is used to heat your house?
A. Wood B. Propane C. Fuel oil D. Natural gas
- ____ 12. Circle each of the things your family owns.
A. Cell phone D. Computer G. Refrigerator
B. TV E. Washing Machine H. Snow machine, 4-wheeler, dirt bike (motorcycle)
C. DVD player F. Dishwasher I. Boat with motor
13. _____ Total Carbon Footprint

Scoring Instructions:

Calculate points for questions 1 through 11: A = 1 point B = 2 points C = 3 points D = 4 points

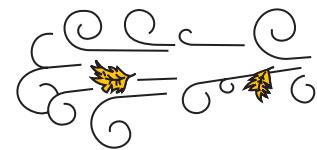
For question 12, assign yourself 1 point for each item circled.

Add all the points together to determine your "carbon footprint." Enter the total number of points in #13.

Name: _____

Levels V-VI

Climate Change Mitigation and Adaptation Student Worksheet



Directions: Answer the following questions.

1. What is CO₂?
 - A. Carbon oxygen
 - B. Core ocean
 - C. Carbon dioxide

2. What is the relationship between CO₂ and climate change?
 - A. CO₂ causes a decrease in temperature
 - B. CO₂ causes an increase in temperature
 - C. CO₂ causes ocean levels to rise

3. List three ways an individual can help mitigate climate change, by reducing their carbon footprint.
 - A. _____

 - B. _____

 - C. _____

Carbon Emissions, CO₂, Concentrations, and Temperature Overhead

