EARTH SYSTEMS

going getting warmer
to global warming

human contributions

△ FRAMEWORKS

SCIENCE
- **NS 1.6.7** Distinguish between scientific fact and opinion.
- **NS 1.7.7** Distinguish between questions that can and cannot be answered by science.
- **ESS 8.7.13** Identify and explain the effects that human activities have on weather and atmosphere.
- **ESS 8.7.20** Describe how human activities may contribute to global warming and the carbon dioxide-oxygen cycle.
- **NS 1.8.6** Formulate inferences based on scientific data.
- **ESS 8.8.1** Analyze the causes and predict the consequences of global warming.

LANGUAGE ARTS
- **W 5.6.10** Write across the curriculum.
- **W 5.7.10** Write across the curriculum.
- **W 5.8.10** Write across the curriculum.

△ OBJECTIVES

The students will learn:

**OBJECTIVE #1** To define global warming.

**OBJECTIVE #2** To define the five main greenhouse gases.

**OBJECTIVE #3** To describe how human activities increase the amount of those greenhouse gases in the atmosphere.

**OBJECTIVE #4** To explain how energy conservation might help reduce global warming.

**OBJECTIVE #5** To appropriately use verbal speaking skills in class discussion with the teacher and Garden Program Specialist.
Growing vegetables at home or at school can help conserve energy. Conserving energy can help slow global warming.

**OVERVIEW**

Human activities—mainly burning fossil fuels for energy consumption and deforestation—are believed to contribute to global warming.

**GARDEN ACTIVITIES**

- Plant, harvest and work in the garden according to the Garden Guide
- Recipes and Taste tests as time permits (refer to Delta Garden Study Recipe Book)
### TIPS FOR THE CLASSROOM

**Pre-lesson preparation:**
1. Carefully study the relationships between gardening and greenhouse gases (listed in the Supporting Information for Teachers).

### LESSON OUTLINE

<table>
<thead>
<tr>
<th>activities</th>
<th>estimated duration</th>
<th>actual duration</th>
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</thead>
<tbody>
<tr>
<td><strong>in the classroom</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>▲ Offer the icebreaker</td>
<td>5 minutes</td>
<td></td>
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<tr>
<td>▲ Present main topic</td>
<td>15 minutes</td>
<td></td>
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<tr>
<td><strong>in the garden</strong></td>
<td>15 minutes</td>
<td></td>
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<tr>
<td>▲ Perform composting activity, explaining how a vegetable garden can help reduce energy consumption and possibly, global warming; plant, harvest and work in the garden according to the Garden Guide</td>
<td>15 minutes</td>
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<tr>
<td>▲ Pick and taste produce as available</td>
<td>5 minutes</td>
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<tr>
<td><strong>back in the classroom</strong></td>
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</tr>
<tr>
<td>▲ Hand out Student Workbooks, review and assign “Take it Home Activity” as homework</td>
<td>5 minutes</td>
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### TIPS FOR THE GARDEN

**Pre-lesson preparation:**
1. Prepare to discuss the relationship between the garden and greenhouse gases.
2. Prepare a garden work activity for students in the garden.
**LESSON PLAN**

I. **Start in the classroom**
   
   A. **Icebreaker**
      
      Ask students: “How many acres of trees do you think could be destroyed in one hour due to use of chain saws, bulldozers or fire?”
      
      **Answer:** Every hour, at least 4,500 acres of trees are destroyed due to chain saws, bulldozers or flames.

   B. **Present Main Topic**
      
      ▲ Review global warming.
      ▲ Detail and explain the five major greenhouse gases and how human activities contribute to increased amounts of these gases in the atmosphere. Explain the carbon dioxide-oxygen cycle.
      ▲ Discuss with students how growing vegetables at home or at school can reduce global warming and positively contribute to the carbon dioxide-oxygen cycle.

II. **Take class to the garden**

   ▲ Discuss how gardening can contribute to reducing fossil-based fuel energy. Example: If we are growing our own lettuce, we don’t need to drive to the supermarket to buy it; hence, we are not emitting carbon dioxide. Or: If we eat more vegetables and less meat, how does that affect animal agriculture and the emission of carbon dioxide and methane?
   
   ▲ Plant, harvest and work in the garden according to the Garden Guide.
   
   ▲ Pick and taste available vegetables. Discuss how this produce was grown without commercial fertilizers, pesticides and herbicides and tie it in with global warming.

III. **Take class back to classroom**

   ▲ Hand out the Student Workbook as reference material and class assignment. Review take it home activities and encourage students to do them.
Supporting Information for Teachers

Background

Five Greenhouse Gases:
- Carbon dioxide (CO₂)
- Chlorofluorocarbons (CFCs)
- Hydrofluorocarbons (HFCs)
- Methane (CH₄)
- Nitrous oxide (N₂O)

To what degree human activities contribute to, or even cause, global warming remains a hotly debated topic. There are extremists on both ends. However, there is agreement that conserving energy on an individual basis can indeed make a collective difference to reduce overall energy demand. That, in turn, could lower everybody’s energy costs as well as lessen a nation’s dependence on fossil fuels. These are positive outcomes regardless of their connection to global warming.

A school garden that provides fresh vegetables, herbs, and fruit plays an important role in reducing greenhouse gases. By growing produce for personal use, individuals can reduce their energy consumption and greenhouse gas emissions in the following ways:

- Carbon Dioxide, CFC, & HFC Emissions
  Harvesting fresh produce in one’s backyard eliminates the need to drive to the supermarket for perishable fresh produce. It also cuts down on consumer demand for foods that are transported thousands of miles to their destination. Less driving translates into less burning of fossil fuels, i.e., fewer carbon dioxide emissions and fewer CFC and HFC emissions from refrigeration in trucks. (This equation only holds true if overall driving is reduced. If a home gardener drives to garden center frequently to pick up topsoil, compost, garden tools, seeds, etc., a reduction of fossil fuel emissions is not necessarily achieved. The overall labor and costs incurred with the development and maintenance of a vegetable garden need to be considered to gauge the environmental impact.)

- Methane (CH₄) & other Carbon Dioxide Emissions
  Having fresh, tasty vegetables readily available in the school or backyard might serve as an incentive to replace meat-heavy meals with more fruits and vegetables. Animal agriculture has led to a collective increase of methane emissions (a powerful greenhouse gas caused from animal waste) and contributed to worldwide deforestation, (clearing large amounts of forests). According to one estimate, if every American skipped one meal of chicken per week and substituted vegetarian foods instead, the carbon dioxide savings would be the same as taking more than a half-million cars off U.S. roads. Growing a garden can help convert more of this CO₂ into Oxygen. Methane is also emitted by coal mining, from landfills and wetlands and some forms of plant agriculture, such as rice paddies, but this amount is far less compared to animal agriculture.

- Nitrous Oxide (N₂O) Emissions
  In your own garden, you control the use of commercial fertilizers, pesticides, and herbicides, so you can eliminate the emissions of greenhouse gases (nitrous oxide) and poisons from such commercial products.

- Waste Reuse, Carbon Dioxide, & Methane
  Garden waste can be reused in composting. Plants love it and reusing reduces the need for trash pick-up and disposal in landfills, thereby reducing emissions of carbon dioxide (driving) and methane (landfill).

- Physical Health
  Gardening is excellent physical exercise, so there is less need to drive to a gym.
SOURCES

The ABCs of Ecology, An Educator’s Guide to Learning Outside
Publication by Ecology Education, Inc., 2006


A Cooler Climate.com

The True Cost of Food

Goveg.com
http://www.goveg.com/environment.asp

Project Learning Tree, Environmental Education Activity Guide, PreK-8

Natural Geographic Magazine
www.facingthefuture.org

How Far did it Travel? Exploring the Geography of Food
There are five major greenhouse gases. These are carbon dioxide (CO₂), methane, nitrous oxide, CFCs and HFCs.

In an earlier lesson, you learned about the greenhouse effect. The greenhouse effect happens when gases in the earth's atmosphere trap heat, preventing it from escaping into space. Up to a point, that's a good thing because it keeps the temperature on earth warm enough for humans to survive. However, over the last century, scientists have noticed that this greenhouse effect is getting stronger and the earth is getting warmer. What's more, this global warming appears to be caused by human activities.

Specifically, these human activities are:

**Burning fossil fuels to satisfy energy demands**: Every time you drive to the store or school, turn on the air conditioner or wash clothes, you are using energy. Most of this energy comes from burning fossil fuels such as coal, natural gas, oil and gasoline. Fossil fuels develop in the earth's crust over hundreds of millions of years. When burned, they release large amounts of carbon dioxide (CO₂) into the atmosphere. Carbon dioxide is the main greenhouse gas. Today, on average, each person in the United States produces 2.3 tons of CO₂ a year, with about half of that coming from cars. Many scientists believe that this great increase of CO₂ in the atmosphere will raise average temperatures across the earth by several degrees Fahrenheit. Can you think of some ways that you might burn fossil fuels?

**Cutting forests (deforestation) to clear land for grazing, agriculture and development**: All green plants take in CO₂ from the atmosphere and convert it into oxygen through a process called photosynthesis. The more plants there are, the more photosynthesis can take place and the less CO₂ is in the air; trapping heat. And, the more oxygen we have to breathe! This flow of carbon dioxide and oxygen through Earth’s ecosystems is called the carbon dioxide-oxygen cycle. The huge area of tropical rain forests in South America, especially Brazil, has been called “the lungs of the earth” because it converts a huge amount of our CO₂ into oxygen. However, forests and grasslands across the globe are being cut down to clear lands for farming, build houses and roads, and graze animals, like cows. All this leaves fewer and fewer plants to convert CO₂ into oxygen.

**Animal agriculture**: Methane is another powerful greenhouse gas and is now considered responsible for half of the earth’s man-
made global warming. Methane (CH₄) occurs naturally in the intestines of livestock, such as cows, sheep and goats. While the amount of methane emitted by a single cow is relatively small, the combined impact of millions of cows is enormous. It is estimated that more than 100 million tons of methane are produced each year by animal agriculture. With steadily rising global demands for meat, methane gas in the atmosphere will increase as well. We can help by replacing some of our meaty meals with more fresh fruits and vegetables.

**Nitrous Oxide from commercial fertilizers, pesticides, and herbicides**: Commercial fertilizers, pesticides and herbicides often release the greenhouse gas nitrous oxide (N₂O). Farmers and gardeners can use natural waste in the place of commercial fertilizers, such as compost and animal manures. Natural herbicides (a substance used to kill certain plants) and pesticides (a substance used to kill certain insects) can also be used instead of commercial herbicides and pesticides.

**Use of CFCs and HFCs**: Two other greenhouse gases are chlorofluorocarbons and hydrofluorocarbons, commonly called CFCs and HFCs. They are used in refrigeration and air conditioning for homes, businesses, and food trucks. Because there are more and more products requiring CFCs and HFCs, there are more and more of these gases being emitted into the atmosphere, making our earth warmer and warmer.

There is a heated debate over global warming, with extreme views on both sides. While there is general agreement that the earth’s temperature has been rising over the last 100 years, people disagree about what should be done about it. Will global warming have devastating natural and economic consequences or will it lead to longer growing seasons with increased food production and lower heating costs in many areas? One outcome is certain: you will hear and learn a great deal more about global warming in the years to come.

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**carbon dioxide-oxygen cycle** the flow of carbon dioxide and oxygen through Earth's ecosystems

**chlorofluorocarbons (CFCs)** a compound of carbon and fluorine, chlorine used in refrigeration and air-conditioning, formerly used in aerosol cans

**fossil fuel** fuel such as oil, coal or natural gas that formed underground millions of years ago from decaying organic matter

**global warming** an increase in the earth’s average temperature that is caused by gases in the atmosphere that trap heat

**hydrofluorocarbons (HCFs)** a fluorocarbon used in refrigeration and air-conditioning that is now replacing chlorofluorocarbon as in aerosol cans; considered to be somewhat less harmful

**methane (CH₄)** a powerful greenhouse gas that occurs naturally in the intestines of livestock

**nitrous oxide (N₂O)** greenhouse gas commonly found in commercial fertilizers, pesticides and herbicides
ESS. 8.7.20 Describe how human activities may contribute to global warming.

1. **What could we do to lessen global warming?**
   
   a. Walk more and use our car less often
   
   b. Eat less meat
   
   c. Plant trees
   
   d. Turn off the lights when we leave the room
   
   e. All of the above

2. **List the five major greenhouse gases and their sources.**
   
   1. 
   
   2. 
   
   3. 
   
   4. 
   
   5. 

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**Take it Home**

*Make it a point to help reduce Global Warming today.*

*Instead of riding in a car to the store, park, church, or school, walk or ride your bike there instead.*
1. What could we do to lessen global warming?
   e. All of the above

2. List the five major greenhouse gases and their sources.
   1. carbon dioxide – burning fossil fuels
   2. CFCs – air conditioning and refrigeration
   3. HFCs – air conditioning and refrigeration
   4. methane – animals or livestock
   5. nitrous oxide – fertilizers, pesticides and or herbicides
ESS. 8.7.20 Describe how human activities may contribute to global warming.

1. What's the connection between our need for energy and global warming?

2. List the five major greenhouse gases and their sources.
   1. 
   2. 
   3. 
   4. 
   5. 

continued next page
3. **What could we do to lessen global warming?**
   a. Walk more and use our car less often
   b. Eat less meat
   c. Plant trees
   d. Turn off the lights when we leave the room
   e. All of the above

4. **Describe the carbon dioxide-oxygen cycle. Explain how growing a garden can play a role in this cycle.**
1. **What's the connection between our need for energy and global warming?**

   Answers may vary but should include something indicating the understanding of deforestation, burning fossil fuels, carbon dioxide, etc.

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   3. HFCs – air conditioning and refrigeration
   4. methane – animals or livestock
   5. nitrous oxide – fertilizers, pesticides and or herbicides

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4. **Describe the carbon dioxide-oxygen cycle. Explain how growing a garden can play a role in this cycle.**

   Carbon dioxide-oxygen cycle is the flow of carbon dioxide and oxygen through the earth’s ecosystems. Answers may vary.
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**answer key**

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**NS 1.6.7** Distinguish between scientific fact and opinion.
**NS 1.8.6** Formulate inferences based on scientific data.
**ESS. 8.7.20** Describe how human activities may contribute to global warming.

1. Research global warming and find out what scientists around the world are saying about it. You can use textbooks, library books, newspaper or the Internet to prepare a one-page report about global warming.