JOB CORPS

Climate Change




USDA

United States Department of Agriculture • Forest Service

CURRICULUM AND ACTIVITY GUIDE—MODULE 1

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PURPOSE OF THE MODULE

The lessons that follow are designed to introduce Job Corps students to the science and impacts of climate change. Your students' future jobs may involve work related to minimizing the impacts of climate change, such as installing solar panels or weatherizing homes. Future careers may also involve work related to adapting to a changing climate, such as planting different species of crops or trees or installing deeper piles for buildings. A general knowledge about climate change can put these future workers at an advantage in the workplace and make them better informed citizens and Earth stewards.

Our Nation's future relies on a well-educated public to be wise stewards of the very environment that sustains us, our families and communities, and future generations. Teaching young people about the environment will help them, as they prepare for the working world, to make the connections between economic prosperity, benefits to society, environmental health, and our own well-being. Ultimately, the collective wisdom of our citizens, gained through education, will be the most compelling and most successful strategy for environmental management.

At the same time, business leaders increasingly believe that an environmentally literate workforce is critical to their long-term success and profitability. With better environmental practices and improved efficiencies impacting the bottom line, businesses will prepare their companies for the future. Charles O. Holliday, Jr., Chairman and Chief Executive Officer of DuPont, speaks for a growing number of his peers in declaring that "an environmentally sustainable business is just good business, given the growing concern for environmental problems across America. A key component of an environmentally sustainable business is a highly educated workforce, particularly involving environmental principles."

INTRODUCTION

The Greenhouse Effect is a natural phenomenon that has made the Earth a perfect place for life. Greenhouse gases in our atmosphere trap the Sun's heat, similar to heat trapped inside a car on a warm day. Without greenhouse gases, our planet would be frozen.

Greenhouse gases enter the atmosphere through natural sources—from volcanoes, wetlands, and forest fires. They also enter the atmosphere through human sources—fossil fuels, livestock, and rice paddies. Since the Industrial Revolution, humankind has burned fossil fuels to drive vehicles, to power factories, and to heat homes. The burning of fossil fuels has increased the amount of greenhouse gases in the atmosphere. Over time, more and more heat is retained, leading to an increase in the Earth's average surface temperature—global warming.

Climate change refers to long-term changes in the climate. Climate change can be natural or might be caused by changes people have made to the land and atmosphere. Based on evidence from tree rings, ice cores, and other natural records and scientific observations made around the world, Earth's average temperature is already warmer than it has been for at least the past 1,300 years.[1] Average temperatures have increased markedly in the past 50 years, especially at the North and South Poles. Measurements have shown that the increase in Earth's temperature tracks with the increase of carbon dioxide (CO_2) in the atmosphere.

DID YOU KNOW?

A pile is a heavy beam of wood, concrete, or steel driven into the Earth as a foundation or support for a building or other structure.

[1] Intergovernmental Panel on Climate Change (IPCC), AR4 Synthesis Report, 2007

"Global atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed preindustrial values determined from ice cores spanning many thousands of years."[2] The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture.[3]

For a brief introduction to climate change, check out the "ACE Situation" video by the Alliance For Climate Education, on your DVD.

The Intergovernmental Panel on Climate Change (IPCC) has stated that an overwhelming consensus of scientific studies on climate indicates that most of the observed increase in global average temperatures since the latter part of the 20th century is very likely due to human activities, primarily from increases in greenhouse gas concentrations resulting from the burning of fossil fuels. A warmer planet is just one result of climate change, but there are many others:

- More frequent and extreme weather events, such as droughts and floods.
- Changes in precipitation patterns, such as more rain/snow in the winter months but less in the summer months.
- Melting glaciers and polar ice caps.
- Increases in hurricane speeds resulting from warmer ocean temperatures. The destructive potential of Atlantic tropical storms and hurricanes has increased since 1970 in association with warming sea surface temperatures.
- Increases in river and lake temperatures may lead to species loss.
- Rise in sea level.
- Increases in frequency of forest fires.
- Longer growing season.
- Increases in some forest productivity.
- Increases in some crop diversity.
- Spread of insects and disease.
- Potential loss of habitats and associated plant and animal species.

Individuals, as well as community, government, business, and industry leaders, can contribute to reducing and adapting to climate change. We need to look at some short-term actions, such as conserving energy, using our resources more efficiently, and switching to renewable resources. But we also need to look at long-term actions, such as investing in new technology, adopting sustainable development strategies, and building a new "green" economy.

REFERENCES

IPCC, 2007: *The Physical Science Basis: Contribution of Working Group I.* The Intergovernmental Panel of Climate Change is the leading body for the assessment of climate change, established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences. http://www.ipcc.ch. (March 15, 2010)

IPCC. 2007. Synthesis Report: Summary for Policy Makers.

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NOAA. 2008. Climate Literacy—the Essential Principles of Climate Sciences, K-12.

USDA Forest Service, What Is Climate Change? www.fs.fed.us/climatechange/climate.shtml (March 15, 2010)

[2] Intergovernmental Panel on Climate Change (IPCC), AR4 Synthesis Report, 2007
[3] Intergovernmental Panel on Climate Change (IPCC), AR4 Synthesis Report, 2007

CONNECTING TO THE CONTENT

Why is climate change important to students and to their future careers?

1. **Climate change can have a negative impact on human health.** Some of the impacts of climate change are warmer temperatures and longer heat waves. Burning fossil fuels in urban areas creates air pollution that can increase respiratory problems such as asthma. Heat related deaths are also increasing throughout the country. Climate change can also increase our exposure to diseases such as West Nile Virus and malaria.
2. **Climate change will impact our work.** To address climate change, many city, State, and Federal governments are changing regulations. We may see rules for energy efficiency in new buildings, more high-occupancy vehicle lanes, or emissions testing for vehicles. There may be new restrictions for construction along coast lines as a result of sea level rise. As students go out into the world of work, they need to know that their vocations may require new skills to meet the needs of a changing climate.
3. **A changing climate means our costs may increase.** Higher costs for bread, pasta, and milk? This could happen during years of extreme drought. It is expected that climate change could impact our ability to grow important food crops and livestock. Pest outbreaks in some forests may result in higher costs for lumber and other wood products. In periods of drought, our use of municipal water supply may become restricted. Students may see higher costs in raw materials that need to be passed along to their customers.
4. **Reducing our carbon footprint will result in jobs.** We need people to show us the way. America is making a green shift towards a low-carbon society, new products, and new ways of living. This green shift has already resulted in the adaptation of many traditional jobs. Solar panels and geothermal heat pumps need to be installed, and homes and offices need to become more energy efficient. Vehicles are becoming more energy efficient, and our new construction must conform to energy efficient guidelines. These jobs can be filled with trained young people.
5. **Taking steps to reduce our carbon footprint has many co-benefits.** Reducing our greenhouse gas emissions will also help us save money, improve air quality, and extend the life of our fossil fuel resources. If we are using our natural resources more efficiently, they will last much longer.
6. **Everyone can take steps to reduce greenhouse gas emissions.** One person or business or government cannot solve our climate change problems. It will take efforts from everyone, from individuals and small business owners to industries and schools. Small steps will be just as important as big nationwide changes.

DID YOU KNOW?

Many centers already have programs to reduce their carbon footprints. Jim Christensen from Palmer, AK, knows that they are practicing what they teach at his Job Corps center. Because of energy saving measures taken by students and staff, the center has cut electrical and natural gas bills by 12 percent.

“Students are involved in all projects and are active in an energy committee,” says Christensen, Operations Manager at the Alaska Job Corps Center. They have installed energy efficient exit lights and driving simulators to save money on gas and diesel for driver’s training.

Besides their energy saving efforts, the Alaska Job Corps Center has instituted recycling programs, where students were involved in the construction of recycling sheds. They also gained hands-on experience by volunteering at the local recycling plant.

ACTIVITY OVERVIEW

Activity Name	Activity Type	Duration	Number of Students Required	Page Number
Battle the Vampires!	Warm-up investigation that asks students to search for power vampires.	Approximately 10 minutes	1	8
Simulating the Greenhouse Effect	An independent activity where students build and monitor a simple, simulated "greenhouse."	Approximately 1 ½ hours	1	9-10
What Is Climate Change?	Students watch a short, animated video entitled "What Is Climate Change?" and then have a discussion.	Approximately 30 minutes	1-15	11
The Carbon Trip	In this simulation activity, students become carbon atoms and move throughout the carbon cycle.	Approximately 1 hour	3 and up	12-15
Planting Trees for Climate Change	A community service project where students create a carbon sink by planting trees. Students calculate the emissions from one carbon-intensive activity and offset those emissions by planting trees.	15 minutes plus tree-planting time	1	16-17

You can select only one activity to complete with students or you can complete them all. They are non-sequential activities and can be completed in any order. Student worksheets and handouts accompany this module and can be photocopied as needed.

At the end of each activity, there are suggested questions for assessment with the students. These questions can be posed to students to facilitate a group discussion or they can be answered individually, using paper or a computer.

WARM-UP INVESTIGATION:
BATTLE THE VAMPIRES!

TIME: 10 minutes

NUMBER OF STUDENTS REQUIRED: 1

TRY THIS ACTIVITY IN:
- Career Preparation Period (CPP)/New Student Phase
- Academic Training: Science

BACKGROUND:
Power vampires are devices that keep sucking electricity even after you think you've turned them off! Many appliances and electronics consume electricity and remain in "stand-by mode" until they are unplugged from the wall. Electronics in particular are almost always power vampires. They include TVs, DVD players, laptop chargers, modems, printers, and MP3 chargers. The U.S. Department of Energy estimates that equipment and appliances in stand-by mode make up approximately 10 percent of residential electricity use. The average home contains about 20 power vampires.

Americans are the largest consumers of energy per capita in the world. This is, in part, due to things like using power when we don't even realize it. Because we use a lot of energy, we burn a lot of fossil fuels to create that energy. There are many simple ways to reduce our energy use while still maintaining our standard of living.

STUDENTS NEED TO:
Select a room or rooms and hunt for vampires. It could be a classroom, residence room, or recreational area. Look for the items listed below. If you are unsure, look for glowing LED (light-emitting diode) lights or a glowing digital clock as a sign that electricity is still being used. As well, look for large black transformers or power bricks on equipment power cords. They can be found at the plug (like cell phone chargers) or along the cord (laptop chargers). Cords with power bricks are power vampires.

Entertainment:
- TV, TV adapter, cable box, satellite receiver, DVR, DVD/VCR, stereo, receiver, CD player, MP3/iPod/iPhone charger, iPod speaker, video game console.

Communications:
- Phone, cell phone charger, fax machine.

Computer:
- Tower, printer, laptop when plugged in, copier, monitor, speakers.

Miscellaneous:
- Microwave, appliances that have digital clocks.

WRAP-UP:
How many vampires did you find in your room? What can you do to battle these vampires? Here are some ideas:

1. Plug items such as computer and entertainment components into a power bar. Turn off the power bar when you are finished using these electronics.
2. Unplug seldom-used appliances. Make a sign as a reminder to others.
3. Unplug televisions and other entertainment equipment when not in use.

DID YOU KNOW?
Unplugging power vampires can save the average American home about $200 each year.

INDIVIDUAL or SMALL GROUP ACTIVITY:

SIMULATING THE GREENHOUSE EFFECT

TIME: About 1.5 hours

NUMBER OF STUDENTS REQUIRED: 1 or more

TRY THIS ACTIVITY IN:
- Career Preparation Period (CPP)/New Student Phase
- Academic Training: Science

DESCRIPTION:
The greenhouse effect is a natural occurrence that keeps the Earth at a temperature that can sustain life. The problem occurs when humans produce more greenhouse gases than our current ecosystem has adapted to. In this activity, the students will actually build and monitor a simple simulated "greenhouse."

WORDS TO KNOW:
Greenhouse effect
Greenhouse gas

OBJECTIVES:

Students will:
- Define greenhouse effect and global warming.
- Graph data from two different greenhouse models.
- List ways to diminish production of excess greenhouse gases.
- Gather further information on greenhouse effect and global warming via the Web.

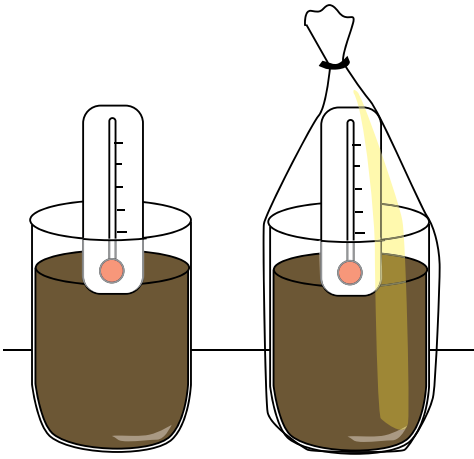
MATERIALS:

For the class:
- Two empty, clean, 2-liter soda bottles, label removed
- 3 cups of potting mix per bottle
- 1 thermometer per bottle
- 1 cup of water per bottle
- 1 piece of plastic wrap for one bottle
- Tape
- Heat lamp or grow light

For each student:
- A copy of the Greenhouse Effect worksheet. This worksheet can be found in the Attachments & Student Handouts section on page 23.
- Graph paper and pencil or graphing software.

PROCEDURE:

Students will:
1. Cut off the tops of two 2-liter bottles.
2. Fill each bottle with 3 cups of potting soil.
3. Pour 1 cup of water into each bottle.
4. Tape or hang a thermometer to the inside of each bottle in such a way that the degrees can be seen from the outside.



INSTRUCTOR TIP:

Does your cafeteria have heat lamps that they use to keep food warm during meal time? Using these lamps may be an easy way to complete this experiment. That way, you don't have to buy a heat lamp or grow light.

5. Cover one bottle with plastic wrap. Secure the edges of the plastic wrap to the outside of the bottle with tape.
6. Place both bottles under a heat lamp or grow light.
7. Begin the simulation.
8. Distribute student greenhouse effect worksheets. Have students record temperature readings every 15 minutes for 1 hour. (If you have time, you could extend this collection period to 90 minutes.)
9. Graph data.
10. Analyze data.

DID YOU KNOW?

According to the Earth Day Network, people living in cities such as Atlanta, Baltimore, and Cincinnati could see a 60-percent increase in the number of high smog level days by mid-century.

ASSESSMENT:

Assessment can be done in a number of ways. These questions may be used to facilitate a classroom discussion or small group conversation. Alternatively, students may record answers to these questions as an assignment to complete the activity.

Discuss the following questions with your students. Why did the temperature in the covered bottle rise? *Heat is trapped in the covered bottle and thus the temperature rises and is then maintained.* Why does the temperature in both bottles level off over time? *Each bottle reaches its maximum temperature. The amount of heat given off in each bottle is determined by the heat source, in this case the light.* How is the covered bottle like a greenhouse? *The covering of a greenhouse holds in heat, as does the plastic wrap over the bottle.*

INDEPENDENT ACTIVITY:
WHAT IS CLIMATE CHANGE?

TIME: 9 minutes to watch the video and 15 minutes to write or have a discussion

NUMBER OF STUDENTS REQUIRED: 1 to 15

TRY THIS ACTIVITY IN:
- Career Preparation Period (CPP)/New Student Phase
- Academic Training: Science, Social Studies
- Student Government Association (assessment portion of activity)

DESCRIPTION:
Students will develop a better understanding of climate change by watching a short animated video entitled "ACE Situation" from the Alliance for Climate Education (ACE).

WORDS TO KNOW:
Climate change
Greenhouse effect
Greenhouse gas

OBJECTIVES:
Students will:
- Develop a better understanding of the greenhouse effect and global warming.
- Understand how they contribute greenhouse gas emissions.
- Name two greenhouse gases.

MATERIALS:
- ACE climate change video on DVD (see inside front cover).
- ACE Video Facts Quiz, found in the Attachments & Student Handouts section on page 29.

PROCEDURE:
1. Have students watch the 9-minute video entitled "ACE Situation."
2. While watching the video, or after it is done, have students complete the ACE Video Facts Quiz.

Post-video discussion:
1. Describe climate change.
2. What human activities contribute to climate change?
3. What greenhouse gases are people adding to the atmosphere?
4. What is happening to plants, animals, and people because of climate change?
5. What are some things we can do to reduce our greenhouse gas emissions?

ASSESSMENT:
Ask students to choose a DOT: a pledge to Do One Thing to help the environment and cool the climate. A DOT can be anything like carrying a reusable water bottle, unplugging energy vampires, or riding a bike instead of driving anywhere within 2 miles. Students should think about actions they can do every day and share their DOT with the group.

Then, ask students to design a DOT poster for their school. What messages and images will be on the poster? How will they try to inspire other students to take action with them? This could help to develop a DOT at your Job Corps center. Find out more by visiting http://www.acespace.org/toolkit/dot.

GROUP ACTIVITY:

THE CARBON TRIP

TIME: About 1 hour including game set-up and assessment

NUMBER OF STUDENTS REQUIRED: 3 or more

TRY THIS ACTIVITY IN:

- Academic Training: Science, Social Studies
- Student Government Association

DESCRIPTION:

Has the carbon cycle changed since we started burning fossil fuels? Students find out by becoming carbon atoms and moving throughout the carbon cycle.

WORDS TO KNOW:

Atmosphere
Biosphere
Carbon cycle
Hydrosphere
Industrial Revolution
Lithosphere

INSTRUCTOR TIP:

If you have not already done so, you may find it very beneficial to have students watch the 9-minute video entitled "ACE Situation" before completing The Carbon Trip.

OBJECTIVES:

Students will:

- Develop a better understanding of the carbon cycle.
- Compare pre-industrial and post-industrial carbon cycle.

MATERIALS:

1. Signs for four stations as follows:
   - The Biosphere—plants/animals.
   - The Hydrosphere—all water on the Earth including in the air, rivers, streams, and underground.
   - The Atmosphere—air on Earth.
   - The Lithosphere—the ground and underground up to 60 miles below the Earth's crust.
2. Regular size (8/0) Pony Beads in the following colors: green (biosphere), blue (hydrosphere), clear (atmosphere) and black (lithosphere). Please note: These beads can be found in most hobby or craft stores and many discount department stores that have hobby departments.

DID YOU KNOW?

Accreditation gives Job Corps students 1 point. Understanding green gives them an additional 1.25 points in the Training Achievement Records. That means a dollar or more in saving or an increase in salary.

INSTRUCTOR TIP:

After you create these cubes, make sure that certain cubes are to be used only at specific stations.

3. Five large cubes created by taking 3-inch Styrofoam cubes (available from the same sources as those mentioned in step 2). Templates for these cubes can be found in the attachments section on page 24 or at http://fs.usda.gov/conservationeducation (click on Educator's Toolbox). Simply cut out the templates and paste them to the different faces of the cubes.
   - **Ground/underground (lithosphere)**—represented by a picture of rocks, coal or oil. (You will create two lithosphere cubes since one will be used during the first round of the game, which will represent the preindustrial period, and the second will be used during the second round, which is the postindustrial period.)
   - **Plants/animals (biosphere)**—represented by a picture of a tree and a person.
   - **Water (hydrosphere)**—represented by a water drop or a lake.
   - **Air (atmosphere)**—represented by a cloud.

   a. The Atmosphere Cube will look like this:
      - Two faces are ground/underground.
      - One face is plants/animals and their environment.
      - One face is respiration/breathing.
      - One face is fire.
      - One face is decomposition.
   b. The Water Cube will look like this:
      - Two faces are water.
      - Four faces are ground/underground.
   c. The Air Cube will look like this:
      - Two faces are water.
      - Four faces are plants/animals.
   d. The Preindustrial Ground/Underground Cube will look like this:
      - Five faces are ground/underground.
      - One face is atmosphere.
   e. The Postindustrial Ground/Underground Cube will look like this:
      - Two faces are ground/underground.
      - One face is air.
      - Three faces are fire/burning.

DID YOU KNOW?

According to Chevron, the world consumes two barrels of oil for every barrel discovered.

INSTRUCTOR TIP:

For round one, the Lithosphere station will have the Preindustrial Ground/Underground Cube.
For round two, the Lithosphere station will have the Postindustrial Ground/Underground Cube.

4. Four small reusable plastic containers, such as food storage containers (to house beads for the activity).
5. White pipe cleaners—about 6 inches long, two for each participant. The pipe cleaners will hold the beads that the students collect during the game. Each pipe cleaner should have one end knotted so that the collected beads will not fall off.

SETTING UP THE STATIONS:

1. Set up four stations throughout the room. Each station represents one part of the Carbon Cycle—the atmosphere, the hydrosphere, the lithosphere, and the biosphere.
2. For each station, post a sign indicating the name of that station and the appropriate cube for that station.
3. At each station, place a container of beads that corresponds to that station. For example, the blue beads and the hydrosphere cube will be placed at the hydrosphere station.

PROCEDURE:

For Round 1, each student:

1. Starts at one station, as chosen by you or the student. There can be more than one student at each station.
2. Receives one knotted pipe cleaner.
3. Represents a carbon atom in the carbon cycle. They will travel around the Earth following the journey of a carbon atom in the preindustrial world—before we began burning lots of fossil fuels.
4. Places one bead from his or her station on the pipe cleaner, when given the signal by the teacher.
5. Rolls the cube at that station. This will tell the student where he or she needs to go. The student will then move to the next station. In some cases, he or she may stay at the same cube. In both cases, the student will add a bead to his or her pipe cleaner.
6. Moves to another station, doing the same thing. The student takes a bead from the container, and then rolls the cube and moves to the next station.

INSTRUCTOR TIP:

After round one, most of the students should have a high portion of black beads on their pipe cleaners. This represents coal, natural gas, oil…all carbon molecules in this area. As a result of energy from the Sun, carbon accumulates in plants and animals. When these living things die, the carbon remains. Over millions of years, the carbon deposits may become fossil fuels.

7. Will move from station to station for about 7 minutes, or until they fill up their pipe cleaner.

This is the end of round one. Ask the students what color beads they have on their pipe cleaner and what happened to them during their trip. Did they see any patterns? For instance did they stay at any place more than once? What may explain this?

Then, announce that we are moving to the Industrial Age—Round 2.

1. Give each student a new pipe cleaner.
2. Exchange the Preindustrial Ground/ Underground Cube for the Postindustrial Ground/Underground Cube.
3. Have students start at the same station they started in the first round.
4. Again, have students pick up a bead from their station and roll the cube. They will move around the room again for about 7 minutes.
5. Stop round 2. Ask the students what kinds of beads they have on their pipe cleaner and what happened to them in their trip/journey. Did they see any patterns? For instance, did they stay at any place more than once? What may explain this?

ASSESSMENT:

Compare the results from the first pipe cleaner exercise to the second one. What did the students notice?

In the second round, their pipe cleaner should have mostly clear beads. The postindustrial era is taking the energy from the ground/underground (lithosphere) and is using this for fuel. By burning the fossil fuel, the carbon in these fuels is released and becomes part of our atmosphere. As a result, there is a concentration that stays in the air and is removed from the ground.

Have students review the Forest Foundation's Carbon Cycle poster. It can be found at http://www.fs.fed.us/climatechange/documents/carbon.pdf. Ask students to describe the path that they took as a carbon atom around the carbon cycle.

DID YOU KNOW?

If every American home replaced just one light bulb with an ENERGY STAR compact fluorescent light bulb, we would save enough energy to light nearly 3 million homes.

U.S. Department of Energy

INSTRUCTOR TIP:

You cannot predict exactly what combinations of beads your students will put on their pipe cleaners. You can be fairly certain that after the second round, more of the black beads will end up in the atmosphere, which is a direct result of the burning of fossil fuels.

INDEPENDENT ACTIVITY:

PLANTING TREES FOR CLIMATE CHANGE

TIME: 15 minutes to complete the worksheet and time for the student to plant their trees

NUMBER OF STUDENTS REQUIRED: 1

TRY THIS ACTIVITY IN:
- Career Preparation Period (CPP)/New Student Phase
- Academic Training: Science, Math
- Student Government Association

DESCRIPTION: Using a worksheet, students select one of their carbon-intensive activities and offset those emissions by planting trees.

WORDS TO KNOW:
Carbon sink
Carbon source
Fossil fuels
Industrial Revolution

OBJECTIVES:

Students will:
- Understand the terms "carbon source" and "carbon sink."
- Be able to explain how carbon dioxide is added to the atmosphere and ways that carbon can be removed from the atmosphere.
- Plant native tree seedlings to offset some of their personal carbon emissions.

MATERIALS:

- Tree planting worksheet. It can be found in the attachments section on page 31.
- Trees for planting. Small native tree seedlings can be purchased in bulk for about $1 per tree from the Arbor Day Foundation.
- Tree planting tools such as spade, stakes, gloves, and compost or soil.

CARBON SOURCES: FINDING THE CULPRITS

Carbon dioxide (CO_2) is one of the gasses produced when we burn fossil fuels to heat our homes, turn on our lights, and run our schools, businesses, and industries. Because all of these activities add carbon dioxide to the atmosphere, we call them carbon sources.

Since the Industrial Revolution, we have increased CO_2 in the atmosphere by 30 percent—this may not sound like a lot but it has already caused an increase in the average global temperature. Scientists are no longer saying "if" but "how warm?" and they agree that the consequences will be dramatic and costly.

Whether we know it or not, we all add carbon to the atmosphere. But, we can also remove carbon from the atmosphere.

CARBON SINKS: TREES TO THE RESCUE!

A carbon sink is any natural system that can absorb carbon dioxide from the atmosphere. The big carbon sinks on Earth are oceans and forests. Green plants, in the ocean and on land, take in carbon dioxide from the atmosphere as they grow. The more forests we have, the more carbon sinks we have, and the more carbon dioxide is removed from the atmosphere.

PROCEDURE:

1. Ask students to complete the worksheet found on page 33. This worksheet asks students to find out how much carbon dioxide is produced when using typical appliances or electronics. Then, students will determine how many trees they need to plan to absorb the carbon dioxide produced by that appliance or electronic device. An example of a completed worksheet can be found on page 31.
2. Help the students plant their trees.

ASSESSMENT:

Ask students about their tree planting experience. Did they enjoy it? Can humans plant trees to eliminate all of our greenhouse gas emissions? *No—we will need to find other solutions as well.* What other solutions can the students find to reduce greenhouse gas emissions at school? What projects could they do that would permanently make their Job Corps Center more energy efficient?

Find out more about the benefits of planting trees at the Colorado Tree Coalition: http://www.coloradotrees.org.

Get these Forest Service resources on trees by calling (202) 205–5681.

How a Tree Grows: FS-8
Color poster showing parts of a tree

How a Tree Grows: FS-32
Booklet that accompanies the posters

Life, Death, & Rebirth of a Tree: FS-356
Color poster showing life cycle of trees

DID YOU KNOW?

Trees properly placed around buildings can reduce air conditioning needs by 30 percent and can save 20 to 50 percent in energy used for heating.

Forest Service

CLIMATE CHANGE EXTENSION ACTIVITIES AND RESOURCES

What do Trees have to do with Climate Change? This hands-on classroom module is the first in a series of modules specifically developed for use by Job Corps Centers in the United States. In this module, students learn about the importance of forests in the climate change issue, they will understand how a tree captures and stores carbon, and they will be able to name at least one thing they can do individually to help control climate change. Request this resource from the Forest Service Conservation Education Office at 202-205-5681 or varthur@fs.fed.us.

Find out how much carbon dioxide you produce through transportation. **The TravelMatters** Web site offers a trio of resources—interactive emissions calculators, online emissions maps, and a wealth of educational content—to emphasize the close relationship between more efficient transit systems and lower greenhouse gas emissions. Visit http://www.travelmatters.org/.

i-Tree. i-Tree software was developed by the Forest Service and our partners to assess the benefits and costs associated with trees in urban forests and landscapes. It has been successfully used by urban foresters and many other professionals. Using a curriculum called i-Tree in the Classroom, the students will learn about the ecosystem services of trees such as carbon sequestration, energy savings, and clean air and water benefits. They can apply their investigations in their schoolyard and other areas in the community. This curriculum provides teachers and students a greater understanding of the benefits of trees and their contribution to sustainable healthy living. The first of a series of lab exercises is currently undergoing classroom testing, and additional modules are planned. Visit http://itreetools.org/education/.

Climate Literacy: "The Essential Principles of Climate Sciences," A Guide for Individuals and Communities. A new version of the Climate Literacy guide has been developed through the U.S. Global Change Science Program. The Essential Principles of Climate Sciences presents important information for individuals and communities to understand Earth's climate, impacts of climate change, and approaches for adapting and mitigating change. Principles in the guide can serve as discussion starters or launching points for scientific inquiry. The guide can also serve educators who teach climate science as part of their science curricula. Visit http://www.climatescience.gov/Library/Literacy/.

Climate Change, Wildlife, and Wildlands Toolkit. This kit, designed for classroom teachers and informal educators, is aimed at the middle school level. The Forest Service, along with six other Federal agencies, developed the kit to aid educators in teaching how climate change is affecting our Nation's wildlife and public lands and how everyone can become "climate stewards." The contents of the toolkit include a 12-minute video introducing climate change issues as they affect wildlife and wildlands. There are 11 case studies on U.S. ecoregions, highlighting regional impacts. Visit www.globalchange.gov/resources/educators/toolkit.

DID YOU KNOW?

If every American home replaced just one light bulb with an ENERGY STAR CFL bulb, we would save enough energy to light nearly 3 million homes.

U.S. Department of Energy

Natural Inquirer Science Education Journal. The Natural Inquirer is a middle school science education journal. The Natural Inquirer was created so that scientists can share their research with middle school students. Each article presents scientific research conducted by scientists in the Forest Service. There is also a Climate Change Education Collection. Search for further articles on climate change at http://www.naturalinquirer.org.

EPA Climate Change Web Site. EPA's Climate Change Site offers comprehensive information on the issue of climate change in a way that is accessible and meaningful to all parts of society—communities, individuals, business, and State and local governments. Visit http://www.epa.gov/climatechange.

WORDS TO KNOW

Atmosphere—The mixture of gases surrounding the Earth. The Earth's atmosphere is made up mostly of nitrogen and oxygen with traces of carbon dioxide and other gases.

Atoms—The basic building blocks of matter that make up everyday objects. A desk, the air, and our food are made up of atoms.

Biosphere–The portion of the Earth and its atmosphere that can support life.

Carbon cycle—A series of processes through which all of the carbon atoms on Earth rotate. The same carbon atoms in your body today have been used in countless other molecules since time began. The wood burned just a few decades ago released carbon dioxide that could have been absorbed by a plant.

Carbon footprint—The impact our activities have on the environment, measured in the amount of carbon dioxide we produce.

Carbon sink—Any natural system that can absorb carbon dioxide from the atmosphere, such as forests and oceans.

Carbon sources—Activities and natural processes that add carbon dioxide to the atmosphere.

Climate change—Long-term changes in the climate. Climate change can be natural or might be caused by changes people have made to the land and atmosphere.

Fossil fuels—Fuels derived from ancient organic remains and include coal, crude oil, and natural gas.

Global warming—A term used to describe an increase in the near surface temperature of the Earth. Global warming is one of the expected impacts of climate change.

Greenhouse effect—A natural phenomenon where the atmosphere near the Earth's surface is warmed. Without the greenhouse effect, our planet would be frozen. The Greenhouse Gases trap heat near the surface of the Earth. As atmospheric concentrations of greenhouse gases rise, the average temperature of the lower atmosphere is increasing.

Greenhouse gas—Natural and man-made gases in the atmosphere that trap heat near the surface of the Earth. Water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), and ozone (O_3) are the primary greenhouse gases in the Earth's atmosphere.

Greenhouse gas emissions—Gases added to the atmosphere from human sources.

High-occupancy vehicle lanes (HOV)—Also known as a carpool lanes, are designated to those vehicles that have two or more people travelling to the same destination together to reduce emissions. Many cities keep these lanes separate so they can avoid traffic jams.

Hydrosphere—Often called the "water sphere," it is a portion of the Earth's atmosphere that includes all the Earth's water found in streams, lakes, the soil, groundwater, and in the air.

Industrial Revolution—A period in history from the 18th to the 19th century marked by major advancements in agriculture, manufacturing, mining, and transportation. Humans began using machines to make life easier and to harness the power of fossil fuels. This was also the time in the Earth's history when humans began to alter the make-up of the atmosphere.

Intergovernmental Panel on Climate Change (IPCC)—The leading body for the assessment of climate change established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide the world with a clear scientific view on the current state of climate change and its potential environmental and socioeconomic consequences.

Lithosphere—The outer solid part of the Earth, including the crust and the upper mantle (approx 62 miles or 100 km underground).

Preindustrial world—A time in history when work was done without the major use of fossil fuels, such as oil and coal.

Postindustrial world—Begun during the Industrial Revolution, this is a time period marked by work done by machines. At this juncture, the extensive use of fossil fuel began.

Precipitation—Any liquid or solid water such as rain, snow, sleet, or hail that is formed by condensation of moisture in the atmosphere.

Renewable resources—Substance of economic value that can be replaced or replenished as it is used.

Sustainable development—Actions that meet the needs of the present without compromising the ability of future generations to meet their own needs. (Based on the Brundtland definition of the 1987 Report of the World Commission on Environment and Development.)

ATTACHMENTS & STUDENT HANDOUTS

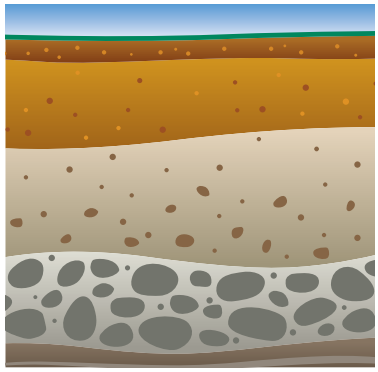
GREENHOUSE EFFECT SIMULATION

Time (minutes)	Temperature	
	Covered Bottle	Uncovered Bottle
0		
15		
30		
45		
60		
75*		
90*		

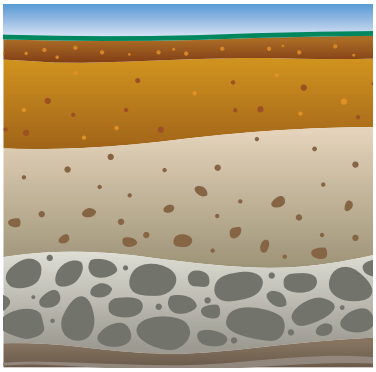
**If time permits*

THE CARBON TRIP – CUBE TEMPLATE

Biosphere



Ground/Underground
(Lithosphere)



Ground/Underground
(Lithosphere)

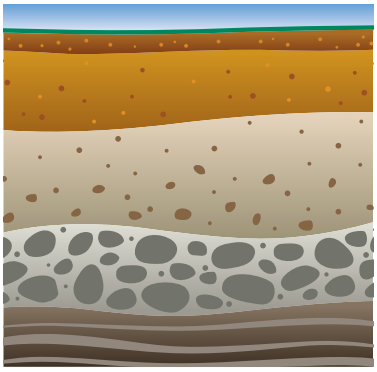
Plants/Animals
(Biosphere)

Respiration/Breathing
(Atmosphere)

Fire
(Atmosphere)

Decomposition
(Atmosphere)

Water



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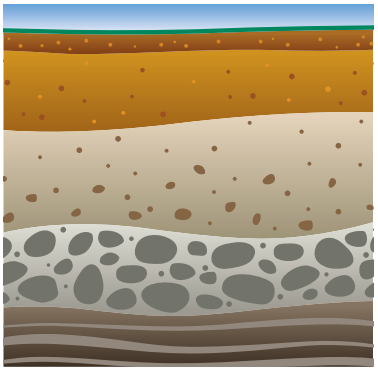

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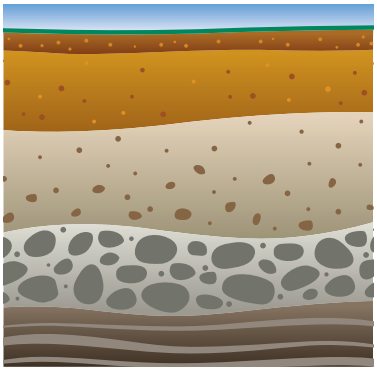
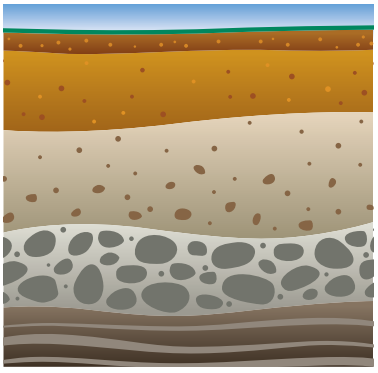


Ground/Underground
(Lithosphere)



Ground/Underground
(Lithosphere)

Water
(Hydrosphere)

Water
(Hydrosphere)

Atmosphere

Water
(Hydrosphere)

Water
(Hydrosphere)

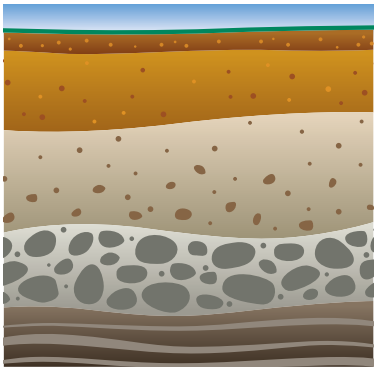
Plants/Animals
(Biosphere)

Plants/Animals
(Biosphere)

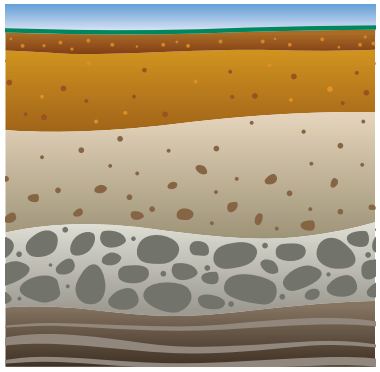
Plants/Animals
(Biosphere)

Plants/Animals
(Biosphere)

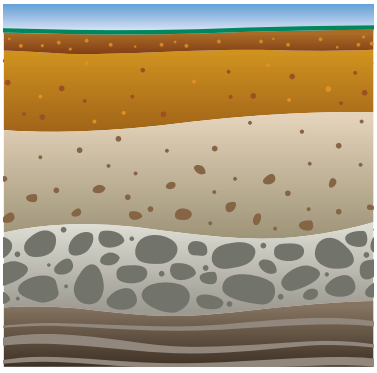
Pre-Industrial Ground



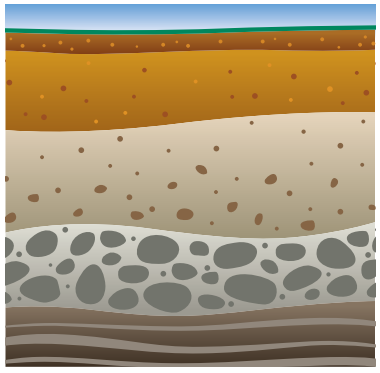
Ground/Underground
(Lithosphere)



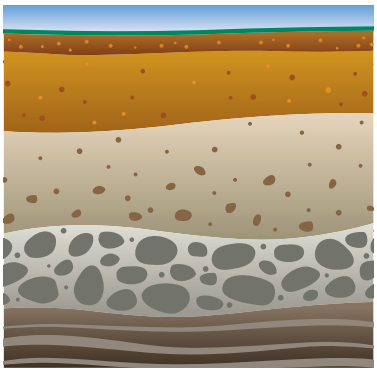
Ground/Underground
(Lithosphere)



Ground/Underground
(Lithosphere)



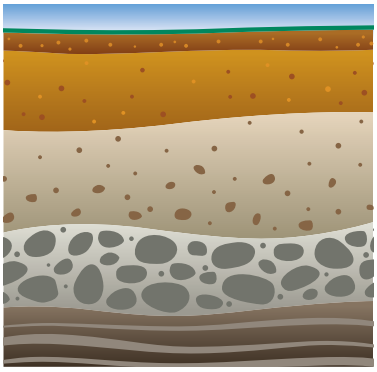
Ground/Underground
(Lithosphere)



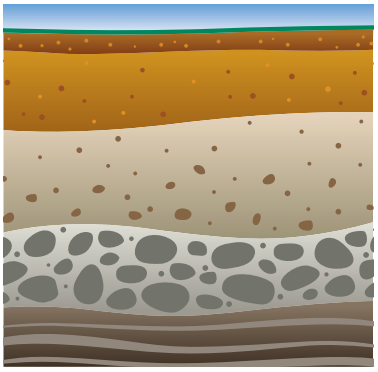
Ground/Underground
(Lithosphere)

Air
(Atmosphere)

Post-Industrial Ground



Ground/Underground
(Lithosphere)



Ground/Underground
(Lithosphere)

Air
(Atmosphere)

Fire
(Atmosphere)

Fire
(Atmosphere)

Fire
(Atmosphere)

ACE VIDEO FACTS QUIZ

1. In this video, what does “livin’ large” refer to?
   a. The bling that we wear
   b. The space that we take up and use, even if we don’t see it
   c. Being overweight

2. According to the video, what has contributed to our “livin’ large” culture?
   a. Advertisements and commercials
   b. Celebrities and their lifestyles
   c. Movies and music

3. How many planet Earths would we need to accommodate everyone in the world living as we do in the USA?
   a. 2
   b. 4
   c. 5
   (But there is only 1 Earth!)

4. Why are fossil fuels so necessary in our society?
   a. They make us feel better when we are sick
   b. They help us get around and power our electricity
   c. They serve as a food source

5. Fossil fuels have improved our living conditions since the industrial revolution, but there is a downside. Circle all that were mentioned in the video.
   a. They will eventually run out
   b. They cause people to fight
   c. They smell bad
   d. Their extraction from the ground damages the Earth
   e. They are turning up the Earth’s thermostat

6. Why is it important to have the right mix of greenhouse gases in our atmosphere?
   a. They make everything taste good by trapping sugar
   b. They make daylight by trapping the sun’s rays
   c. They keep the climate stable by trapping heat

7. What is the connection between fossil fuels and greenhouse gases?
   a. Burning fossil fuels makes *more* greenhouse gases
   b. Burning fossil fuels makes *less* greenhouse gases
   c. Burning fossil fuels helps *balance* the greenhouse gases

8. Earth’s natural “sinks” (the trees and the ocean) cannot absorb enough to keep up with our production of which greenhouse gas?
   a. Methane (CH_4)
   b. Carbon dioxide (CO_2)
   c. Ozone (O_3)

9. What will happen if Earth’s temperature continues to rise at a rapid rate?
   a. Nothing will happen
   b. There will be another Ice Age
   c. We don’t know exactly, but weather patterns as we know them will change

10. What are you willing to do about it? Circle all that apply.
    a. Face the facts and spread the word
    b. Take up less space and use less energy
    c. Get a “green” job
    d. Reduce, Reuse, and Recycle
    e. Ride your bike instead of driving
    f. Plant a tree

ACE VIDEO FACTS QUIZ (ANSWER KEY)

1. In this video, what does "livin' large" refer to?
   a. The bling that we wear
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    c. Get a "green" job
    d. Reduce, Reuse, and Recycle
    e. Ride your bike instead of driving
    f. Plant a tree
    Personal preference: any answer is correct.

TREE PLANTING WORKSHEET (EXAMPLE)

In the United States, electricity is produced mostly from the burning of fossil fuels such as coal, oil, and natural gas. This means that when we use electricity, we are producing greenhouse gases such as carbon dioxide (CO_2).

Based on the devices in the following table, select one activity—like watching TV or playing on the computer—that uses electricity during your day. Then fill in the blanks to determine:

1. How much CO_2 this activity produces.
2. How many trees to plant to absorb the CO_2 from this activity.

Step 1 Select an electronic device from the list below. Fill in this information:

Electronic Device: 36" TV *(example)*

Watts used per hour: 133

TYPICAL WATTAGES OF VARIOUS ELECTRONIC DEVICES

(from the U.S. Department of Energy)

Here are some examples of the range of wattages for various household appliances:

Electronic Device	Watts Used per hour
Clock radio	10
Clothes washer	350–500
Clothes dryer	1,800–5,000
Window fan	55–250
Hair dryer	1,200–1875
Heater *(portable)*	750–1,500
Clothes iron	1,000–1,800
Microwave oven	750–1,100
Personal computer (CPU and monitor)	270
Laptop	50
Radio (stereo)	70–400
Televisions (color)	
19"	65–110
27"	113
36"	133
53"–61" Projection	170
Flat screen	120
Toaster	800–1,400
VCR/DVD	17–21 / 20–25
Vacuum cleaner	1,000–1,440

Step 2. Using the following formula, calculate the amount of kilowatt hours you use this electronic device each year:

133 watts (Wattage of your appliance) x 4 (hours used per day) x 365 days/year ÷ 1,000 watts / kilowatt =

Your electronic device uses 194.2 kilowatt hours each year.

Step 3. Calculate the amount of CO_2 produced by this activity using the following formula:

194.2 (kWh (kilowatt hours used each year)) x 1.397 pounds of CO_2 per kWh = 271.3

While watching TV, I produce 271.3 pounds of CO_2 per year.

Step 4. Determine the number of trees you need to plant and allow to grow for 10 years to offset these CO_2 emissions:

One medium-growth (approximately 1 inch in diameter at 4.5 feet above the ground) coniferous tree sequesters about 85 pounds of CO_2 every 10 years.

271.3 pounds of CO_2 per year ÷ 85 pounds of CO_2/tree = 3

3 trees to plant to absorb the carbon dioxide produced from watching TV.

INSTRUCTOR TIP:

To offset your carbon emissions, you would have to have the 3 trees grow for 10 years or plant 32 trees to have an instant carbon offset.

TREE PLANTING WORKSHEET

In the United States, electricity is produced mostly from the burning of fossil fuels such as coal, oil, and natural gas. This means that when we use electricity, we are producing greenhouse gases such as carbon dioxide (CO_2).

Based on the devices in the following table, select one activity—like watching TV or playing on the computer—that uses electricity during your day. Then fill in the blanks to determine:

1. How much carbon dioxide this activity produces.
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Step 1 Select an electronic device from the list below. Fill in this information:

Electronic Device: _____

Watts used per hour: _____

TYPICAL WATTAGES OF VARIOUS ELECTRONIC DEVICES

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Here are some examples of the range of wattages for various household appliances:

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VCR/DVD	17–21 / 20–25
Vacuum cleaner	1,000–1,440

Step 2. Using the following formula, calculate the amount of kilowatt hours you use this electronic device each year:

_____ watts x _____ x 365 days/year ÷ 1,000 watts / kilowatt =
Wattage of your appliance hours used per day

Your electronic device uses _____ kilowatt hours each year.

Step 3. Calculate the amount of CO_2 produced by this activity using the following formula:

_____ x 1.397 pounds of CO_2 per kWh = _____
kWh (kilowatt hours used each year)

While _____, I produce_____ pounds of CO_2 per year.

Step 4. Determine the number of trees you need to plant and allow to grow for 10 years to offset these CO_2 emissions:

One medium-growth (approximately 1 inch in diameter at 4.5 feet above the ground) coniferous tree sequesters about 85 pounds of CO_2 every 10 years.

_____ pounds of CO_2 per year ÷ 85 pounds of CO_2/tree = _____

_____ trees to plant to absorb the carbon dioxide produced from _____.

ACKNOWLEDGEMENTS

The development of this module has been funded by the U.S. Department of Agriculture, Forest Service, National Job Corps Office, and the Conservation Education Program.

This curriculum was developed following the North American Association for Environmental Education Guidelines for Excellence in Environmental Education.

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Special thanks to the Module Advisory Committee who reviewed drafts and provided invaluable feedback on the creation of this document:

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Thank you to Harpers Ferry Job Corps Civilian Conservation Center for pilot testing many of the activities found in this module.

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Promoting excellence in environmental education

September 2010 FS-962a