# aninconvenienttruth IN THE CLASSROOM



A Component of the National Wildlife Federation's *Climate Classroom* Initiative www.climateclassroom.org













#### **ACKNOWLEDGMENTS**



The National Wildlife Federation (NWF) is committed to creating age- and developmentally appropriate curricula and projects that educate youth about the causes of and remedies for global warming through its Climate Classroom initiative. An Inconvenient Truth In the Classroom is the teen component of this initiative, built around the Academy Award-winning documentary An Inconvenient Truth. It is designed to encourage students to analyze the science of global warming and its relevance to current events and their daily lives.

To learn more and get involved in the solutions, go to: www.climateclassroom.org

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#### Thank you to ...

### The Honorable Al Gore and the producers, directors and team from Participant Productions, Inc. and Paramount Vantage that made the movie An Inconvenient Truth

This curriculum evolved from one developed by Topics Education in conjunction with the release of *An Inconvenient Truth* on DVD.

#### www.climateclassroom.org

Vice

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#### PARTNERS



For more than 70 years, the **National Wildlife Federation (NWF)** has been connecting people of all ages to nature through education and conservation action projects. Today, NWF is at the forefront of raising awareness about global warming and the threat it poses to people and wildlife.

NWF has the largest U.S. member base of any conservation organization. Its experts have spent decades helping local communities learn to enjoy and protect nature. Our awardwinning education programs and resources at the K-12 and university levels include:

- Campus Ecology<sup>®</sup>
- Schoolyard Habitats<sup>®</sup>
- Green Hour® website
- Climate Classroom website
- Access Nature<sup>®</sup> book series
- $\bullet$  NatureScope  ${}^{\ensuremath{\mathbb{R}}}$  book series
- Your Big Backyard® magazine
- Ranger Rick<sup>®</sup> magazine



**Participant Media** is the leading provider of entertainment that inspires and compels social change. It is a Los Angeles-based production company that focuses on socially relevant, commercially viable feature films and documentaries. Participant Media is headed by CEO Jim Berk and President Ricky Strauss and was founded in 2004 by philanthropist Jeff Skoll, who serves as Chairman.

Recent films include Errol Morris' Standard Operating Procedure, Tom Mc Carthy's The Visitor, Brett Morgen's Chicago 10, Ted Braun's Darfur Now, Marc Forster's The Kite Runner, Mike Nichols' Charlie Wilson's War and Davis Guggenheim's Academy Award®-winning An Inconvenient Truth, one of the highest grossing documentaries in history.

www.participantmedia.com

#### *Climate Classroom:* Environmental Education to Inspire the Next Generation of Leaders

National Wildlife Federation (NWF) recently partnered with former Vice President and Nobel Laureate Al Gore and the makers of An Inconvenient Truth to bring the issue of global warming from the big screen to the classroom. NWF was pleased to assist as project advisor, curriculum developer and to provide faculty for The Climate Project. In its first year, this project taught 1,000 Americans and hundreds of community leaders in Australia and the United Kingdom how to spread An Inconvenient Truth's message by equipping them with the skills to deliver Mr. Gore's presentation in their communities.

NWF has since created specific training programs and presentations for natural resource agency staff, gardeners, birders and industry leaders. On the heels of these successful training programs for adults, we are pleased to launch age and developmentally appropriate curricula

and projects that educate youth about the causes of and remedies for global warming through our *Climate Classroom* initiative.

*Climate Classroom* provides resources and projects, both online and in the community, for parents, teachers, kids and teens. What is innovative about our approach is the acknowledgement that the size and extent of the global climate change problem may seem overwhelming, especially for young children, but also to teens, who do not fully grasp the complexity of the underlying science and all the possibilities for solutions.



Accordingly, the *Climate Classroom* initiative proposes guidelines for K-12 global climate change education with the North American Association for Environmental Education. (Available at www.climateclassroom.org)

An Inconvenient Truth in the Classroom is the teen component of this initiative, built around the Academy Awardwinning documentary An Inconvenient Truth. It is designed to encourage students to analyze the science of global warming and its relevance to current events and their daily lives.

Our goal is to utilize the popularity of the film as a springboard for integrating climate education in high school classrooms.



Based on the Environmental Education Guidelines for Excellence of the North American Association for Environmental Education (NAAEE), *Climate Classroom* works to ensure that students understand the science of global climate change as well as steps they can take in their daily lives to reduce and reverse global warming.

Designed for educators who work with high school students, *An Inconvenient Truth in the Classroom* encourages students to analyze the science of global warming and its relevance to current events, what's happening around them, and focuses on how teens can be part of the solution.

This curriculum:

- Uses timely environmental education material to remove barriers to getting vital, compelling science instruction into classrooms
- Offers content that is tailored and appropriate for teens and aligns with established teaching standards
- Gives educators a way to connect with students using engaging, activity-oriented lessons and cooperative projects

An Inconvenient Truth in the Classroom will provide teachers with the tools they need to engage students, including:

- Guidelines for teaching about global warming
- Adaptable classroom activities they can tailor to individual time frames and across subject areas
- A strategy for using one of the most acclaimed films in popular culture today to advance science instruction
- Conservation action projects to engage kids in active learning

#### An Inconvenient Truth in the Classroom

encourages students to complete service learning projects focused on solutions to global warming. For example:

- In Los Angeles, students will help guide district-wide energy audits aimed at reducing carbon footprints of their schools.
- In Houston, the program will complement an ongoing student greenscaping project and a demonstration project to build solar panels to power their high school.



This curriculum encourages students to explore the fields that will be critical to solving the problem of global warming.

An important long-term goal of *Climate Classroom* is to raise awareness among students of possible career opportunities to clean up the environment and restore nature via the creation of better jobs and new technologies.





### Age-Appropriate Global Warming Education

K-12 education is best done in developmental stages according to age levels to provide effective global climate change. Age-appropriateness is a vital ingredient of global warming education because of its deep, underlying complexity.



The following has been adapted from the National Wildlife Federation /North American Association for Environmental Education (NAAEE) Guidelines for K-12 Global Climate Change Education.

Global warming has become the leading U.S. public environmental concern. Even those who considered the overall subject "debatable" have changed their minds as more conclusive evidence has come in from all corners of the globe. This means two things for the state of global climate change education in our schools:

- 1. There is a significant deficit of global climate change education in our schools because it has been deemed controversial by some. That controversy has had a chilling effect on its being treated as a bona fide school subject.
- **2.** Growing public enthusiasm for addressing global warming may mean that some of the K-12 global warming education efforts do not take place in schools. These NAAEE guidelines are mostly sufficient for addressing the quality of global climate change education, fostering higher quality education programming on global change in America.

Using the approach and structure of the NWF/NAAEE Guidelines for Excellence, NWF recommends that global warming education be carefully designed and organized according to age level. Age-appropriate education allows for cognitive and problem-solving development of the human mind. It provides effective building blocks of knowledge and skills for a difficult subject.

The following is a summary of the global warming content areas that are appropriate for students at the eighth and twelfth grade levels.

#### **Eighth Grade**

Students at this level are able to think abstractly with higher-order thinking skills and to engage in creative thinking in general. They are developing sophisticated cognitive abilities that let them understand the interrelationships of scientific, environmental and human systems, such as the ability to:

Develop questions and learn about the environment by conducting environmental investigations, finding answers to particular questions, assessing and evaluating the strengths and weaknesses of the information and synthesizing observations and findings into coherent explanations.

Understand the basic physical processes that shape the Earth and relate differences in physical patterns to their causes, as well as understand basic interconnections among atmosphere; hydrosphere, lithosphere; biosphere and cryosphere. And understand cycles including: solar energy and albedo, the water cycle, changing seasons and atmospheric movement patterns, ocean currents, the carbon cycle, volcanism and plate tectonics.

## NWF/NAAEE Guidelines

Understand that biotic communities are made up of plants and animals that are uniquely adapted to live in particular environments that can be affected by a changed climate and describe the importance of genetic variation in species and the possible implications of species extinction.

Understand that the way individuals perceive the environment is influenced, in part, by individual traits, by group membership, or affiliation. Also, become familiar with a wide range of cultures and subcultures while understanding that perspectives about the environment may vary by culture. Additionally, grasp the relative value and efficacy of global warming solutions based on emission reductions, sequestration and natural resource and human adaptation.

#### **Twelfth Grade**

Students in this age group are able to understand the complexity of many environmental subjects and related issues, and, most importantly, to learn how to address them. This is a period when understanding of the science of global warming can be combined with an understanding of what it means to be a responsible citizen who has problem-solving skills, including the ability to:

Develop and explain questions that guide environmental investigations and identify factors that influence the questions they pose, even developing approaches for investigating unfamiliar types of problems and phenomena.

Locate and collect reliable information for environmental investigations of many types. Understand how to use technology to collect and display information and to apply basic logic and reasoning skills to evaluate the completeness and reliability of information.

Understand the physical processes that shape the Earth and relate these processes to the characteristics of the Earth's surface as well as the relationships among atmosphere, hydrosphere, lithosphere, biosphere and cryosphere.

Understand and analyze large-scale natural cycles, including distribution of solar energy, the water cycle, changing seasons and atmospheric movement patterns, ocean currents, the carbon cycle, volcanism and plate tectonics, and overall familiarity with the basic elements and interactions of Earth's atmosphere, land and oceans.

Apply their knowledge of energy and matter to make connections among phenomena such as light, heat, electricity and the motion of objects. Understand basic population dynamics and the importance of diversity in living systems, as well as the basic ideas and the genetic mechanics behind biological evolution.

Understand and assess the relative value and efficacy of solutions based on emission reductions, sequestration and natural resource and human adaptation.

Possess a realistic self-confidence in their effectiveness as citizens and understand the importance of exercising those rights.





#### INTRODUCTION

#### Applying Science to Everyday Life

From the NWF/NAAEE proposed guidelines, NWF aims to meet an educational need by introducing vital, compelling science-based instruction on global warming into classrooms. The movie *An Inconvenient Truth (AIT)* has brought the issue of global warming to the forefront of today's society and media. It is hard to see a newspaper, listen to the radio, watch TV or surf the web without finding something pertaining to this issue. Whether they are listening or not, it is hard for teens to miss the global warming message.

For the last twenty years, scientists from around the world\* have recognized and studied the phenomenon of global warming and its potential consequences. So how was our society able to doubt and question it for so long? Most likely, it is because we were unable to separate the political agendas from the reality of the science. This curriculum will teach students to use science to think critically about questions pertaining to the environment and to take action.

**\*The Intergovernmental Panel on Climate Change (IPCC)** was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in recognition of the problem of global warming. Through the IPCC, climate experts from around the world synthesize the most recent climate science findings every five to seven years and present their report to the world's political leaders. The IPCC has issued comprehensive assessments in 1990, 1996, 2001 and 2007.

#### The Role of Action Projects in Climate Classroom

Student action projects are the most effective method by which students can implement the knowledge they learn in the classroom and thus retain this information for the long term. Action projects engage students in solving problems in their communities and schools and helps them master curriculum content by making meaningful connections between what they are learning and the world at large. Action projects can also help students develop a range of skills, such as communication, collaboration, leadership and organization.

Action projects are designed to impact the recipients (residents, wildlife, community members, etc.) and the students involved. This is accomplished by combining opportunities that link the project with self-reflection and the acquisition of skills, values and knowledge.



### COOL LINKS

United Nations Environment Programme www.unep.org/themes/climatechange/ The Intergovernmental Panel on Climate Change (IPCC) www.ipcc.ch The Climate Project www.theclimateproject.org

## Curriculum Design and Summary

An Inconvenient Truth in the Classroom is designed to help teachers integrate classroom instruction, outside research, action projects and green careers in a multidisciplinary way. It provides an emphasis on understanding the science of what is happening to our planet due to global warming and the solutions for stopping it. This curriculum utilizes *An Inconvenient Truth* as a catalyst for:

- Introducing vital, compelling science instruction into classrooms
- Helping teachers connect with students using engaging, activity-oriented lessons and cooperative projects
- Preparing a new generation of educated consumers of science

There are many ways to teach the subject of global warming. *An Inconvenient Truth in the Classroom* provides several strategies for using the documentary to help teens study global warming and explore solutions for climate change in a developmentally appropriate manner. (See the summary of NWF/NAAEE Guidelines on page 8-9 or download complete guidelines from www.climateclassroom.org). Some teachers explained that there was only time to show the movie and lead a few supporting activities. Others wanted a highquality method for teaching the carbon cycle as a way to understand global warming. Still others wanted ideas for using this topic as part of a semester-long environmental science course. Almost all educators interviewed expressed a need for action project plans that students could use for a science project or a project to meet their community service requirements.

This curriculum provides the necessary background, tools and resources for implementing the strategy of choice. As a companion to the curriculum, teachers and students may refer to the *Climate Classroom* website for updated lesson plans, surveys, student project profiles and ongoing instruction. Join the learning community at www.climateclassroom.org



### COOL LINKS

Marian Koshland Science Museum of the National Academy of Science Provides facts on global warming and predictions for the future www.koshlandsciencemuseum.org/exhibitgc/

The U.S. Environmental Protection Agency (EPA) Climate Change Kids Site www.epa.gov/climatechange/kids/gw

#### Global Climate Change - Exploratorium

Research the atmosphere, hydrosphere, cryosphere, biosphere and global effects www.exploratorium.edu/climate

The Atmospheric Radiation Measurement (ARM) Education and Resources for Students Program was created in 1989 with funding from the U.S. Department of Energy (DOE). Sponsored by DOE's Office of Science and managed by

the Office of Biological and Environmental Research, ARM is a multi-laboratory, interagency program www.education.arm.gov

#### INTRODUCTION

#### Activity Overview for An Inconvenient Truth in the Classroom

The following activities are designed as stand-alone lessons contingent upon the amount of time available and requirements covered. However, each activity is designed to build upon the next and can be implemented in succession for a complete unit on the science of climate change. All activities offer the meaningful application of scientific principles and the use of communication skills in research and action projects.

	Activity	Class/Subject	Short Description/Goals	Time
Scenario 1	A: Students as Consumers of Science	<ul><li>Science</li><li>Language Arts</li><li>Economics</li></ul>	Understanding and using scientific terms; distinguishing between hypothesis and scientific theory.	2 1/2-3 hours
	B: Global Warming Perspectives and Movie Circle	<ul><li>Science</li><li>Language Arts</li><li>Economics</li></ul>	Asking meaningful questions and conducting investigations; designing surveys and collecting data to support scientific inquiry.	2 1/2-3 hours
	C. Values Assessment and Comparison	<ul> <li>Earth Science</li> <li>Language Arts</li> <li>Economics</li> <li>Social Studies</li> </ul>	Weighing scientific evidence against uncertainties and popular media.	2 1/2-3 hours
Scenario 2	The Carbon Cycle	<ul> <li>Social Studies</li> <li>Life Science</li> <li>Government Economics</li> </ul>	Understanding basic ecology, how the carbon cycle works and what causes changes in earth's systems.	3-4 hours
Scenario 3	Scenario 3What Is Your Carbon Footprint?• Social Studies • Physical Science • Government EconomicsUsing math and technology for increase understanding and communication of climate science; critically thinking about human impacts on environment.		4-6 hours	
Writers' Corner	Reflect and Communicate	• All	Applying science and social studies to reflective writing; communicating scientific principles and climate change in a meaningful way. [Can be used alone or in conjunction with other activities above]	School year or semester 2-4 hours for research



## Introduction, Global Warming 101

This section, global warming 101, is intended as an essential overview of global warming. It should be read by students and teachers alike.

### The Greenhouse Effect

When direct sunlight heads toward the Earth, it passes right through the Earth's atmosphere. Some of the sunlight is reflected back into space by clouds or light-colored surfaces of the Earth (e.g., ice caps). But most of the sunlight is absorbed by the Earth and warms the planet's surface. The Earth then radiates some of that heat (or infrared energy) back into the atmosphere.

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The greenhouse effect is a natural occurrence and helps to keep the lowest 10 miles of our atmosphere livable. This is why Earth is called the "Goldilocks Planet"-it is just right.

Naturally occurring greenhouse gases in the atmosphere, such as carbon dioxide  $(CO_2)$  and methane, absorb some of this infrared energy, heating up the Earth's atmosphere as well as reradiating it in all directions, including back to Earth.

This is basically how the "greenhouse effect" keeps the Earth's atmosphere and surface temperature much warmer than they would be if these infrared radiation absorbers were absent from the atmosphere. Human activity—in the form of energy production and burning of fossil fuels such as coal, oil and natural gas—is causing more greenhouse gases to build up in the atmosphere. As the atmosphere "thickens" with more greenhouse gases, more heat is held in by the atmosphere (the way throwing on a thicker blanket at night will retain more heat).

## Example of the Greenhouse Effect

The sun's energy passes through the car's windshield.

This energy (heat) is trapped inside the car and cannot pass back through the windshield, causing the inside of the car to warm up.

#### What is a greenhouse?

A greenhouse is a building with glass ceilings and walls used to grow plants. The sun comes through the windows, heating up the inside so that the plants stay warm even in winter or cold climates. The windows in the greenhouse keep the warm air inside. So it just gets hotter and hotter until you open a window to let the warm air out.



### COOL LINKS

The University of Arizona Center www.b2science.org Basics on Biosphere www.geography4kids.com Global Climate Change: Research Explorer www.exploratorium.edu/climate

#### **Human Activity**

Global warming is the observed increase in the average temperature of the Earth's atmosphere and oceans. For millions of years, the amount of greenhouse gases found in the atmosphere has kept the temperatures of the planet within a range that is comfortable for humans and other living creatures. Compare this balance in temperature to two other planets: Mars has very little atmosphere, retains little heat and is very cold, while Venus has large amounts of greenhouse gases in the atmosphere and is much too hot for humans.

Human beings, their industries, transportation and settlements are now sizable and numerous enough to be capable of altering the chemistry of the Earth's atmosphere. The creation of the ozone hole due to our releasing chlorofluorocarbons is one example. Now we are concerned about the increase in greenhouse gases, especially carbon dioxide. Fossil fuels such as oil, coal and natural gas are high in carbon and, when burned, produce major amounts of carbon dioxide. Burning a single gallon of gasoline, for example, puts 19 pounds of carbon dioxide into the atmosphere. Yet today these fuels make up most of the energy production and use in the United States. In fact, the U.S. is responsible for about 21.6 percent of the world's energy use even though we have just four percent of the world's population. China is the world's second-largest producer of  $CO_2$ emissions due to its large population and increasing industrialization.

Scientists have observed that, over many thousands of years, the amount of  $CO_2$  in the atmosphere corresponds quite closely to the Earth's overall temperature. As the amount of  $CO_2$  increases, the temperature soon increases and vice versa. This is one factor that contributed to the ice ages and warming periods extending back thousands of years.



#### **Scientific Evidence**

The measurements of scientists working around the world show that the amount of  $CO_2$  has increased sharply since 1800. And if we look at the Earth's average temperature over that same time period, we see that it follows the same pattern. That's just what we would expect, because we know that more CO<sub>2</sub> means a stronger greenhouse effect. The year 2005 was the hottest of any previous year. The year 2007 tied with 1998 for the second hottest year on record. The eight warmest years have all occurred since 1998. The fourteen warmest years have occurred since 1990. The strong warming trend of the past 30 years has been attributed to the effect of increasing humanmade greenhouse gases. Nineteen of the 20 hottest years on record have occurred since 1980.

Scientists have learned that carbon levels have stayed within a fairly close range up until recent times when higher levels have become evident. At no point in the past 400,000 years did carbon dioxide concentrations in the atmosphere rise above 300 parts per million (ppm) molecules. In modern times, however, they are now at roughly 380 ppm. As the atmosphere "thickens" through the addition of greenhouse gases, more heat is held in by the atmosphere.

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As we predicted last year, 2007 was warmer than 2006, continuing the strong warming trend of the past 30 years that has been confidently attributed to the effect of increasing human-made greenhouse gases.

> James Hansen, Director of the National Aeronautics and Space Administration (NASA) Goddard Institute of Space Studies (GISS)

### COOL LINKS



Some people think the term global warming is more politically charged, while climate change is often considered more scientific because it indicates that it isn't just temperature that changes as the Earth heats up. It also increases the intensity/frequency of severe weather events such as droughts and floods. You can point out that both terms are really referring to the same overall concept. However, there are some subtle differences between the two phenomena.

**Global warming** is the increase of the Earth's average surface temperature due to a build-up of greenhouse gases in the atmosphere.

**Climate change** is a broader term that refers to long-term changes in climate, including average temperature and precipitation.



## The USA National Phenology Network (USA-NPN) is currently being designed and organized to engage federal agencies, environmental networks and field stations, educational institutions, and mass participation by citizen scientists. www.usanpn.org



There are several ways to measure carbon dioxide  $(CO_2)$  concentrations in the environment.

### Ice Core Data

Dr. Lonnie Thompson, at The Ohio State University's Department of Geology, is one of the key scientists measuring global warming. He is recognized for collecting and measuring the carbon content of drilled ice cores from mountain glaciers and ice caps in the polar, tropical and sub-tropical regions of the world. He takes research teams all over the world to measure the carbon concentrations trapped in ice that was formed year by year over the centuries.

To obtain data prior to 1958, scientists studied ice core characteristics from Antarctica so that they could determine the Earth's temperature and atmospheric gas concentrations. They used long, thin cores of ice drilled out of the Earth's large ice sheets as a "time capsule" that recorded what the Earth's atmosphere was like when each layer of ice froze.

### **Atmospheric Measurements**

Since 1958, scientists have been able to take atmospheric measurements for both temperature and greenhouse gas concentrations at the National Oceanic and Atmospheric Administration (NOAA) atmospheric laboratory at Mauna Loa in Hawaii. There has been a steady increase in  $CO_2$  levels annually from 1958 through 2007. The pre-industrial concentration of  $CO_2$  was 280 parts per million. In 2005, the  $CO_2$  level, measured high above Mauna Loa, was 381 parts per million.

These measurements have continued year by year for almost half a century, have been collected daily and stand as one of the most important measures in the history of science.

### COOL LINKS

Ice Core Paleoclimatology Research Group The principal objective is the acquisition of a global array of ice cores providing high resolution climatic and environmental histories that will contribute to our understanding of the complex interactions within the Earth's coupled climate system. Ice core histories from Africa, Antarctica, Bolivia, China, Greenland, Peru, Russia and the United States make it possible to study processes linking the Polar Regions to the lower latitudes where human activities are most intense. These ice core records contribute prominently to the Earth's paleoclimate record, the ultimate yardstick against which the significance of present and projected anthropogenic effects will be assessed. Dr. Lonnie G. Thompson is a professor at The Ohio State University www.bprc.osu.edu/Icecore

Mauna Loa Observatory (MLO) is a premier atmospheric research facility that has been continuously monitoring and collecting data related to atmospheric change since the 1950's. The undisturbed air, remote location and minimal influences of vegetation and human activity at MLO are ideal for monitoring constituents in the atmosphere that can cause climate change. The observatory is part of the National Oceanic and Atmospheric Administration (NOAA) - Earth System Research Laboratory (ESRL) - Global Monitoring Division (GMD). www.mlo.noaa.gov

**U.S. Geological Survey (USGS)**, Earth Resources Observation and Science established metrics for phenological characterization. Phenology is the study of the timing of biological events, particularly in response to climatic changes to the environment. To study large areas, remote sensing from satellites is an essential tool. In the Phenological Characterization project, USGS has developed methods of analyzing time-series vegetation index data to derive a set of phenological metrics. www.edc2.usgs.gov/phenological/

### Visible Signs of Global Warming

For a long time, people did not agree about whether global warming was really happening and, if it was, whether people were to blame or not. Now that has changed. There is now irrefutable evidence that the Earth's climate is changing and global temperatures are rising. Consensus has emerged among a majority of scientists and experts.

Today many people see these changes directly:

Glaciers are melting around the world. A

glacier is a moving mass of ice that survives some melting from year to year. In the United States, the Portage Glacier, a major Alaskan glacier, displays a profound loss of ice clearly visible over a 90-year period. All but 100 of the 1,100 glaciers researched are receding.

**River levels are variable throughout the year, but rivers will be even more affected by climate change.** For example, lower water levels have been observed along the Colorado River in the western United States. Between 1999 and 2004, the Upper Colorado River Basin experienced five consecutive years of below average flows, dipping to a low of 25 percent of average annual flows in 2002.

Global warming causes water in the oceans to evaporate faster, which can fill the atmosphere with more moisture in some areas. In other areas where there is naturally less precipitation, global warming also causes soils to dry out faster. This contributes to desertification. Increased carbon dioxide in the atmosphere reduces the degree of soil moisture in large areas of the nation by 20 to 40 percent, effectively doubling the amount of carbon dioxide.

The near doubling of carbon dioxide in the atmosphere could happen by the year 2050 unless there are significant reductions in greenhouse gas emissions. No reduction could result in an average 35 percent soil moisture loss in major areas of U.S. agricultural land, contributing to lower water levels and to reduced agricultural productivity.



Many naturalists and outdoor enthusiasts and the scientific community have noticed other visible signs of global warming taking place.

Birdwatchers have noticed that migrating birds are returning earlier in the spring and leaving later in the fall, indicating that winters are becoming shorter in some areas.

#### Gardeners see signs of shorter winters, too.

For example, flowers are blooming earlier than they used to bloom. These changes have a significant impact on people, wildlife and weather agriculture resulting in a shift in the hardiness zones throughout the United States. A hardiness zone is a geographically-defined area in which a specific category of plant life is capable of growing, as defined by the ability to withstand the minimum temperatures within the zone. The zones were developed by the United States Department of Agriculture (USDA) to help people know when and where to plant particular species. The zones are categorized according to the mean of the lowest temperature recorded each winter, termed the "average annual minimum temperature."

These observations all seem to be part of a pattern. The movie *An Inconvenient Truth* provides more examples worldwide of the signs of global warming, from melting ice at the polar regions to more intense storms and weather.



### **COOL LINKS**

Environmental Defense Fund, Global Warming's Increasingly Visible Impacts www.edf.org/documents/4891 GlobalWarmingImpacts.pdf

The Wilderness Society www.wilderness.org/Ourlssues/GlobalWarming/index.cfm?TopLevel=Home

**Concern Worldwide, Climate Change: Visible Signs in the Poorest Countries** www.concernusa.org/Public/News.aspx?ld=645

### Impacts on Earth and Us

Although there are many effects of global warming, there are four major ones highlighted in the 2007 report by the Intergovernmental Panel on Climate Change (IPCC). The current IPCC is a group of 2,000 of the world's leading scientists. The following impact projections come from this report:

**1. Rising sea level:** Some of the most vulnerable areas are coastal regions, because they are susceptible to changes occurring in both land and sea and tend to be densely populated. In 2003, about 53 percent of the U.S. population lived in countries bordering the ocean. The IPCC projects a rise in sea levels ranging from 10 to 23 inches by the year 2100 if we continue on our current path of increasing amounts of  $CO_2$  in the atmosphere. Even in the most optimistic scenario presented, sea levels would rise 7 to 15 inches by the year 2100.

**2. Increased temperatures:** The average global temperature increased just 1.3°F during the 20th century. Now climatologists are saying to expect a further rise of four to eleven degrees in the 21st century due to greenhouse gas pollution—and the ripple effect of warming temperature over the last century. The rise in temperature will affect every species on the planet, from microorganisms to humans.

**3. Habitat change and species affected:** There is every likelihood that terrestrial, biological and ecological systems will be affected, including earlier timing of spring events (such as leaf-unfolding, bird migration and egg-laying). For higher elevations and more northern directions, (poleward and upward), the range of plant and animal species will shift. Approximately 20 to 30 percent of plant and animal species are likely to be at increased risk of extinction if increases in global average temperature continue at the same pace as today.

4. Changes in water supply: Water resources are likely to be strongly affected by global warming. In particular, some of the world's most water-stressed regions, (e.g., northeastern Brazil, southern Africa, the southwestern United States and northern Mexico) are likely to see a 10 to 30 percent decline in water availability by the end of the century. Snowpack in the mountains, which accumulates during the winter and provides freshwater to many areas of the western United States in summer, is also likely to decrease, exacerbating drought conditions. In the northern United States, northern Europe and southeastern Asia, rainfall will most likely increase, which could lead to increased flooding.

Water quality is likely to decrease in many areas as warmer temperatures promote algal growth and reduce oxygen levels in rivers and lakes. Developing countries, which lack resources to deal with these changes, may be the hardest hit. Hundreds of millions of people will be exposed to water stress worldwide.

### COOL LINKS

For more information on global warming, try one of these resources:

The status of global warming impacts and policy in each state www.nwf.org/globalwarming/statefactsheets.cfm

How hurricanes are increasing in intensity, duration and storm surge due to global warming www.nwf.org/globalwarming/pdfs/HurricanesAndGlobalWarming.pdf

An overview of how wildlife are affected by global warming and what you can do to help www.nwf.org/globalwarming/pdfs/WildlifeAtRisk.pdf

#### **Help for Our Hot Planet**

Scientists recommend we reduce greenhouse gas emissions to stop the increase and "hold" the levels at no more than 400 to 450 parts per million. But, without any significant changes in current policies and behaviors, scientists project that we could see  $CO_2$  levels of 650 parts per million by the year 2100.



In the past, the difference between a CO2 level in the high 200s and one in the low 100s has been the difference between a warm summer day and a two mile thick sheet of ice over your head. No one knows what levels exceeding 400 parts per million molecules will mean.

Al Gore, former Vice President and Nobel Laureate

Greenhouse gas emissions will continue to rise and heat up the planet if we keep doing what we have been doing. Climate scientists say that a two percent reduction in greenhouse gases between now and 2050 will avoid the worst case scenarios of global warming and impacts on humans as well as fish, wildlife and their habitats.

There is no single solution to solving the global warming pollution problem. We need a multitude of ways to address the issue so that we can accomplish the task of meeting our goal by 2050.

Two economists at Princeton University, Robert Socolow and Stephen Pacala, concluded that the United States already has the fundamental scientific, technical and industrial know-how to resolve significant carbon and climate problems over the next 50 years. They estimate emissions can be lowered in various energy sectors and with various technologies by 50 percent.

### COOL LINKS

For more information on strategies to reduce global warming, look at additional resources:

Environmental Protection Agency www.EPA.gov

U.S. Department of Energy, Energy Efficiency and Renewable Energy www.fueleconomy.gov

The Sierra Club www.sierraclub.org/foundation

Project Plan-it-a service of Youth Service America www.ysa.org/planit

We Can Solve It www.wecansolveit.org

Socolow and Pacala wedges www.princeton.edu/~cmi/resources/CMI\_Resources\_new\_files/Environ\_08-21a.pdf

#### National Wildlife Federation

## Six 'Wedges' of Progress to Stop Global Warming

Socolow and Pacala identified a total of fifteen categories of technology that store carbon, provide energy without producing carbon emissions or improve the efficiency of carbonbased energy supplies. The large-scale use of any one of these technologies can reduce global carbon emissions by at least one billion tons a year by the year 2054. They show how each of the fifteen options identified could be pieced together in six wedges, as illustrated by the graph at right. They identify opportunities and difficulties associated with each option and compare alternative combinations of six wedges. Each one billion tons per year equals a wedge. They are:

- **1. Energy Efficiency.** We can start to see progress through more efficient use of electricity in consumer activities such as electrical use in the home.
- **2.** Other End-Use Efficiency: Will also help buildings and businesses use far less energy than they do now.
- **3. Vehicle Efficiency:** Higher mileage vehicles and the manufacturing of cars and trucks that run on less fossil fuel and use alternative technologies will be important.
- **4. Other Transportation:** Improved mass transit and business transportation systems can produce significant gains in energy efficiency.
- **5. Renewable Energy Sources:** Will play a role in helping us to increase our reliance on renewable energy such as wind and sustainably harvested biofuels.

#### 6. Carbon Capture and Storage (CCS):

CCS are emerging technologies with promise because the carbon emissions from power plants and industrial sources can be captured, condensed and stored much in the same way we use pollution control devices to keep pollutants out of our air and water.



Scientists say we are at a turning point with global warming. They think that if we take action now, we can slow it down. But if we don't, it will soon be too late. We still don't know exactly what the effects of global warming will be, so there's no way to know exactly how much time we have. But now, almost all scientists agree that it is a big problem and that the wise thing to do is to take action—right now.

#### Summary

The important thing to remember is that humans have caused this problem, so humans should be able to fix it. Many people around the world are working hard to find solutions and new options seem to be presented almost daily. But remember there is no single solution; it is going to be a combination of people and governments working together implementing a range of strategies to tackle this problem.

#### D

Scientists have told us that we must reduce global warming pollution by 80 percent by 2050 to avoid the worst impacts of global warming. They have set the goal, now we have to set the pace. We can get there by reducing global warming pollution by 2 percent every year for the next 40 years.

> Larry Schweiger NWF President and Chief Executive Officer



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## Scenario 1: Climate Change in Our Society

→ cience is deeply embedded in our everyday lives–common consumer and health choices are actually science issues. Advertisements bombard us at every turn forcing  ${\cal J}$  us to sort reality from gimmicks that aim to make us do certain things or buy a special product. How do we sort fact from fiction when seduced by claims that promise perfect skin or protection from disease or even ways to become rich? And what if these claims are backed up by scientists? Do we believe them then?

We have learned that "experts" are not always giving us the whole picture, and often we need to rely on our own knowledge and background and sort through information in order to make sound decisions about our health and consumerism. Whether we realize it or not, we regularly use science and technology to make these everyday decisions, while questioning and finding answers to much bigger issues as well.

Consider global warming. What did you think when you first heard about it? Did you believe it? Why or why not? Did the source of the information impact your opinion? Did you have enough background knowledge to understand the competing arguments? People need a fundamental understanding of science to answer these and many other types of questions faced daily.

These activities foster critical thinking about science and scientific investigation. Students will be able to apply science investigation in their daily lives. Students will recognize the importance of science in answering questions about the nature of the world. Activity Options A, B, and C may also be used as tools to assess your student's current understanding of global warming. Students may also write their findings in a paragraph or on poster board and present for wider class discussion.

After watching the An Inconvenient Truth (AIT), students will participate in a "movie circle." This format has proven to be an effective instructional strategy that generates greater interest in the subject, more initiative in fulfilling the objectives and higher levels of comprehension. Because there is minimal intrusion from outside (e.g., the teacher), students in small peer groups feel free to ask questions of each other, listen to opposing viewpoints, explain their own perceptions and defend their own rationale. The skills developed through this cooperative learning experience will not only help make this a successful assignment, but will also prove invaluable outside the classroom as the students face the complex challenges of careers, daily living and citizenship.



topics education

This curriculum evolved from an original curriculum developed by Topics Eduction in conjunction with the strategies for education impact<sup>\*\*\*</sup> release of *An Inconvenient Truth* DVD .



#### Summary:

Students share their knowledge and impressions of global warming and the underlying science; watch and discuss An Inconvenient Truth.

#### Time: 3 hours

Pre-movie Activities: 30 minutes each Movie Viewing Time: 96 minutes Post-movie Activity: 30-60 minutes

#### Grade level: 9-12

Social Studies Science Language Arts Government Economics

#### **Skills:**

Evaluation Analysis Problem-solving Observation Description Research Critical thinking

#### **Learning Objectives:**

Students will be able to:

- Understand how scientific progress is made by asking meaningful questions and conducting careful investigations
- Identify several causes of global warming
- Differentiate between credible sources and non-credible sources
- Recognize misuse of scientific terms-specifically understand the meaning of scientific theory
- Describe relationships between industry and global warming
- Identify several problems associated with global warming
- Propose solutions to problems that cause global warming

#### **Materials:**

The film, An Inconvenient Truth, note cards or paper, access to periodicals and news broadcast programs, research materials, internet and other materials as needed.

## Scenario 1: Climate Change in Our Society

#### Pre-movie Activity Option A: Students as Consumers of Science Procedure

- **1.** Consider having your students, individually or as group, answer these questions on paper. Alternatively, use these questions to guide a class discussion.
  - a. Explain global warming in your own words.
  - b. Is global warming real? Why?
  - c. What are some causes of global warming?
  - d. Is there any controversy surrounding global warming? Why or why not?
- 2. Discuss with your students or assign the students to discuss in small groups the following questions:
  - a. How do they use the term "theory" in their everyday lives?
  - b. What is meant by the term "scientific theory"?
- **3.** After the discussion with students in large or small groups, read the two paragraphs highlighted below. After reading the paragraphs, ask students the following questions:
  - a. How might a misunderstanding about "scientific theory" lead to controversy with the topic of global warming?
  - b. Why is it important for you to understand scientific terms?

In order for something to be a scientific theory, thousands of tests must have been done to support a phenomenon. Unfortunately, casual English language has changed the word "theory" to mean something much less rigorous and scientific. When individuals say that they have a theory, they usually just mean that they have a hunch that something is true or an opinion about something. As a result, many people believe that scientists also only have "hunches" when they talk about scientific theories.

Alan Leshner, Chief Executive Officer of the American Association for the Advancement of Science (AAAS) said:

It is really unfortunate that that the word "theory" is an English vernacular term as well as a scientific term. For something to be a theory in science, thousands of studies must have been done. Establishing a "theory" requires a great amount of empirical observation and experimental testing of diverse hypotheses. You don't get to call something a theory until it's been subjected to a rigorous amount of scientific study. In the English language, however, a theory could be anything. Scientists get to call something a scientific theory–for example, gravity or the big bang–only after a tremendous amount of preparatory work.

–Alan Leshner

**4.** Continue on to the next step by participating in a movie circle activity (page 27).

## Scenario 1: Climate Change in Our Society

#### Activity Option B: Global Warming Perspectives Procedure

- **1.** Make copies of the Global Warming Survey on page 29 and have your students complete it. Use the completed questionnaire as a tool to discuss their level of knowledge of global warming.
- 2. Students can represent their answers on a graph or chart.

After completing Activity Option A and/or B, please continue with the following activities.

#### Activity: Movie Circle Procedure

**Make plans for your students to watch** *An Inconvenient Truth.* The film's running time is 96 minutes. Divide the class into small groups (5-7 students) called movie circles. Each group should include as diverse a mix of students as possible, in terms of academic and conversational skills.

**1. Post-movie activity: movie circle** Assign each student in each group one of the roles—clarifier, summarizer or questioner—as described in the Discussion Sheet for movie circle (see page 30). Allow the students to select from the film chapters listed below. After viewing *An Inconvenient Truth*, students will discuss the film in group meetings.

Chapter 3: Basic Science of Global Warming Chapter 4: Global Warming Cartoon Chapter 6:  $CO_2$  Measure Since 1958 Chapter 9:  $CO_2$  Levels Back 65,000 Years Chapter 18: Resistance to Change Chapter 26: Is There a Controversy? Chapter 27: Science Fraud Chapter 28: Balancing the Economy Chapter 29: City by City Chapter 30: The Solutions Are in Our Hands Chapter 31: Are We Capable of Doing Great Things? Chapter 32: Our Only Hope



- **2.** Allow each member of the movie circle to share what he or she learned about the assigned chapter with the other group members.
- 3. Ask the "summarizer" from each group to present the group's findings to the remainder of the class.
- 4. Ask students to share their thoughts on topics such as these:
  - a. Does evidence exist that seems to link global weather patterns with temperature increases?"
  - **b.** Are there energy options for the average citizen that do not contribute to global warming?
  - **c.** Would they purchase products that use less energy from fossil fuels, even if it cost more? These include compact fluorescent light bulbs and Energy Star<sup>™</sup> computer monitors.

## Scenario 1: Climate Change in Our Society

### Activity Option C: Values Assessment and Comparison

#### Procedure

- **1.** Ask students to name a few things that are valuable to them. What things would they not want to live without? These might be small things like an iPod or larger items such as a car or their room.
- **2.** Before viewing the movie, ask students to write their top ten most important values on a piece of paper. After they have done this, have them reduce their list to eight. Then have them reduce their list to five. Give them time to think about and consider each choice.
- 3. After viewing the film, ask students to review their lists again and make any changes.
- **4.** Invite volunteers to share their lists with the class. Challenge students to come up with a top five or top ten list of values for the class.
- **5.** Discuss some of the effects of different values in the real world. Consider these questions in the discussion:
  - How do people reconcile their different values?
  - How do values have an effect on the problem of global warming and climate change?
- **6.** How are the lists similar or different from student to student? Write out the class list of values on a large piece of paper and post it on a wall of your classroom.
- **7.** Periodically revisit this list throughout the year to make any necessary changes or additions as you address more real world scientific issues.



Student

Page

## Scenario 1: Climate Change in Our Society

## **Global Warming Survey**

**1.** How often do you hear the term global warming in your everyday life?

\_\_\_\_Very often \_\_\_\_ Somewhat often \_\_\_\_ Never

2. How often does global warming come up in your everyday conversations with friends and family?

\_\_\_\_Very often \_\_\_\_\_Somewhat often \_\_\_\_\_Never

- **3.** Rate the following environmental concerns according to how important you believe it is to find solutions for them: (1=most important, 8=least important)
  - \_\_\_\_ Acid Rain
  - \_\_\_\_ Endangered Species
  - \_\_\_\_\_ Air Pollution
  - \_\_\_\_ Global Warming
  - \_\_\_\_\_ Responsible Forestry
  - \_\_\_\_\_ Irresponsible Land Development
  - \_\_\_\_\_ Availability of Safe Drinking Water
  - \_\_\_\_\_ Disposal and Management of Solid Waste
- **4.** How important is it to have leaders in our government who will take action against the impacts of global warming?
  - \_\_\_\_ Very important \_\_\_\_\_Somewhat important \_\_\_\_\_ Not important at all
- 5. What are you and your family doing to lessem the impact of global warming?

\_\_\_\_\_ We are not doing anything at this time

- \_\_\_\_\_ We are doing a few small things to reduce the impact of global warming
- \_\_\_\_\_ We are doing many things to reduce the impact of global warming

## Scenario 1: Climate Change in Our Society

Student	Discussion Sheet for Movie Circle				
Page	Name:				
	Chapter(s):				
	After you have finished viewing the film, prepare for the movie circle meeting by assuming the identity of one of the strategists described below, and then complete and present your strategy.				
	<b>Clarifier:</b> Your job is to find five words or concepts that are important to the chapter, to list and explain each word/concept. Write down its location in the film.				
	1				
	2.				
	3				
	4				
	5				
	<b>Summarizer:</b> Your job is to prepare a brief summary of your film segment to share with the rest of the class. Convey how people are influenced by the various events depicted in the film and how the conflict contributes to a possible resolution. Be sure to present the essential ideas of the segment.				
	Key Events:				
	Summary:				
	<b>Questioner:</b> Your job is to develop a list of four questions about this film that your movie circle might discuss. Your task is to help circle members discuss the big ideas in the film and share their reactions. Center your questions on the who, what, when, where and how. Be prepared to show key segments of the film that present the answers. List appropriate segments of the DVD or videotape.				
	Question 1:				
	Answer:				
	Question 2:				
	Answer:				
	Question 3:				
	Answer:				

## Scenario 1: Climate Change in Our Society

### **Extensions and Research**

It is interesting to examine the arguments against global warming and how to respond to those positions. A great exercise for students is to have each one write down one thing on a piece of paper that they have heard or read that suggests global warming is not real, and then have them write their name on the paper. Next, all the students should trade their papers, review the "myths," research the opinions and refute them.

- A great source for scientific information is www.realclimate.org. This is an independent website, maintained by top scientists. Specifically look at the review and blog about the film *An Inconvenient Truth*. Many answers are posted there and the sources are sound.
- Have students explore the official website for the film *"An Inconvenient Truth"* at www.climatecrisis.net. Suggest they look at the science page and compare the amount of evidence today versus the amount available at the release of the film.
- Ask students to keep a journal or list documenting all the references to global warming and climate change they observe in one week, such as advertising, Internet, film, TV news, billboards and radio. Compare their lists at the end of the week.

### **Action Projects**

Listed here are brief descriptions of three action projects to consider using in your class as you study global warming in Scenario 1. Detailed information about each project (and ideas for many more) can be found in the "Solutions Now: The Guide to Action" section of the curriculum (See page 52).

#### **1.** A Movie-Watching Party

When *An Inconvenient Truth* was released in theaters in May 2006, it helped spark a discussion across America about how people and wildlife will be affected by global warming. Now that this Oscar-winning film has been released on DVD, you can help continue this discussion in your own community by organizing your own movie circle for people to watch and talk about this film.

## 2. Surveying a Classroom, a School or a Community

What were the results when your class took the Global Warming Survey? Have the students considered surveying their families and others, such as the whole school or even the community? Students can tally the results and think creatively about sharing the data and addressing any lack of knowledge they uncovered.

#### 3. Global Warming Awareness Fair

After surveying their community, students may find that many of their peers have a lot to learn about global warming. Have them design and plan a Global Warming Awareness Fair, with speakers, activities and discussion groups like those outlined in this guide.



### COOL LINKS

Scientific American www.sciam.com/earth-and-environment Climate Science www.realclimate.org Official website for *An Inconvenient Truth* www.climatecrisis.net World Meteorological Organization www.wmo.ch Examine Global Issues www.globalissues.org/EnvIssues/GlobalWarming.asp

## case study

## Boston Latin School Youth Climate Action Network: "Fridays with Al"



Saturday, May 10th 2008 @ MIT in the Stata Center 9:00-3:30 Red Line Kendall Square T Stop Register Online At http://www.blsvouthcan.org

## Boston youth are changing their schools and their communities

"Our group actually got started when I showed Al Gore's movie to my 8th grade students last year and they insisted on taking action. That resulted in a climate action club forming that had 90+ students at the first meeting on January 23rd 2007! ...Since then we've run a film series called "Fridays with Al."

-Cate Arnold, faculty member, Boston Latin School

fter the DVD release of *An Inconvenient Truth*, students at Boston Latin School organized a film series called "Fridays with Al." They screened the movie every Friday for a few months to make it available to the entire student body, faculty and parents. Creating awareness was not enough. After watching the movie, students knew they needed to change their community and help be part of the movement to stop global warming.

One of the first changes to school activities was looking at more environmentally friendly school fund-raisers. All of the students conducted a CFL light bulb fund-raiser through NSTAR, the largest Massachusetts-

based, investor-owned electric and gas utility, that raised over \$5,000. They used the money to host a Youth Summit on Global Warming at MIT on May 19, 2007. The Summit was successful and brought teachers and students together from 50 schools. Boston Latin School students brought in speakers and resource professionals to learn more about what they could do to change their schools and influence the curriculum.

To ensure that the momentum of bringing everyone together did not end at the summit, students worked with school administrators to create a website and Youth Climate Action Network (YouthCAN) in Boston.

Members of Boston's YouthCAN meet regularly to implement carbon-reducing practices at their schools and to plan city-wide initiatives. Their projects range from bus-idling reduction programs and reducing the use of plastic bottles at schools to coordinating an Annual Global Warming Youth Summit to getting their schools to become part of the Massachusetts Energy Consumers Alliance New England Wind Solar Challenge.

Visit the Boston Latin School Youth Climate Action Network website at www.blsyouthcan.org.

#### **Contact:**

Elizabeth Soper, Manager, Regional Education Programs, National Wildlife Federation Northeastern Natural Resource Center. *Email:* soper@nwf.org

## Scenario 2: The Science of Global Warming

In this activity, students will use "box" models of the carbon cycle to study the effect of greenhouse gas emissions on global warming. Boxes will represent places where carbon accumulates (storages or stocks); arrows will indicate the movement of carbon (flows or fluxes) among these boxes. This exercise leads to an understanding that although carbon moves continuously, the rate of movement varies between the atmosphere, lithosphere (i.e., rocks and soil), hydrosphere (i.e., water) and biosphere (i.e., living organisms). Students will find that in some parts of the ecosystem, carbon is recycled rapidly, but in others–such as when shells sink to the bottom of the ocean or when plants become fossil fuels–carbon cycles very slowly. It is important that students understand the concept of rate differentials.

In additon, this activity on the carbon cycle provides a deeper understanding of several of the scientific conclusions that were introduced in the film *An Inconvenient Truth*. The problem of global warming is exacerbated by human activities that alter the rates of the carbon cycle's flows or fluxes. When we choose to release much of the carbon stored in fossil fuels, we are drastically altering the quantity of carbon in the atmosphere at a particular time. This means that changes must occur in other Earth systems.

Carbon has been trapped for millennia in fossil fuels. Since the Industrial Revolution, we have been releasing it into the atmosphere at an alarming rate.

Remind students:

- Everything is connected to everything else in ecology which means that changes must occur in other Earth systems.
- The First Law of Thermodynamics states that energy can be changed from one form to another, but it cannot be created or destroyed.
- Photosynthesis is the basis of life on Earth: carbon dioxide + water + sunlight = organic material (sugar) + oxygen 6CO<sub>2</sub> + 6H<sub>2</sub>O yields C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> +6O<sub>2</sub>.
- Respiration is the reverse of photosynthesis: organic material + oxygen = carbon dioxide + water + energy.

As a result of this activity, students will understand how the carbon cycle works and what causes it to change by integrating information from biology, chemistry, oceanography and geology.

#### Helpful hint:

Ask students to read Global Warming 101 on pages 13-21.



#### Summary:

Students study the carbon cycle in the context of global warming

Grade level: 9-12

Time: 2-3 Weeks

#### Subjects:

Social Studies Science Government Economics

#### Skills:

- Communication
- Analysis
- Conceptual thinking
- Problem identification
- Perception
- Creative problem solving
- Research

#### Learning Objectives:

- Students will understand that matter and energy are neither created nor destroyed, but may change forms and locations
- Students will be able to create and explain the carbon cycle

#### Materials:

- Paper and pen
- Flip chart with markers and tape
- Access to the Internet for community and/or school contacts



## Scenario 2: The Science of Global Warming

After completing Scenario 1, continue with the following activity. Activity: The Carbon Cycle

- **1.** Tell students that the culminating goal of this activity is for them to be able to understand the carbon cycle in the context of global warming.
- **2.** Remind students about the four principles listed below, provided on a student page, use as a transparency, or write on a board.
  - Everything is connected to everything else in ecology which means that changes must occur in other Earth systems.
  - The First Law of Thermodynamics states that energy can be changed from one form to another, but it cannot be created or destroyed.
  - Photosynthesis is the basis of life on Earth: carbon dioxide + water + sunlight = organic material (sugar) + oxygen 6CO<sub>2</sub> + 6H<sub>2</sub>O yields C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> +6O<sub>2</sub>.
  - Respiration is the reverse of photosynthesis: organic material + oxygen = carbon dioxide + water + energy
- **3.** Demonstrate how to draw a simple box model. For example, you could draw a seed to a mouse to a snake to an owl.
- **4.** Distribute the student page titled "The Illustrated Carbon Cycle" (See page 37). Explain to students that both matter and energy move through this model. Reservoirs or stocks are places where matter or energy accumulate and are represented by boxes within the box model. Flows are energy or matter.
- **5.** Emphasize that it is important to pay attention to the direction of the arrows since they indicate



where matter and energy are moving to and from.

6. Explain to students that carbon continuously moves among the atmosphere (i.e., air), lithosphere (i.e., the Earth's crust, including rocks and soil), hydrosphere (i.e., the Earth's water, including fresh and salt water), and biosphere (i.e., living things on land and in water) in what is termed a biogeochemical cycle. It is human alteration of the quantity and movement of carbon that is mostly responsible for global warming.

## Scenario 2: The Science of Global Warming

- 7. Place roughly the same number of students in each sphere group below:
  - Carbon in the atmosphere
  - Carbon in the lithosphere
  - Carbon in the hydrosphere
  - Carbon in the biosphere
- **8.** Ask students to gather information on the rates at which carbon flows into and out of the sphere to which they have been assigned. For supporting research, look at the National Oceanic and Atmospheric Administration website.
- 9. Ask the students to draw a box with the name of their sphere in the middle of it.
- **10.** Ask them to draw arrows into and out of their box to indicate carbon inputs and outputs that affect their sphere.
- **11.** Ask each sphere group to nominate one representative and have these representatives gather together as a group to examine their assigned boxes and to create an overall model of the carbon cycle.
- **12.** Ask students to look at the overall model of the carbon cycle they created and identify at least four places in the cycle where humans can make changes to reduce global warming.

#### Helpful hint:

Students will probably need to create several drafts of their carbon cycle box models and their models may look different from those of the other groups. This is okay. Students will need to think about all of the ways that carbon flows into and out of their particular sphere (i.e., atmo-, litho-, hydro-, and bio-).



### COOL LINKS

National Oceanic and Atmospheric Administration (NOAA) www.climate.noaa.gov/index.jsp?pg=./about\_climate/about\_index.jsp&about=physical

For supporting graphical data, visit the **Intergovernmental Panel on Climate Change** website at: www.ipcc.ch/graphics Particularly useful are the graphics, Also, see the Climate change 2001– Synthesis report.

Also Check out the Shodor Eduction Foundation website at www.shodor.org

## Scenario 2: The Science of Global Warming

## Student Page

#### The Carbon Cycle Background

It seems like there have been a lot of questions raised here about how much carbon humans are adding to the atmosphere and why it matters. We've got to take a look at the carbon cycle to try to understand these things. The carbon cycle is extremely complex, and this will in no way be an exhaustive reference on the subject.

Carbon is the foundational element of all organic substances on Earth, from fossil fuels to family pets. Carbon moves through the Earth's systems in several different ways. In geologic time, weathering and erosion wash carbon-containing compounds into the ocean. Eventually they settle to the bottom where they are eventually drawn into the Earth's mantle through a process called subduction. That carbon is eventually reintroduced into the atmosphere as carbon dioxide during volcanic eruptions.

On a shorter time scale, plants use solar energy and the process of photosynthesis to remove carbon dioxide from the air and produce carbohydrates. Plants and animals return that  $CO_2$  to the atmosphere through respiration and also through decomposition. In the ocean, carbon dioxide processed by phytoplankton gets processed into calcium carbonate shells by some organisms. Those shells settle to the bottom of the ocean and form sediment. Carbon dioxide also enters sea water through simple diffusion at the surface, and some of that gets mixed into the deep ocean.

Fire consumes biomass material and releases carbon dioxide into the atmosphere.

Carbon dioxide in the atmosphere has diminished over several billion years of geologic history. Some of that carbon dioxide was (and is) locked into fossil fuels and sedimentary rock.



All of these things happen without human intervention. So how are we impacting the carbon cycle? When we burn fossil fuels, we're releasing carbon into the atmosphere at a rate of 5.5-6 gigatons of carbon (GtC) per year (giga=1 billion). In addition, land use changes such as deforestation add about 1.6 GtC per year to the atmosphere. Some of that human-produced carbon is captured by the oceans and other carbon sinks, but the net result is an addition of 3-4 GtC per year added to the atmosphere, which is why a graph of carbon dioxide concentration looks like this:

## Scenario 2: The Science of Global Warming

### The Illustrated Carbon Cycle

The carbon cycle is the process by which carbon is exchanged between the various geological systems of the Earth and its atmosphere. The carbon keeps circulating between the four main carbon reservoirs: the atmosphere (i.e. the air, where it exists mainly as carbon dioxide), lithosphere (i.e., the Earth's crust, including rocks and soil), hydrosphere (i.e., the Earth's water, including fresh and saltwater), and biosphere (i.e., living things on land and in water).

Carbon is unquestionably one of the most important elements on Earth. It is the principal building block for the organic compounds that make up life. Carbon's electron structure can readily form bonds with itself, leading to a great diversity in the chemical compounds that can be formed around carbon; hence the diversity and complexity of life. Carbon occurs in many other forms and places on Earth. It is a major constituent of limestone, occurring as calcium carbonate and it is dissolved in ocean and fresh water. It is present in the atmosphere as carbon dioxide, the second most important greenhouse gas.

The flow of carbon throughout the biosphere, atmosphere, hydrosphere and lithosphere is one of the most complex, interesting and important of the global cycles. The carbon cycle challenges us more than any other global cycle as it draws together information from biology, chemistry, oceanography and geology. All scientific disciplines are needed to understand how it works and what causes it to change. You will discuss these processes in more detail as you construct and experiment with various renditions of the carbon cycle.



## Student Page

## Scenario 2: The Science of Global Warming

## **Extensions and Research**

- Based on their experience of the carbon cycle, have students identify three human behavioral changes that would reduce global warming. Then, students may propose government policies or laws that would encourage or mandate those changes.
- For environmental AP classes, ask students to research online fluxes and flow rates and report on their impact on the carbon cycle.
- The National Center for Atmospheric Research (NCAR) and the University Corporation for Atmospheric Research (UCAR)

The University Corporation for Atmospheric Research promotes partnership in a collaborative community dedicated to understanding the atmosphere and the interconnected processes that make up the Earth system, from the ocean floor to the Sun's core. The National Center for Atmospheric Research and the UCAR Office of Programs provide research, observing and computing facilities, and a variety of services for the atmospheric and Earth sciences community.

#### • Schoolyard Habitats,<sup>®</sup> National Wildlife Federation

The National Wildlife Federation's Schoolyard Habitats program has assisted over 3,000 schools and outdoor eduction providers nationwide in the development of outdoor habitat areas designed to protect wildlife and enhance the educational experiences of students, teachers and community members.

• Tree Planting: Arbor Day Foundation The Arbor Day Foundation offers detailed information on dozens of commonly planted landscape trees that grow throughout the United States. Here you will find information on height and spread, soil and sun requirements, leaves and fruit, history, use as wildlife habitat and more.

## COOL LINKS

Earth Observatory: National Aeronautics and Space Administration www.earthobservatory.nasa.gov/Library/CarbonCycle/ Earth System Research Laboratory Global Monitoring Division, National Oceanic & Atmospheric Administration www.esrl.noaa.gov/gmd/

The National Center for Atmospheric Research (NCAR) and University Corpration for Atmospheric Research (UCAR) www.ncar.ucar.edu/research/clmate/

Schoolyard Habitats® National Wildlife Federation www.nwf.org/schoolyard

Tree Planting: www.itreetools.org/treecalculartor/ Arbor Day Foundation: www.arborday.org
### Scenario 2: The Science of Global Warming

#### **Action Projec0ts**

Listed here are brief descriptions of three action projects to consider using in your class as you study global warming in Scenario 2. Detailed information about each project (and ideas for many more) can be found in the "Solutions Now: The Guide to Action" section of the curriculum (See page 52).

#### 1. Schoolyard Habitats®

Ask students and other team members to study and map out a potential schoolyard garden. It's also fun to learn about the history of your site. How was the land used before your students arrived? Students might interview long-time community residents and conduct other research while they plan their garden.

#### 2. Tree Planting

Collaborate with local landscaping companies, municipal parks and recreation departments to see if they will donate trees and to help you with your planting project. You can choose an area in the community where habitats have been compromised or plant the trees in your schoolyard for beauty and shade. Organize a tree planting day. Call local media and get publicity for your project.

#### **3.** Adopt an Elementary School

Talk to teachers and administrators of elementary schools in your area to see if you can collaborate with them on a habitat action project on their campus. Whether they have a lot of open space that could use habitat restoration or limited space for extra greening, high school students should take charge of the project and mentor the elementary school students to set an example for how to take care of their communities.



# case study

# Scenario 2: The Science of Global Warming Earth Tomorrow<sup>®</sup> Environmental Leadership Training for Youth

#### Teens in Atlanta and Detroit get down to Earth to show everyone the power of greening.

It is within our reach to create a better world. Many people do not believe that they have the ability to positively impact global warming, but each person can do their part by recycling, by planting trees in their communities and providing habitat for birds and small animals, by carpooling or by riding trains.

 F. Johnson, Westlake High School student, Atlanta Earth Tomorrow Summer Institute

Earth Tomorrow® has been acknowledged by the the Environmental Protection Agency (EPA) and the mayor's offices of Detroit and Atlanta for its work to create more sustainable communities. **E** arth Tomorrow is the National Wildlife Federation's environmental education and leadership program for urban teens. Programs have been running in Atlanta and Detroit for over a decade and reach hundreds of teens annually. Students participate in community action projects they plan and implement, such as habitat restoration, invasive species removal, native plant gardening and tree planting by providing shade and a cool

> place for all. With so much concrete and little open space in some urban settings, greening projects have become an example to the entire community of how to confront global warming.



Habitat projects start with a lot of planning. Youth involved in the Earth Tomorrow program receive hands-on training in environmental conservation and protection from resource professionals living and working in their communities. Through after-school clubs, residential summer institutes and career guidance, this program nurtures the growth of future environmental leaders. At the annual Earth Tomorrow Summer Institute, students participate in and often teach workshops that help them and community volunteers to develop green projects for their schools and to increase awareness of how global warming is affecting them now.

### case study

### Scenario 2: The Science of Global Warming (continued)

In Detroit, Earth Tomorrow<sup>®</sup> students have long taken the lead on community action projects, including the creation of schoolyard habitat sites, on-going restoration of wetlands in the heart of the city along the Detroit River, lead testing and drinking water awareness campaigns, waste reduction and school clean-up days. Students and members of the community have also installed demonstration wildlife habitats in local parks and at schools.

In 2007, Atlanta teens installed a butterfly habitat at the Harland Boys and Girls Club in Atlanta's West End neighborhood, a lowto-moderate income community. Atlanta teens also conducted community surveys and communicated their findings to local press and elected officials to raise awareness of global warming.

These initiatives result in the provision of essential habitats for wildlife often displaced by climate change and habitat loss. Each project conveys an important and very visible message to everyone who walks by or visits: We can restore our planet's health.

#### Contacts:

Atlanta: Na'Taki Osborne Jelks, Manager, Community and Leadership Development Programs, National Wildlife Federation Southeastern Natural Resource Center. *Email:* osborne@nwf.org

**Detroit: Rebecca Nielsen,** Manager, Regional Education Programs, National Wildlife Federation Great Lakes Natural Resource Center. *Email:* nielsenr@nwf.org





#### Summary:

Students apply the lessons learned in previous lessons to think more deeply about the impact of lifestyles choices on overall carbon emissions.

#### Grade level: 9–12

Time: 4-6 hours

#### Subjects:

Social Studies Science Math Government Economics

#### Skills:

Analysis Comparison Description Research Synthesis

#### Learning Objectives:

- Students will be able to:Identify resources they use in their own lives
- Quantify their current carbon footprint
- Identify and present ways in which they could reduce their carbon footprints
- Design and conduct an action project as a class

#### **Materials:**

- Research sources
- Student access to the Internet
- Student worksheets

#### CLASSROOM LESSON PLANS

### Scenario 3: Moving from Knowledge to Action

fter watching *An Inconvenient Truth*, it may seem to students that the only way they can help is to stop using energy derived from fossil fuels entirely, and, of course, they can't. The real message is that each of us is able to critically think about the amount of carbon we emit directly and indirectly through our daily activities and choices. We can then determine how best to reduce or even eliminate our impact. In fact, increasing numbers of companies are starting to produce and market lower impact products.

This activity should help students realize the range of options they have in everyday life to reduce carbon output, and that the most important lesson to understand is that they should critically evaluate their carbon-producing activities. Their decisions can have a big impact.

### What is a Carbon Footprint?

Carbon footprint is an expression that describes how much carbon dioxide a person emits/releases over his/her lifetime. This is direct impact. For example, each time you drive or ride in a car, hundreds of pounds of carbon are released into the atmosphere in the form of carbon dioxide (CO<sub>2</sub>). By changing activities–for example taking public transportation one day of the week or participating in a carpool with a friend–an individual can help reduce his/her carbon footprint. It is also important to think about the whole life cycle of the products we use and consider how the manufacturing, transportation, packaging and disposal of an item will impact your carbon footprint, whether it is a piece of fruit or a new computer. If everyone commits to lowering their respective footprint, we will leave the Earth healthier for future generations.



### Scenario 3: Moving from Knowledge to Action

Complete Scenario 1 and Scenario 2 prior to beginning Scenario 3

#### Activity: What is Your Carbon Footprint?

The purpose of this activity is to help students apply the science learned in previous lessons and to think more deeply about the impact of lifestyle choices on overall carbon emissions.

**1.** Brainstorm with students the various ways human activity emits carbon. These may include the obvious heating or cooling of your home with energy from fossil fuels and purchasing fruit that has been shipped from another country.

MeetTheGreens.org is a new kids' guide to looking after the planet. Kids can watch THE GREENS' cartoon adventures and discover related green games, news, downloads, action tips, links, and much more. This innovative, Web-only project comes from WGBH in Boston, the producer of shows like *ZOOM*, *ARTHUR, Frontline and NOVA*.

2. Instruct students to individually create a list of the ways in which they contribute to carbon emissions daily. Encourage them to

think of all the things they need to get through the week (food, clothing, transportation, heating/cooling in the apartments or houses, entertainment, etc.). After students have written their own lists, ask them to get into small groups and compare lists, adding to their lists items that they may have forgotten and modifying as they discuss.

- **3.** Ask students if they have heard of the term "carbon footprint." Discuss the definition provided on the student page. Ask them how they might determine their carbon footprint. Explain that there are calculators designed to do exactly that. As an assignment, hand out the "Calculating Your Carbon Footprint Questionnaire" on student pages 47-48\*\* and ask students to record their answers.
- 4. Instruct students to go to www.meetthegreens.org/features/carboncalculator.html and calculate their carbon footprint for the year. In the next class, ask students to volunteer information from their carbon footprint score. Which activities use the most carbon? Which activities use the least?



#### COOL LINKS

#### Carbon Calculators:

There are several carbon calculators to support this activity online www.meetthegreens.org/features/carbon-calculator. html From the makers of *An Inconvenient Truth* www.climatecrisis.net/takeaction/carboncalculator **Other calculators:** www.carbonfootprint.com; www.zerofootprint.org **CLASSROOM LESSON PLANS** 

### Scenario 3: Moving from Knowledge to Action

5. Start a discussion about the ways students may reduce their carbon footprint or offset the amount of carbon emissions they produce by doing certain activities. Ask each student to identify one example of a new technology or strategy that is designed to reduce carbon dioxide emissions - for example, natural gas cars, solar screens to cool homes, solar powered MP3 players, planting trees, or carpooling. Ask them to find other examples on the web, the newspaper or from a report they hear on the radio or TV.

On the board draw four columns, label the first column Activity and label the remaining columns One, Two and Three. Have the students list an activity that emits carbon and then share the carbon dioxide-reducing new technology or strategy they find. As a group, have the students rate each item for how well it reduces carbon dioxide emissions, 1 = excellent, 2 = good and 3 = not very good. Give the example of the amount of carbon reduced by replacing one incandescent light bulb with a compact fluorescent and compare that option with natural light in the day, timers on lights and solar or wind powered homes. Discuss the ways we can lower or offset carbon emissions from the chart. Are there any controversies over how to rank carbon-reducing technologies and strategies? What are some strategies and technologies more viable than others?

6. Based on the findings above, ask students to construct or conduct a survey for their peers and family members, highlighting which activities they would be willing to change in order to reduce their average carbon footprint and which they would not Document their reasons for the survey responses. Use the questionnaires in the student pages (pages 47-48) from class and websites provided as a basis for designing the survey.

This can be done as an individual homework assignment or as a group project with each group taking a different component of the carbon footprint, such as transportation, heating and cooling, food choices and appliance use. Ask students to report back on their findings describing the challenges people express or new ideas discovered of changing their carbon footprint. What keeps people from making the changes necessary to reduce their carbon footprint? What makes it easy for people to make changes to reduce their carbon footprint?

Replace one 75-watt incandescent (\$0.75) with one 20-watt CFL (\$4.00)									
	SAVINGS AFTER								
Lamp Use	1st year	2nd year	3rd year	5th year	10th year				
2 hrs/day	\$0.21	\$4.40	\$8.60	\$17.00	\$38.10				
4 hrs/day	\$4.40	\$12.90	\$21.30	\$38.10	\$72.30				
8 hrs/day	\$12.90	\$29.70	\$46.60	\$72.30	\$153.80				
12 hrs/day	\$21.30	\$46.60	\$67.83	\$114.40	\$232.00				

### Scenario 3: Moving from Knowledge to Action

#### **Extensions and Research**

- Have students investigate purchasing and use of fossil fuel patterns at their schools cafeteria, offices, or classrooms. What kinds of impacts do they discover? How could the class help the school reduce its carbon footprint?
- Now that students understand the concept of a carbon footprint and how to critically think about their use of fossil fuels, introduce the concept of ecological footprints. An ecological footprint is the area of productive land and water required for a given population to exist at a given consumption level. It measures how much of nature's carrying capacity we use to feed, clothe, and otherwise maintain ourselves. All consumption of energy and materials and all discharge of wastes require land or water for resource production or waste disposal.
- Use the lists they created in the exercise above, or have each student create a new list of everything they bought or was bought for them in the past week. Alternately, you could ask students to record everything they buy or that is bought for them in the week ahead. Encourage them to try to think of all the kinds of items they need to get through their week (food, clothing, transportation, heating/cooling, entertainment, etc.).

After students have written their individual lists, place them into small groups and have them compare lists, adding items that they may have forgotten and modifying lists as they discuss, as they prepare a group list. Then have groups compare their lists to those of other groups.

• Using the same approach as that used for examining carbon footprints, ask students to research and determine the ecological footprint of particular items. For example, how many tee shirts do each of your students have? Ask them to calculate how much land and other resources are represented by the shirts they buy in one year. Are some brands of shirts made from organic cotton or synthetic fibers? You may want to assign particular items, or start them off with specific resources for the products to get them started.

The websites below will help students research and calculate their ecological footprint(s).

#### COOL LINKS

**Options available to examine carbon impacts at the EPA site** www.epa.gov/air.urbanair/

The low carbon diet program–remove 5,000 pounds www.empowermentinstitute.net/lcd/index.html Americans shifting to carbon neutral lifestyles www.csmonitor.com/2006/1206/p13s01-sten.html An interesting carbon calculator from the United Kingdom www.carboncalculator.co.uk/

Ecological Footprint Calculator Center for a Sustainable Future www.concord.org/resources/browse/251/

Economic Input-Output Lifecycle Assessment Carnagie-Mellon Green Development Institute www.eiolca.net/ Redefining Progress www.rprogress.org/education/footprint education.htm

#### **CLASSROOM LESSON PLANS**

### Scenario 3: Moving from Knowledge to Action

- Ecological Footprint Calculator Center for a Sustainable Future This page offers an Ecological Footprint Calculator program, which provides a tool for students that will help them learn how these are calculated and what different land uses (crops, grazing, forest, developed land) are represented. The site also provides tools for students to create their own footprint surveys with their own questions to determine the further impact of human activities.
- Economic Input-Output Lifecycle Assessment, Carnegic-Mellon Green Development Institute This is somewhat complicated for students, but can give you some ideas to help them get started or provide some broad statistics for industries, such as food, fabrics, paper, etc.
- **Redefining Progress** Use a footprint quiz and calculator and comparative statistics, as well as suggestions for links for changing personal consumption patterns. Also use the teacher's footprint-related manuals and sample lesson plans.

Note: See Cool Links websites on page 45

#### **Action Projects**

Detailed information about each project and ideas for many more can be found in the "Solutions Now: The Guide to Action" section of the curriculum (See page 52).

#### **1.** Bus/Car Idling Project

Driving churns out carbon dioxide as one contributing factor to global warming. Though they might not drive themselves yet, students still have influence over curbing vehicle emissions. This project gives action options such as implementing a campaign for turning off buses while idling, switching buses to biodiesel, promoting the purchase of alternative energy through the local power company and encouraging friends and family to consider Earth-friendly ways to commute to work and school.

#### **2.** Pump Up Your Ride

Increase tire inflation awareness in your school or community. Dedicate a weekend to getting others to inflate their tires. Organize a fund-raiser and charge a fee per pound of air to inflate tires, organized similar to a car wash. Get the word out through the media: tell them what you are doing and why.

#### 3. Bike to School Day

Coordinate a Bike to School Day with students where participants agree to not use cars to get to school. You can even put together a pledge drive and raise money for "miles traveled" where the more miles a student bikes or walks, the more money they raise to put toward school conservation efforts. The day can also be extended to a week or a month. As an extension, include teachers and administrators in the challenge and provide awards to the students who biked or walked the most miles and raised the most money and/or the students who biked the most days.

## Scenario 3: Moving from Knowledge to Action

### **Calculating Your Carbon Footprint Questionnaire:**

Carbon footprint is an expression that describes how much carbon dioxide a person emits/releases over a given period of time.

#### **Transportation:**

Use these answers to help determine your carbon footprint by using the calculator at www.meetthegreens.org

How Do You Get To School? (more than one can be checked)	YES	NO
Car		
City bus		
School bus		
I walk or bike to school		
Have you flown in a plane in the last month?		
Do your parents ride their bikes to work?		

#### What You Eat:

What kind of food does your family eat?	Just Vegetables (Vegan)		Eggs and Dairy (Vegetarian)		Everything	
How often do you eat at a fast food restaurant?	Never	Once a Week	Twice a Week	More Often		
How much soda do you drink?	0 Cups a Day	1 Cup a Day	2 Cups a Day	3 Cups a Day	4 Cups a Day	5 Cups a Day
Do you bring your lunch in a bag or lunch box?	Yes		•	No		

#### Source:

Courtesy of Zerofootprint.org

# Student Page

### CLASSROOM LESSON PLANS

# Scenario 3: Moving from Knowledge to Action

### Student Page

Home & School:	4					
What type of home do you live in?	Apartment			House		
How many people live in your home?	One	Two	Three	Four	Five	More
Do you have a summer house?		Yes		No		
Do you have a lawn?	Yes			No		
How often do you shower?	Twice per day	Once per day	Once every 2 days	Once every 3 days	D bel in sh	on't lieve lowers
How many loads of laundry do your parents do each week?	One	Two	Three	Four	Five	More
What type of clothes washer do you use?	Top Loading		Front Loading			
Do your parents dry your laundry outside?	Yes		No			
Do you brush your teeth once or twice a day?	Once		Twice			
Do you leave the tap on when brushing your teeth	Yes		No			
Do you own a swimming pool?	Yes			No		

#### Source:

Courtesy of Zerofootprint.org



### 3-2-1 Campaign, Alaska Youth for Environmental Action (AYEA)

#### Alaska youth answer the question "What can I do about global warming?" with a results-oriented action campaign

"We decided that we wanted to do something about global warming since it's having huge affects in Alaska. And we, the youth of Alaska, are going to be its next generation and we'd like to inherit a healthy planet."

> — L. Evans, Alaska Youth for Environmental Action (AYEA), Anchorage chapter

The Alaska Youth for Environmental Action (AYEA) is the National Wildlife Federation's environmental leadership program for Alaska teens. AYEA members crafted a plan to reduce carbon dioxide emissions through a program they called the 3-2-1 Efficiency Campaign. Their strategy was to invite individuals to take a pledge to replace **3** incandescent light bulbs with compact fluorescent bulbs, turn their thermostat down **2** degrees in the winter and unplug **1** household appliance when not in use.

The first year of the 3-2-1 Efficiency Campaign was a huge success, and the students estimated that as result of their campaign there was an annual prevention of almost 10 million pounds of carbon from entering the atmosphere. They continued their work, expanding the reach of their campaign and raising the level of actions they are asking pledge-signers to commit to. Most recently, AYEA partnered

# case study

#### The AYEA 3-2-1 Pledge:

- 3 Unplug 3 electronic appliances (e.g, stereo, TV) when not in use (Saves 3,000 lbs. CO<sub>2</sub> / year)
- 2- Bring 2 reusable plastic or canvas bags when you go shopping (*Saves 50 lbs. CO<sub>2</sub> / year*)
- Replace 1 regular use incandescent light bulb with a compact fluorescent light bulb (Saves 100 lbs. CO<sub>2</sub> / year)

with the Alaska Association of Student Governments (AASG) and turned their campaign into a contest. The AASG districts are now competing against one another to see which can get the most people to take the new 3-2-1 revised pledge. In the pledge, signers commit to unplugging **3** electronic appliances, taking **2** reusable bags when going shopping and replacing **1** incandescent bulb with a CFL bulb. They aim to get 5,000 people to take the pledge to reduce carbon emissions in Alaska by an estimated 19.8 million pounds.

#### **Contact:**

Outreach Coordinator, Alaska Youth for Environmental Action, National Wildlife Federation Alaska Natural Resource Center. **Polly Carr,** Manager, Alaska Youth for Envronmental Action *Email:* carrp@nwf.org



### In addition to their 3-2-1 Efficiency Campaign AYEA received the 2006 President's Environmental Youth Award

for their work in a statewide global warming outreach and education project. The AYEA teens developed a petition requesting federal

legislation that would reduce greenhouse gas emissions and invest in renewable energy. AYEA collected 5,000 teen signatures from 105 communities in Alaska, which represented more than 10 percent of the enrolled high school population. They presented their petition to Senator Lisa Murkowski, who requested that AYEA members meet with climate change specialists in Fairbanks to bridge the "science and public awareness" divide, which they continue to do through their organization. In 2007, AYEA teens traveled to Washington D.C. to testify on energy issues and global warming. See them on the YouTube video at www.youtube.com/watch?v=9IEBZBTrfpo

#### **CLASSROOM LESSON PLANS**

# Writer's Corner

#### Activity: Reflect and Communicate

These activities provide reflective writing opportunities for students. They may be used with the previous activities in this guide or independently for shorter writing-focused exercises relating to the topics covered in *An Inconvenient Truth*.

- **Keep a journal** for one day cataloging all of the advertisements you see TV, clothes, signs, etc.—about global warming.
- Write an essay about what you think is your class collective carbon footprint. Compare the footprint to that of a similar high school class in one other country such as China, India or Switzerland. Research information on the Internet about the carbon footprint of the country selected.
- Describe the kinds of actions you could take to reduce your carbon footprint.
- **Discuss** how the U.S. consumption of fossil fuels compares with that of other countries, examining the social equity issues. What would you think if you were from another culture looking at U.S. consumption patterns? Would you want to be like us? How do you feel about China's increasing use of fossil fuels?
- Write an essay describing how to make your town a carbon-neutral city of the future. Include transportation, food distribution, heating and cooling of buildings, building design, natural areas, etc.
- **Describe your favorite advertisement** or one that most influenced you to buy or do something. Why was it effective? Why do you remember it?
  - Design a compelling advertisement or slogan to influence your peers to reduce their carbon footprint.
- Write about the process of making consumer choices. How can you as a consumer change corporate policies and reduce global warming emissions?"
- **Choose your favorite quote from the movie.** Explain why it appeals to you and its significance in the movie.

#### Summary:

Students apply science and social studies to reflective writing; communicating scientific principles and climate change in a meaningful way.

#### Grade level: 9-12

Time: Semester, 3-6 hours each

Subjects: All

**Skills:** Language Arts

#### Learning Objectives:

Integrate science into reflective writing and language arts

#### **Materials:**

- Paper
- Pen
- Computer

### SOLUTIONS NOW: THE GUIDE TO ACTION



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### The Importance of Promoting Student Action

Student action projects are the most effective method by which students can apply the knowledge they have learned in the classroom and retain this information for the long term. Action projects engage students in solving problems in their communities and schools and help them master curriculum content by making meaningful connections between what they are learning and the world at large. Action projects can also help students develop a range of skills. In addition, projects help students realize that their actions matter, helping to develop their ability to influence others and sense that they can make a difference.

Action projects are designed to impact both the recipients (community members, ecosystems health, etc.) and the students. This transformation is accomplished by combining opportunities that link the project with self-reflection and the acquisition of skills, values and knowledge.

Recent studies indicate that students are more receptive to learning when their surroundings and activities complement and reinforce the subject matter. For example, if students are taught the principles of recycling and waste reduction and there are no efforts being made to reduce waste in the school, it is unlikely that the lessons taught will have a significant effect. However, in many cases when recycling is taught in conjunction with an existing waste reduction program, or if students start reusing paper or implement other sustainable practices, they will better understand resource management and change their behavior at school and at home.

Action projects can include fairly simple individual behaviors as well as more comprehensive school-wide events and activities. The scale of the project does not always determine its merit. For action projects to be significant for all involved, they need to be well-researched, outcome-oriented, planned, communicated, well-promoted and evaluated. Look at the *Climate Classroom* web site for more information on the benefits and attributes of successful action projects and service learning.

After watching *An Inconvenient Truth*, individuals overwhelmingly express a feeling that they must take action to reduce greenhouse gas emissions and stop global warming. These actions include telling their friends to see the movie, trying to help others understand the issue, reducing their own energy use or working for community-wide changes in the way energy is produced.

In this section, we have provided examples and guidelines for action projects. Examples are provided to create greater awareness for the issue of global warming and educate others about individual and community activities to reduce carbon. More involved examples focus on detailed school and local policy changes that will impact how to value and use natural resources. In this section, an initial list of projects and resources is provided. These have been grouped based on the classroom activities introduced in the previous sections. Explore all of the solution projects proposed here as possibilities. Each action project will be unique to those involved and their own environment.



### Act 1: Climate Change in Our Society

#### **Teacher Background Information**

How well did the class do when they took the Global Warming Survey in Scenario 1? Have the students consider surveying their family and others.

Raising awareness about climate change issues is critical for finding and implementing solutions. This simple survey reveals a lot about what people do and don't know. Students using this survey may be surprised how much people understand and do not understand about global warming. Ideally, the results of a survey such as this will spur students to become more active in educating their family, friends, school and the larger community.



If you have not already done so, complete the Option B Activity in Scenario 1. Recap the results of the survey. Tally the votes as a class and put the results on the board. Were students surprised by the results? What do the results suggest? The survey can extend to the whole school or the community. Students can tally the results and think creatively about sharing the data and addressing any lack of knowledge they uncover.

Suggest to students that as a project they use this survey to assess people's knowledge of global warming and use the results to plan an activity or event to address any gaps in understanding or misconceptions.

#### COOL LINKS

For educational resources from the **Center for International Earth Science Information Network (CIESIN)**, check out: www.ciesin.org/edresources.html

For Global Change and Environmental Education, look at www.gcrio.org/edu/

**Educational resources on regions** are available from the U.S. National Assessment of the Potential Consequences of Climate Variability and Change at www.usgcrp.gov/usgcrp/nacc/education/default.htm

Argonne National Laboratory provides Ask a Scientist www.newton.dep.anl.gov/askasci/env98.htm

The Scripps Institute of Oceanography provides a research site called Earthguide www.earthguide.ucsd.edu/

### Act 1: Climate Change in Our Society

#### **Student Action Project**

#### School-Wide Global Warming Survey

Many people hold the longstanding, but false, assumptions that the Earth and its atmosphere are too vast to harm through human activity, or even if real environmental harm is done, that the Earth would recover quickly. In reality, scientists find that the Earth's atmosphere is so thin that we have been changing its chemical composition through human activities and that these changes are having observable effects. It is important to help people understand what global warming is and why it is happening. One way is by teaching people some basics through the Global Warming Survey on page 29.

Some questions to answer:

- How well did you do on the Global Warming Survey that you took?
- The interesting thing about a survey like this is that it helps you see what you don't know, and that can be really useful. Think about the questions that you got wrong.
- Do you know the answers to them now?
- How would your friends and family do on such a survey?
- Take a look at the survey. As a group, discuss the questions to determine if there is anything that should be added or taken away. Make sure to set up a database for tallying all of the information before beginning.

Remember: It is best not to put in any "openended" questions into the survey, because that information is very hard to analyze. This project is one way to help others see what they don't know, and then it gives you the chance to help them learn!

#### **Helpful Hint**

Project Plan It! Is an easy interactive series of questions and templates that allow you to plan a service project or program. When completed, you will be able to print:

- Project plan
- Funding proposal
- Press release
- Service learning reflection plan
- Other helpful resources.

You will also be able to post your project on servenet and be able to convert your project or program into your own web site soon. www.ysa.org/plantit

### COOL LINKS

See the servenet website to find existing volunteer opportunities in your community through the servenet database. www.servenet.org/toolkit/serviceopportunities/findopportunities www.energystar.gov/index.cfm?c=cfls.pr\_cfls

Set up the quiz online using a resource such as **Survey Monkey**, www.surveymonkey.com Your job is to make sure your intended audience goes online and takes the survey.

### Act 1: Climate Change in Our Society

Ask students to:

- First, figure out who should take the survey (maybe their grade, the whole school or all of the teachers).
- Next, make a list of everyone they want to survey. If one wants to try to get the whole school or maybe just one grade to take the survey, obtain a list from the principal's office of the students targeted. Check off this list to ensure that everyone takes the survey.
- Determine the best way to get everyone on the list to take the survey. For instance, you could go to each science class and have the students take the survey. Or maybe you could set up a booth before or after school and get students to take the survey as they are arriving or leaving. Encourage your peers to take the survey home and give it to adults when completed.
- Compare adult responses with teen responses when all the surveys are completed.

Once students have collected all of the information, have them tally all of the results to see what people know and what they don't. Communicating the results of any action project is key to success. Participants will want to know the results of the survey. Students can brainstorm ways to represent the data collected (pie charts, graphs, creative posters) and then prepare a report for distribution via school radio, newspapers, website or local cable access channel. Students can use this data to plan their next project.



### Act 1: Climate Change in Our Society

#### **Additional Action Projects and Resources**

#### Throw An Inconvenient Truth Movie Watching Party

Plan the party by setting the date, time and location. Decide who they want to invite, create and send out electronic invitations. When planning the party, remember that the movie is about one

Create some fact sheets to use in guiding the post-movie discussion or follow-up meeting.

and one-half hours long. Don't forget to add extra time for a group discussion after the movie. Students will need a copy of the movie and a good place to watch it. Try renting it or borrowing it from the library, and reserve a space at school or a local community center or library to watch the movie.

Ask viewers to consider how they felt after seeing the movie. Did they have questions about things they saw in the film? Anticipate that after seeing the movie, the viewing group may have the same questions. Create a handout in advanced that answers some of the "burning questions" presented in the movie. Hosting a discussion after the movie will help you plan for a follow-up meeting to discuss individual actions that can help reduce global warming or projects that the group might like to initiate.

#### Global Warming Awareness School Fair

After surveying your school, you may find that many of your fellow students have a lot to learn about global warming. Design and plan a Global Warming Awareness Fair with speakers, activities and discussion groups. Alternatively, you and your peers may form a Global Warming Communications Committee for their school and create a newsletter or website. Look for speakers to talk at your fair on global warming–consider local politicians or nonprofit groups that address this issue.



#### COOL LINKS

Customize and send an e-card Invitation or download a printable invitation. www.evite.com

### Act 1: Climate Change in Our Society

#### Host an Information Booth

Compile climate change information, create sheets, flyers, posters and/or PowerPoint presentations on global warming, and set up an information booth in the hallway or outside the cafeteria at your school. Encourage students to make the booth appealing in order to encourage others to approach them and discuss climate change information. Have them provide sign-up sheets to enable other interested students to continue to receive information and learn about opportunities for future actions.

#### Trash on the Lawn Day

This project requires that you receive permission from the principal and maintenance staff at your school. Once you have the necessary permissions, dump all trash from the school onto the lawn and go through and figure out what is not being recycled and what could be. Ask them to weigh the stuff that should be recycled and use that information to develop an ongoing recycling and composting program. Use information to educate students, staff and even the community about the amount of energy it takes to make products from virgin materials versus products made from recycled materials.

*Note:* Encourage all students and staff to wear protective gloves when handling trash. Again, make sure all of your school protocols are followed.



#### Hold a Global Warming Youth Summit

Try holding a Global Warming Youth Summit. Bring schools within your district together to network, learn more about global warming, gain skills and develop a network of "power" between schools. You can research and invite different speakers to talk about the issues, plan a day-long event and involve students from different schools in a collaborative action project for the day or for the long term.

#### COOL LINKS

www.ClimateClassroom.org has a great educational slide show and PowerPoint presentation that can be used to teach others about global warming.

Look at the **TV show** dedicated to help families go green: www.ecorazzi.com/2007/12/13/new-discovery-show-wasted-helps-families-go-green/

See what clubs and communities are doing about the environment www.sierraclub.org.



### Act 2: The Science of Global Warming

#### **Teacher Background Information**

Action projects in this section are designed to complement the study of the carbon cycle in Scenario 2 in the previous section. Suggested projects include planting vegetation, altering landscapes and using renewable energy to benefit wildlife and people.

The creation of a Schoolyard Habitat<sup>®</sup> is an excellent opportunity to reach out to community members and invite their participation. To build support for projects, introduce your community to the contributions that the projects will make to enrich the school's educational offerings. For example, the Schoolyard Habitat can be a benefit to the entire community as a public example of what individuals can do to confront global warming.

Encourage students to find assistance in the community from a wide variety of sources, such as landscape architects ready for a new challenge; local businesses willing to donate plants, landscape materials and expertise; garden and civic clubs excited to offer their knowledge and hands-on involvement. These are only a few suggestions for making the link between the project and the community; don't be afraid to ask others for support! The material contributions, in-kind support and resource connections will be invaluable to your project and will help strengthen school communities.



#### **SOLUTIONS NOW: THE GUIDE TO ACTION**

# Act 2: The Science of Global Warming

#### Student Action Project

#### Schoolyard Habitat<sup>®</sup>

Get students and other team members to study and map out the potential garden. Everyone can participate by either writing or drawing:

- Physical elements: soil, topography, water sources, drainage patterns, sun and wind exposure
- · Ecological components: plants and animals, including insects
- Human influences: buildings, sidewalks, playing fields, utility right-of-ways and asphalt areas
- Boundaries: including nearby habitats

#### Habitat benefits include:

- Providing carbon producing activity impacts because plants take in carbon and produce oxygen
- Provide thermal cover for wildlife to minimize the impact of higher and lower temperatures (heat and cold).
- Provide essential habitats for wildlife. Habitats can be displaced due to climate change.

It's also fun to learn about the history of your site. How was the land used before your students arrived? Students might interview long-time community residents and conduct other research.

When you and your students choose your site, make sure it's welcoming to wildlife and people-or that you can introduce elements to make it welcoming. Wildlife require food, water, cover and places to reproduce and raise their young. Make it

accessible for classes to use and for community members to visit. Some examples of things your students might discuss include finding:

- Water pools in one area of the schoolyard for planting water-loving plants
- A steep slope and whether or not to plant on it
- Part of the schoolyard that was a landfill in a historical study, so it might not be safe to dig there
- A natural area that already attracts wildlife and deciding to protect it from human interference

Have students make a plan of what needs to be done and by whom, including maintenance time after the project is done-watering, weeding and other chores throughout the summer and the following school year. Be sure to include sustainable gardening practices in the maintenance plan.

Set goals and action items. Identify the resources you will need, where they may be located and who will be responsible for each action. Set a date to start the project and an anticipated finish date. Celebrate your progress along the way and plan a ceremony for the grand opening of your habitat.



#### COOL LINKS

Check out NWF's Schoolyard Habitat program online at www.nwf.org/schoolyard

### Act 2: The Science of Global Warming

#### **Additional Action Projects and Resources**



#### **Tree Planting**

Collaborate with local government non-profit organizations and landscaping companies and see if they will donate native trees and machinery to help you plant them. Ask their advice on the correct types of trees and optimum location to provide cooling shade in the summer and wind blocks in the winter. You can choose an area in the community where habitats have been compromised or plant the trees in your schoolyard for beauty and shade.



#### Adopt an Elementary School

Talk to teachers and administrators of elementary schools in your area to see if you can collaborate with them on a habitat action project on their campus. Whether they have a lot of open space that could use habitat restoration or limited space for extra greening, high school students should take charge of the project and mentor the elementary school students to set an example for how to take care of and get involved in greening their communities.



#### Solar Challenge

Have students develop a solar challenge for their school, where they educate school staff, officials and students about solar energy and then work to raise funds to qualify for solar panels through various means such as through British Petroleum (BP) or the Mississippi (MS) Energy Consumer's Alliance.

#### COOL LINKS

**Plant trees to help reduce carbon in the atmosphere** Learn about energy-efficient landscaping at www.eere.energy.gov/consumer (click on "landscaping").

**Trees from The Arbor Day Foundation** You receive ten trees with your \$10 annual membership, and the Foundation has lots of information about planting and maintaining your trees: www.arborday.org

National Renewable Energy Library, Solar Energy Basics www.nrel.gov/learning/re solar.html

**Consumer Energy Alliance** supports the thoughtful utilization of energy resources to help ensure improved domestic and global energy security and reduced prices for consumers. www.consumerenergyalliance.org

### Act 2: The Science of Global Warming



#### Light Bulb Sale

Sell energy efficient compact fluorescent light bulbs (CFLs) to raise money to support your community campaign or to help the school buy new light bulbs.



#### **Changing Light Bulbs**

Work to get your community to change their bulbs from incandescent to the more energy efficient CFLs. Find out if your local energy company offers rebates and/or conservation kits for changing light bulbs to CFLs. If so, develop a plan for spreading the word in your community and getting people to take advantage of the program. If you cannot find a source for a rebate program, try starting your own community-wide campaign to get residents to pledge to change their next burned-out light bulb to a CFL. Ask

a home improvement center to partner with you and perhaps they can offer coupons for CFLs that you can hand out as part of your campaign.



#### Think Outside the Bottle Pledge

Educate your school about problems with bottled water and other drinks. Have students and teachers sign a pledge not to drink bottled water but to use reusable water bottles instead. Give prizes to homerooms that have all students sign the pledge.

The goal is to have individuals use reusable containers for water and sports drinks whenever possible!

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#### COOL LINKS

**Compact Fluorescent Light Bulbs Use** www.energystar.gov/index.cfm?c=cfls.pr\_cfls **Think Outside the Bottle Pledge** www.thinkoutsidethebottle.org

## Act 3: Moving from Knowledge to Action

#### **Teacher Background Information**

Students apply what they learned about how to reduce their carbon footprints to develop strategies and projects that result in reduced use of fossil fuels at school and on a community-wide basis. Students use the same method as well as critically thinking about how to encourage actions among many people that result in a collective reduction of green house gas emissions. The suggested solutions focus on transportation choices and energy use and represent cumulative applications of these lessons.

Transportation options are critical to solving the climate crisis. On average, a gasoline-powered car
emits about 12,000 pounds of carbon a year! Almost everything we use, from food to clothes,
involves transportation of some form. Simple strategies, such as properly inflating tires, reduce CO<sub>2</sub>
emissions by improving gas mileage up to 10 percent and extending the life of tires, thereby cutting

down the demand to produce more of these petroleum-based products.

- Alternative energy, or energy produced from resources besides oil, natural gas and petroleum, is gaining interest in America and around the world. As our world's population grows, human consumption of energy grows, thus exhausting the already limited oil and gas supplies. For example, sustainably harvested bio-diesel is an option because it is available right now. Any car or truck that runs on diesel can use it, and there are currently many new buses and trucks available that have either diesel engines or flexfuel engines which can take both gasoline and biodiesel.
- Our consumption of electricity in our daily lives is another primary source of carbon emissions. Students can implement programs to reduce the collective use of electricity in school buildings

### The 3-2-1 Pledge:



Unplug 3 electronic appliances (e.g., stereo, TV) when not in use (Saves 3,000 lbs. CO<sub>2</sub> / year)



Take 2 reusable plastic or canvas bags when you go shopping (Saves 50 lbs.  $CO_2$  / year)



Replace 1 regular-use incandescent light bulb with a Compact Fluorescent Light bulb (Saves 100 lbs. CO<sub>2</sub> / year)

and their homes. These actions include changing daily behaviors as well as implementing long lasting institutional changes such as solar water heating and increased insulation.

For an excellent example of the impact on global warming as a result of behavioral change through simple remedies, refer to the case study in Scenario 3. Alaska Youth for Environmental Action and the Alaska Association of Student Governments created the "3-2-1 Campaign." The 5,000 people who took the 3-2-1 pledge will collectively reduce carbon emissions by an estimated 19.8 million pounds!

### Act 3: Moving from Knowledge to Action

#### **Student Action Project**

#### **Bus/Car Idling Project**

Driving is one major contributing factor to global warming, because it churns out  $CO_2$ . You still have influence over curbing vehicle emissions, even if you do not drive yourself.

Every day, thousands of schools buses are used across the country and they provide safe and effective transportation for kids. Buses contribute to global warming whenever they sit idling in front of schools, wasting fuel and money. When idling, a typical school bus engine burns approximately half a gallon of fuel per hour. School districts that eliminate unnecessary idling can save significant dollars in fuel costs each year and reduce their carbon footprint.

Idling buses can also pollute air in and around the bus. Exhaust from buses can enter school buildings through air intakes, doors and open windows. Diesel exhaust from excessive idling can be a health concern.

Develop a school bus idling campaign in which a plan is drawn up to end bus idling.



#### COOL LINKS

Try out the **bus idling calculator** to determine how much CO<sub>2</sub> is being released now in your schools' fleet of school buses. www.epa.gov/otaq/schoolbus/idle fuel calc.htm

EPA has a tool kit for conducting your own bus idling campaign at www.epa.gov/otag/schoolbus/antiidling.htm#implement

### Act 3: Moving from Knowledge to Action

#### **Additional Action Projects and Resources**



#### Pump Up Your Ride

Dedicate a weekend to getting others to inflate their tires and increase tire inflation awareness in your school or community. Organize a fund-raiser and charge a fee per pound of air to inflate tires – similar to a car wash fundraiser. You can rent an air compressor for the day at an equipment rental outlet, or work with a local service station to coordinate an event on their site. Get the word out

through the media-tell them what you are doing and why. Connect "Pump Up Your Ride" to other transportation projects in your area, such as biodiesel promotion, alternative transportation or neighborhood carpooling campaigns, by communicating with other local groups working on these issues.

Tires can lose several pounds of pressure a month due to temperature and seasonal changes, so it is important to check the air pressure regularly. It is easy to fill a vehicle's tires with air.

#### What you will need:

- Air pressure gauge tool-Looks like a steel pen and costs about \$2.50.
- **Correct psi** (pounds per square inch) for specific tire inflation (usually found on the inside of the driver's side door and/or on the tire).
- Air pump-Gas station air for less than a dollar is the easiest way to inflate car tires.

#### COOL LINKS

Alternative commuting to help reduce your use of fossil fuels:

**GoLoco** is an online service that helps people quickly arrange ride sharing between friends, neighbors and colleagues. It also handles online payments from passengers to drivers for their share of the trip costs. www.Goloco.com

Get rewarded for your carpools with NuRide. www.nuride.com/nuride/main/main.jsp

Find out how much your driving affects your carbon footprint: look up your car's city and freeway gas mileage www.epa.gov/greenvehicles

#### Tax breaks for certain hybrid cars bought after December 31, 2000: http://www.fueleconomy.gov/feg/tax hybrid.shtml

Anything that rolls can be ridden to work or school, but some bikes make their riders lives easier – specialized bicycles are available for commuters at www.electrabike.com/home and http://www.trekbikes.com/us/en/bikes/2008/urban/ as well as www.commuterbicycles.com.

**An organization started by Matthew Modine** http://www.bicycleforaday.org/index.php The "Day" will launch in fall of 2008 as a demonstration of how doing ONE thing – in this case, riding a bike instead of driving – can help improve the environment.

**Carpooling** There are lots of resources on the web for carpoolers, including municipal websites. See www.erideshare.com to contact others interested in carpooling.

### Act 3: Moving from Knowledge to Action



#### **Bike to School Day**

Coordinate a Bike to School Day where participants agree to not use cars to get to school. You can even put together a pledge drive and raise money for "miles traveled" where the more miles a student bikes, the more money they raise to put toward school conservation efforts. The day can also be extended to a week or a month. As an extension, include teachers and administrators in the challenge and

provide awards to the students who biked the most miles (and raised the most money) and/or the students who biked the most days.



#### School Carpool or Ride Share

Do you see more students driving rather than taking the school bus? High school student schedules often have more flexibility and many students need transportation for after-school jobs. Teachers' schedules are also complex due to before- and after- school activities. Try to reduce the number of cars parking at your school by starting a carpool program for students and teachers. This will

reduce congestion at school and reduce  $CO_2$ , and you may even meet some new friends. There are two great websites listed in the resources section (on page 65) that can help you get your program started.

### Act 3: Moving from Knowledge to Action

#### You, Me and Bio D

Reducing  $CO_2$  emissions by changing behavior is really important, but using new sources that simply don't pollute as much is an excellent idea too. Solar, wind, water and biodiesel (Bio-D) are all forms of alternative energy that use renewable or unlimited resources. Biodiesel is a relatively unfamiliar energy source but may be the most interesting option for cars. It can come from used vegetable oil, which is easily collected at area restaurants, or it can be made from unused vegetable oil. Either way, it is processed into a clear fuel called biodiesel. Biodiesel can be used in cars that already accept diesel fuel. It is gaining in popularity and becoming easier to find. Right now it is available in all 50 states.

Start a campaign to get all municipal buses including school buses, to switch to sustainably harvested biodiesel fuels. Work with local organizations that are offering unique or innovative solutions for cleaner, alternative energy sources. Contact them to see how your group can help them publicize their goals and projects. In addition, many energy companies have programs where you can sign up to have a percentage of the electricity you purchase come from alternative energy sources, so check with your local power company to see if they offer such a program. If so, start a drive to get your school, local businesses and community members to sign up for this program.

#### **Run a Good Neighbor Contest**

Start a residential campaign in your neighborhood to see which household can reduce the most carbon emissions. Students from your school can provide training for any interested resident and serve as the resource for their neighborhood.



#### **COOL LINKS**

For information on **biodiesel** and where to find it in your state, go to: www.biodiesel.org/buyingbiodiesel/guide/default.shtm For more information on all **alternative fuels** for vehicles and their pros and cons, read the article www.climateprotect.org/at6 More information on the **Good Neighbor program** can be found at www.nwf.org./goodneighbor



### **Explaining Global Warming to Others**

#### **Background on Project**

There are many methods you can use to get your message across, and letter writing is one of the easiest and most effective. Letter writing serves other important purposes as well: It helps educate your group and others on the issues, and it can help bring in new membership to clubs or interest groups. Writing letters is a great first step in sharing your opinion with both peers and politicians. This activity is intended to outline the "how-to" of a successful letter-writing campaign in your school and in your community.

Teaching students that their opinions matter and instilling in them the importance of addressing their government representatives will help them form good habits of civic participation that can last throughout their lives. Such habits also promotes confidence in their opinions, writing skills and ability to disseminate information and explain their viewpoints in writing.



## **Explaining Global Warming to Others**



#### **Student Action Project**

#### Letter Writing

Our elected officials are accountable to us, and we must communicate our concerns to them. Few decision-makers can ignore outcry from their constituents, and most are genuinely interested in the opinions of the people they represent. Remember: Your letters DO count, they ARE read and they DO make a difference!

When planning and writing your letter, there are a few things to keep in mind to get your point across in the most effective way.

- Address decision-makers properly (a rude letter will be recycled at best, and may hurt more than help).
- If your official has a good environmental voting record, be sure to commend him/her.
- Use area-specific examples to support your position.
- Limit your letter to one topic, and if possible, use only one page.
- Ask your legislator to state his or her position on the issue in a reply.
- If you are writing to a legislator other than your own senator or representative, also forward a copy of your letter to your district legislator as a courtesy.

Writing a letter lets you tell other people about something you think is important. You can write a letter to a local business, a newspaper or elected official - such as a city council member, mayor or state or federal representative - to let them know how you feel and what you think needs to be done. This is called a "persuasive" letter. Persuade means "to try to get someone to do something by helping them to understand."

Use the formal parts of a letter:

- 1. Return address write your address in the upper right corner.
- 2. Today's date under your address.
- 3. **Inside address** Below the date and two lines down on the left side, write the name, title and address of the person to whom you are writing the letter on the right side.
- 4. **Greeting** below the inside address, write "Dear" followed by the persons title, last name, and a colon (:) For example, you might write "Dear Senator Rodriguez:". This part of the letter is also called the salutation.
- 5. Body This is where you write what you want the person to know. Write clearly and simply.
- 6. **Closing** This is the way you end or close your letter. Use a comma and you can use, "Sincerely" as a closing for your letter.
- 7. Signature Sign your name! You may also choose to include your age.

Do you want to write to your lawmakers asking them to protect wildlife from the effects of global warming? Go to National Wildlife Federation's "Action Headquarters": www.nwf.org/action. to learn about important laws and bills to help wildlife and save their natural habitats. Research the issues and write a letter to your local representatives or members of Congress. Let them know how you think they should vote on these bills and why.

If you are interested in generating mass support for an issue, consider holding a public letter-writing session in your school or community. Be sure to get permission from the appropriate officials before setting up a table or booth. When publicizing your activities, always remember that it helps to have a local angle. List the reasons that your issue matters to the local community as well as to the state and country. If at all possible, have something that you can give to those who do write letters. Something as simple as a button or a sticker shows the person's involvement. Tape a sample letter and the decision-maker's address to the table in full view. After collecting the letters, send them out in batches. Getting a few letters a day for a week or two on a single issue has a big impact on your legislator.



### **Explaining Global Warming to Others**

#### **Additional Action Projects and Resources**



#### **Design Community Flyers**

Research some of the most pressing issues facing your community in terms of climate change. Identify the ones you think are most important—is it CFL light bulbs? Car use? Plastic bags? Brainstorm for some good ideas and then design flyers and signs to post around your community to encourage adults and other kids to act more responsibly toward their environment.



#### Start a Blog

Start a school blog about climate change issues in your community and discuss action projects that you or other students have undertaken to improve local habitats. Students can take turns writing entries, and these entries can range from scientific write-ups to descriptions of projects to journal entries to creative pieces such as poems or stories. Be sure to include pictures and/or video if you have them.



#### **Develop a Poster or PSA Contest**

Invite students at your school to create a poster or public service announcement about a climate change issue. You can identify different categories to judge them: best video, best radio spot, best poster, etc. Then have a school assembly to present all the winners and include local news media to interview the students and broadcast their winning entries.



#### Start a Newsletter

Develop a Global Warming Communications Committee for your school and create an ongoing newsletter or website. If you have surveyed the school with the Global Warming survey, reporting the results would be a great topic for your first issue. Use the newsletter to report on steps the school is taking to become more energy-efficient or to highlight things that could be changed in the school to make it more energy-efficient.



### Ideas and Resources for Green School Audits

#### **Conduct a School or Home Energy Audit**

There are lots of existing websites and resources for conducting a school energy audit. Use these sites for information on how to conduct a complete audit, or identify one way to reduce fossil fuel use at your school. Some energy audit resources are referenced in cool links below.

#### **Check Out Your Local Power Company**

Many energy companies have programs where you can sign up to have a percentage of the electricity you purchase come from alternative energy sources. Check out your local power company to see if they offer such a program. If so, start a drive to get your school, local businesses and community members to sign up for this program.

#### Conduct a Light Bulb Audit in Your School

Find out how many incandescent light bulbs are being used that could be changed to CFLs. Calculate the potential savings in cost and pollution. Use the information you have collected to start a campaign to replace all light bulbs in your school with compact fluorescents. Try working with a local business, such as a home improvement store or your local energy supplier, to get them to donate CFLs or to provide funding to buy CFLs. Set a goal and calculate the emissions saved. Consider challenging another school to see which of you can get the most light bulbs replaced.

#### COOL LINKS

U.S Department of Energy www.eere.energy.gov/consumer/your home/energy audits/index.cfm/mytopic=11160

Local utilities offering "green power" There are various forms of green power purchases, including renewable energy certificates where any percentage up to 100% of your electricity can be offset by electricity generated from renewable energy sources such as wind turbines. www.eere.energy.gov/greenpower.

Alliance to Save Energy www.ase.org/content/article/detail/971

Energy Star www.energystar.gov/

Saving energy in your home using energy audits Find out how to save energy in your home at www.energystar.gov Click on "Explore Home Improvement" to use the Home Energy Yardstick. There are also professional energy auditors you can hire; to find one, start

with your local utility company. Information on efficient models of home appliances are also available at the EnergyStar® site.

Solar power How much would you need to supply your home with electricity? Estimate its cost. www.findsolar.com.

**State Tax incentives for renewable energy** Your state may offer tax incentives for renewable energy to offset part of the cost. You may also be eligible for a federal tax credit. See the Database of State Incentives for Renewable Energy at www.dsireusa.org.

**CFL Disposal** Compact fluorescent light bulbs contain a tiny amount of mercury. When they are burnt out, they should be disposed of with other toxic-containing trash such as lithium batteries. They can be recycled and local recycling for CFLs can be found at www.earth911.org

**Conserve water to save energy** Find leaks in your home and find out how much water even tiny leaks can waste at www.h2ouse.org. For more ways to conserve water visit www.wateruseitwisely.com/100ways.

Stop junk mail from cluttering your mailbox and wasting resources Use Catalog Choice to opt out of unwanted catalogs. Catalog Choice is endorsed by the National Wildlife Federation: http://www.catalogchoice.org/about

#### Toward a Green Future

All over the planet, an explosion of creativity is resulting in the development of new, environmentally friendly approaches to energy, transportation, agriculture, construction, finance, manufacturing, communication, education, tourism—even fashion and the arts. The new green economy has unlimited opportunities. We continue to have an urgent need for the best-known environmental careers—like foresters, wildlife biologists and park rangers. These are fantastic career options, but there are so many more.

Our society (and this world) needs green employees in all business fields-sales and marketing, accounting, information management, human resources, facilities and operations, product design, finance, public relations, risk management-everything!

Progressive business leaders are accepting responsibility for assuring ecological health for the planet and social justice for all people. The same transformation is happening in hospitals, schools, universities, government agencies, the military and nonprofit groups.

See Appendix 2, Toward a Green Future: Environmental and Conservation Career Opportunities for a complete guide to help students explore environmental careers that are emerging to solve the climate crisis. Book suggestions, web sites and other resources related to green careers are also available in Appendix 2 (page 84)



#### APPENDICES



Appendix 1: Global Warming Curriculum Connections

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Appendix 2: Toward a Green Future: Environmental and Conservation Career Opportunities

Appendix 3: Glossary

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# **Global Warming Curriculum Connections**

The National Science Education Content Standards (NSES) Grades 9-12

The following curriculum connections have been taken from the chapter titled 'Science Content Standards 9-12, of the *National Science Education Standards*.

## Science as Inquiry (NSES, p. 173)

### **Content Standard A:**

As a result of activities in grades 9–12, all students should develop:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

# **Abilities Necessary to Do Scientific Inquiry**

- **a.** Identify questions and comments that guide scientific investigations. Students should formulate a testable hypothesis and demonstrate the logical connections between the scientific concepts guiding a hypothesis and the design of an experiment. They should demonstrate appropriate procedures, a knowledge base and conceptual understanding of scientific investigations.
- **b.** Design and conduct scientific investigations. Designing and conducting a scientific investigation requires introduction to the major concepts in the area being investigated, proper equipment, safety precautions, assistance with methodological problems, recommendations for use of technologies, clarification of ideas that guide the inquiry and scientific knowledge obtained from sources other than the actual investigation.

The investigation may also require student clarification of the question, method, controls and variables; student organization and display of data; student revision of methods and explanations; and a public presentation of the results with a critical response from peers. Regardless of the scientific investigation performed, students must use evidence, apply logic and construct an argument for their proposed explanations.

- **c.** Use technology and mathematics to improve investigations and communications. A variety of technologies, such as hand tools, measuring instruments and calculators, should be an integral component of scientific investigations. The use of computers for the collection, analysis and display of data is also a part of this standard. Mathematics plays an essential role in all aspects of an inquiry. For example, measurement is used for posing questions, formulas are used for developing explanations and charts and graphs are used for communicating results.
- **d.** Formulate and revise scientific explanations and models using logic and evidence. Student inquiries should culminate in formulating an explanation or model. Models should be physical, conceptual and mathematical. In the process of answering the questions, the students should engage in discussions and arguments that result in the revision of their explanations. These discussions should be based on scientific knowledge, the use of logic and evidence from their investigation.



# Global Warming Curriculum Connections (continued)

- **e.** Recognize and analyze alternative explanations and models. This aspect of the standard emphasizes the critical abilities of analyzing an argument by reviewing current scientific understanding, weighing the evidence and examining the logic so as to decide which explanations and models are best. In other words, although there may be several plausible explanations, they do not all have equal weight. Students should be able to use scientific criteria to find the preferred explanations.
- **f.** Communicate and defend a scientific argument. Students in school science programs should develop the abilities associated with accurate and effective communication. These include writing and following procedures, expressing concepts, reviewing information, summarizing data, using language appropriately, developing diagrams and charts, explaining statistical analysis, speaking clearly and logically, constructing a reasoned argument, and responding appropriately to critical comments.

## **Understandings About Scientific Inquiry**

- **a** Scientists usually inquire about how physical, living or designed systems function. Conceptual principles and knowledge guide scientific inquiries. Historical and current scientific knowledge influence the design and interpretation of investigations and the evaluation of proposed explanations made by other scientists.
- **b.** Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena or test the conclusions of prior investigations or the predictions of current theories.
- **c.** Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.
- **d.** Mathematics is essential in scientific inquiry. Mathematical tools and models guide and improve the posing of questions, gathering data, constructing explanations and communicating results.
- **e.** Scientific explanations must adhere to criteria such as: a proposed explanation must be logically consistent; it must abide by the rules of evidence; it must be open to questions and possible modification; and it must be based on historical and current scientific knowledge.
- **f.** Results of scientific inquiry–new knowledge and methods–emerge from different types of investigations and public communication among scientists. In communicating and defending the results of scientific inquiry, arguments must be logical and demonstrate connections between natural phenomena, investigations and the historical body of scientific knowledge. In addition, the methods and procedures that scientists use to obtain evidence must be clearly reported to enhance opportunities for further investigation.

# Global Warming Curriculum Connections (continued)

### Physical Science (NSES, p. 176) Content Standard B:

As a result of their activities in grades 9–12, all students should develop an understanding of:

- Chemical reactions
- Conservation of energy and increase in disorder
- Interactions of energy and matter

## **Chemical Reactions**

- **a.** Chemical reactions may release or consume energy. Some reactions such as the burning of fossil fuels release large amounts of energy by losing heat and by emitting light. Light can initiate many chemical reactions such as photosynthesis and the evolution of urban smog.
- **b.** A large number of important reactions involve the transfer of either electrons (oxidation/reduction reactions) or hydrogen ions (acid/base reactions) between reacting ions, molecules or atoms. In other reactions, chemical bonds are broken by heat or light to form very reactive radicals with electrons ready to form new bonds. Radical reactions control many processes such as the presence of ozone and greenhouse gases in the atmosphere, burning and processing of fossil fuels, the formation of polymers and explosions.
- **c.** Chemical reactions can take place in time periods ranging from the few femtoseconds (a femtosecond is one quadrillianth of a second) required for an atom to move a fraction of a chemical bond distance to geologic time scales of billions of years. Reaction rates depend on how often the reacting atoms and molecules encounter one another, on the temperature and on the properties–including shape–of the reacting species.
- **d.** Catalysts, such as metal surfaces, accelerate chemical reactions. Chemical reactions in living systems are catalyzed by protein molecules called enzymes.

## **Conservation of Energy and Increase in Disorder**

- **a.** The total energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations and in many other ways. However, it can never be destroyed. As these transfers occur, the matter involved becomes steadily less ordered.
- **b.** All energy can be considered to be either kinetic energy, which is the energy of motion; potential energy, which depends on relative position; or energy contained by a field, such as electromagnetic waves.
- **c.** Heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion.
- **d**. Everything tends to become less organized and less orderly over time. Thus, in all energy transfers, the overall effect is that the energy is spread out uniformly. Examples are the transfer of energy from hotter to cooler objects by conduction, radiation or convection and the warming of our surroundings when burning fuels.

# Global Warming Curriculum Connections (continued)

## **Interactions of Energy and Matter**



- **a.** Waves, including sound and seismic waves, waves on water and light waves, have energy and can transfer energy when they interact with matter.
- b. Electromagnetic waves result when a charged object is accelerated or decelerated. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays and gamma rays. The energy of electromagnetic waves is carried in packets whose magnitude is inversely proportional to the wavelength.
- **c.** Each kind of atom or molecule can gain or lose energy only in particular discrete amounts and, thus can absorb and emit light only at wavelengths corresponding to these amounts. These wavelengths can be used to identify the substance.
- **d.** In some materials, such as metals, electrons flow easily, whereas in insulating materials such as glass they can hardly flow at all. Semiconducting materials have intermediate behavior. At low temperatures some materials become superconductors and offer no resistance to the flow of electrons.

### Life Science (NSES, p. 181) Content Standard C:

As a result of their activities in grades 9–12, all students should develop understanding of:

• Interdependence of organisms

### **Interdependence of Organisms**

- **a.** The atoms and molecules of the Earth cycle among the living and nonliving components of the biosphere.
- **b.** Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
- **c.** Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
- **d.** Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

# Global Warming Curriculum Connections (continued)

## Earth and Space Science (NSES, p. 187) Content Standard D:

As a result of their activities in grades 9–12, all students should develop an understanding of:

- Energy in the Earth system
- Geochemical cycles

## **Energy in the Earth System**

- **a.** Earth systems have internal and external sources of energy, both of which create heat. The sun is the major external source of energy. Two primary sources of internal energy are the decay of radioactive isotopes and the gravitational energy from the Earth's original formation.
- **b.** The outward transfer of Earth's internal heat drives convection circulation in the mantle that propels the plates comprising Earth's surface across the face of the globe.
- **c.** Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents.
- **d.** Global climate is determined by energy transfer from the sun at and near the Earth's surface. This energy transfer is influenced by dynamic processes such as cloud cover and the Earth's rotation, and static conditions such as the position of mountain ranges and oceans.

# **Geochemical Cycles**

- **a.** The Earth is a system containing essentially a fixed amount of each stable chemical atom or element. Each element can exist in several different chemical reservoirs. Each element on Earth moves among reservoirs in the solid earth, oceans, atmosphere and organisms as part of geochemical cycles.
- **b.** Movement of matter between reservoirs is driven by the Earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide and in all organisms as complex molecules that control the chemistry of life.

### Science and Technology (NSES, p. 190) Content Standard E:

As a result of activities in grades 9–12, all students should develop:

- Abilities of technological design
- Understanding about science and technology

# Global Warming Curriculum Connections (continued)

## **Abilities of Technological Design**

- **a.** Identify a problem or design an opportunity. Students should be able to identify new problems or needs and to change and improve current technological designs.
- **b.** Propose designs and choose between alternative solutions. Students should demonstrate thoughtful planning for a piece of technology or technique. Students should be introduced to the roles of models and simulations in these processes.
- **c.** Implement a proposed solution. A variety of skills can be needed in proposing a solution depending on the type of technology that is involved. The construction of artifacts can require the skills of cutting, shaping, treating and joining common materials–such as wood, metal, plastics and textiles. Solutions can also be implemented using computer software.
- **d.** Evaluate the solution and its consequences. Students should test any solution against the needs and criteria it was designed to meet. At this stage, new criteria not originally considered may be reviewed.
- **e.** Communicate the problem, process and solution. Students should present their results to other students, teachers and others in a variety of ways, such as orally, in writing and in other forms–including models, diagrams and demonstrations.

## **Understanding About Science and Technology**

- **a.** Scientists in different disciplines ask different questions, use different methods of investigation and accept different types of evidence to support their explanations. Many scientific investigations require the contributions of individuals from different disciplines, including engineering. New disciplines of science, such as geophysics and biochemistry, often emerge at the interface of two older disciplines.
- **b.** Science often advances with the introduction of new technologies. Solving technological problems often results in new scientific knowledge. New technologies often extend the current levels of scientific understanding and introduce new areas of research.
- **c.** Creativity, imagination and a good knowledge base are all required in the work of science and engineering.
- **d.** Science and technology are pursued for different purposes. Scientific inquiry is driven by the desire to understand the natural world, and technological design is driven by the need to meet human needs and solve human problems. Technology, by its nature, has a more direct effect on society than science because its purpose is to solve human problems, help humans adapt and fulfill human aspirations. Technological solutions may create new problems. Science, by its nature, answers questions that may or may not directly influence humans. Sometimes scientific advances challenge people's beliefs and practical explanations concerning various aspects of the world.
- **e.** Technological knowledge is often not made public because of patents and the financial potential of the idea or invention. Scientific knowledge is made public through presentations at professional meetings and publications in scientific journals.

# Global Warming Curriculum Connections (continued)

### Science in Personal and Social Perspectives (NSES, p. 193) Content Standard F:

As a result of activities in grades 9–12, all students should develop an understanding of:

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national and global challenges

## **Natural Resources**

- **a.** Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.
- **b.** The Earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.
- **c.** Humans use many natural systems as resources. Natural systems have the capacity to reuse waste, but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

## **Environmental Quality**

- **a.** Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.
- **b.** Materials from human societies affect both physical and chemical cycles of the Earth.
- **c.** Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political and religious views, and different ways humans view the Earth.

# **Natural and Human-Induced Hazards**

- **a.** Normal adjustments of Earth may be hazardous for humans. Humans live at the interface between the atmosphere driven by solar energy and the upper mantle where convection creates changes in the Earth's solid crust. As societies have grown, become stable and come to value aspects of the environment, vulnerability to natural processes of change has increased.
- **b.** Human activities can enhance potential for hazards. Acquisition of resources, urban growth and waste disposal can accelerate rates of natural change.

# Global Warming Curriculum Connections (continued)

- **c.** Some hazards, such as earthquakes, volcanic eruptions and severe weather, are rapid and spectacular. But there are slow and progressive changes that also result in problems for individuals and societies. For example, change in stream channel position, erosion of bridge foundations, sedimentation in lakes and harbors, coastal erosions and continuing erosion and wasting of soil and landscapes can all negatively affect society.
- **d.** Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards-ranging from those with minor risk to a few people to major catastrophes with major risk to many people. The scale of events and the accuracy with which scientists and engineers can (and cannot) predict events are important considerations.

### Science and Technology in Local, National and Global Challenges

- **a.** Science and technology are essential social enterprises, but alone they can only indicate what can happen, not what should happen. The latter involves human decisions about the use of knowledge.
- **b.** Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics and ethics of various science- and technology-related challenges. However, understanding science alone will not resolve local, national or global challenges.
- **c.** Progress in science and technology can be affected by social issues and challenges. Funding priorities for specific health problems serve as examples of ways that social issues influence science and technology.
- **d.** Individuals and society must decide on proposals involving new research and the introduction of new technologies into society. Decisions involve assessment of alternatives, risks, costs and benefits and consideration of who benefits and who suffers, who pays and gains and what the risks are and who bears them. Students should understand the appropriateness and value of basic questions such as "What can happen?" and "What are the odds?" and "How do scientists and engineers know what will happen?"
- **e.** Humans have a major effect on other species. For example, the influence of humans on other organisms occurs through land use–which decreases space available to other species–and pollution–which changes the chemical composition of air, soil and water.

### History and Nature of Science (NSES, p. 200) Content Standard G:

As a result of activities in grades 9-12, all students should develop an understanding of:

- Science as a human endeavor
- Nature of scientific knowledge

# Global Warming Curriculum Connections (continued)

## Science as a Human Endeavor

- **a.** Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.
- **b.** Scientists have ethical traditions. Scientists value peer review, truthful reporting about the methods and outcomes of investigations and making public the results of work. Violations of such norms do occur, but scientists responsible for such violations are censured by their peers.
- **c.** Scientists are influenced by societal, cultural and personal beliefs and ways of viewing the world. Science is not separate from society but rather science is a part of society.

# Nature of Scientific Knowledge

- **a.** Science distinguishes itself from other ways of knowing and from other bodies of knowledge through the use of empirical standards, logical arguments and skepticism, as scientists strive for the best possible explanations about the natural world.
- **b.** Scientific explanations must meet certain criteria. First and foremost, they must be consistent with experimental and observational evidence about nature, and must make accurate predictions, when appropriate, about systems being studied. They should also be logical, respect the rules of evidence, be open to criticism, report methods and procedures and make knowledge public. Explanations on how the natural world changes based on myths, personal beliefs, religious values, mystical inspiration, superstition or authority may be personally useful and socially relevant, but they are not scientific.
- **c.** Because all scientific ideas depend on experimental and observational confirmation, all scientific knowledge is, in principle, subject to change as new evidence becomes available. The core ideas of science, such as the conservation of energy or the laws of motion, have been subjected to a wide variety of confirmations and are, therefore, unlikely to change in the areas in which they have been tested. In areas where data or understanding are incomplete, such as the details of human evolution or questions surrounding global warming, new data may well lead to changes in current ideas or resolve current conflicts. In situations where information is still fragmentary, it is normal for scientific ideas to be incomplete, but this is also where the opportunity for making advances may be greatest.

## Works Cited:

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*National Science Education Standards.* 1995. National Academy Press. March 15, 2007. http://books.nap.edu/readingroom/books/nses/6e.html



# Toward a Green Future: Environmental and Conservation Career Opportunities

Reverse that careers are one of the fastest growing sectors in the job market due to the fact that the environment impacts nearly all aspects of our lives and the lives of plants and animals that share our environment. You can incorporate many of the things you enjoy doing in your everyday life into an environmental career. This environmental career guide is designed to help you find an environmental career that complements both your in-school and out-of-school interests by providing you with information on the specific environmental careers that are available and tips on matching your skills and interests with those careers.

## What Is an Environmental Career?

A common theme that runs through all environmental careers is the protection and conservation of our environment. As we learn more about how human activities affect the environment, we see an increased need for professionals who help mitigate the negative effects of these activities. Environmental careers are not just those involved in working in wilderness areas or national parks. Today, you can combine your love of the environment with practically any academic discipline in any professional field. Environmental professionals can be found in science, education, policy, law, activism, journalism and many other disciplines. Furthermore, environmental protection is an important agenda for most businesses and industries. Companies look to environmental engineers and planners to reduce their impact on the environment and to help them comply with environmental protection laws.

### Activities to Help Students Plan a Career Path Developing a Career Strategy

With so many environmental career choices available, the selection process can seem daunting. To help you identify career areas that might be interesting, look first at career options, list your basic interests and then see how your interests match to career options.

Take a look at the careers listed to see what excites you. Research the job titles and profiles of professions working in these careers. The careers are listed according to the subjects you study in school:

- English and Communications
- Math and Engineering
- Science and Computer Science
- Social Studies and Law

Many of these careers fit into more than one subject area. The careers grouped and listed below provide a variety and breadth of job titles in each of the subject areas, however the list is not intended to be comprehensive. To learn more about green jobs, conduct research on organizations and interview professionals or organizations focused on your areas of interest. In some cases, an internship may be a great way to determine whether or not the career path you have chosen is the right one for you. We can promote a green future regardless of the path chosen through the commercial sector, public service or a non-profit organization.

#### **English and Communications**

Increasing people's knowledge and awareness about the environment requires effective English and communications skills. People use these skills to effectively convey environmental issues that are important to public health and conservation. These careers get the word to others. If you are interested in communicating environmental issues clearly and accurately to technical and non-technical people, sharing information with others, interviewing people, planning educational programs, writing news articles and public speaking for television, radio, and newspapers, then a career as an environmental journalist, educator, or activist might be right for you. These careers:

- Educate and information people about environmental issues and the ways to weigh various sides of a matter to make informed and responsible decisions
- Involve critical thinking, problem solving and effective decision-making skills
- Motivate others to take responsible actions on environmental issues

#### Examples of English, Communications and the Arts Careers

Activism Specialist Interior Designer Artist Librarian Author Marketing Specialist/Manager College Professor Museum Curator Non-profit Development Director Communications Specialist /Director Community Organizer Park Ranger Community Public Relations Coordinator Philosopher Community Relations Coordinator Photographer Entrepreneur Product Designer Environment, Health and Safety Director Public Administrator Environmental Communications Specialist Rangeland Specialist/ Manager Environmental Conflict Manager **Recreation Administrator** Environmental Educator **Restoration Ecologist** Environmental Journalist Risk Assessor/Manager Exhibit Designer Salesperson/Sales Manager Filmmaker Schoolteacher Florist Technical Environmental Writer Fund Raiser Trainer/Training Coordinator Governmental Affairs Manager

## **Math and Engineering**

Today there is a growing demand for environmental information. Politicians and policymakers require information on the quality of the air and water we breathe; conservations need to know the minimum area for planning a national park; and environmental engineers need information on the latest technology for pollution prevention and so on.

An important activity in working in the environmental field is solving problems. Trout in the stream are found dying. The problem is that the stream where the trout live is being polluted. How can the death of more trout be prevented and pollution stopped? This is the kind of problem many environmental professionals face. Critical thinking, analysis and problem-solving skills are required to design an effective solution to this and other problems they face in their careers. An education in mathematics provides for a greater understanding of people, ideas and the natural world.

Math and engineering are required to determine this information as well as to effectively understand and convey this information to others.

Environmental engineers make use of mathematics—developing graphs, equations and tables, analyzing data and exploring the relationships between different factors and variables—in solving environmental problems and determining feasible solutions.

#### **Examples of Math and Engineering Careers**

Accountant	Investment Advisor/Broker
Architect	Investor
Auditor	Landscape Architect
Business Process Designer	Mechanical Engineer
Chemical Engineer	Oil/Gas Engineer
Civil Engineer	Operations Manager
Electric Power Generation Technician	Planner
Electrical Engineer	Public Finance Specialist
Electronics Engineer	Quality Control Engineer
Energy Technician/Manager	Real Estate Developer
Ecological Engineer	Statistician
Environmental Engineer	Survey and Mapping Technician
Facilities Inspector	Transportation Planner
Finance Manager	Water/Wastewater Engineer
Institutional Purchaser	

## **Science and Computer Science**

Are you a naturally curious person? Do you look at a bird and wonder how it can fly? Why do elephants live in herds? What will happen if the Amazon rain forest disappears? Are you amazed by the power of nature, such as thunderstorms and hurricanes? These are questions that science seeks to answer. A scientific understanding of the world is based on asking questions and organizing experiments to answer the questions. Scientists develop theories and hypotheses on how the world works and tests the theories through inquiry, computer modeling and experimentation. A natural curiosity provides the foundation for becoming a successful scientist.

The natural world continually challenges scientists. The disciplines of biology and ecology are branches of science that seek answers to the fascinating phenomena of the natural world. Biologists and ecologists also have a love for the natural world and use their work to help protect it. Scientific inquiry is especially important in understanding species extinction, biological diversity and the relationship between humans and the environment. Scientists are therefore indispensable in planning effective conservation programs. Today there are many and various environmental careers that require a scientific and/or a computer background. Computers and computer models are instrumental in documenting scientific data. Scientists working in the environmental field combine a curiosity and love for the environment with their scientific work.

Agricultural Extension Specialist/Engineer	Groundwater Professional
Agronomist	Hazardous Materials Handler
Air Pollution Control Technician	Horticulturist
Anthropologist	Hydrologist
Archaeologist	Information Management Specialist
Botanist	Marine Biologist
Conservation Biologist	Metrological Technician
Ecologist	Meteorologist
Entomologist	Oceanographer
Environmental Health Physician	Political Scientist
Environmentalist	Public Health Nurse
Environmental Forensic Scientist	Social Scientist
Farmer	Toxicologist
Fisheries Biologist	Veterinarian/Vet Technician
Geographer	Water Pollution Control Technician
Geographic Information Systems Specialist	Watershed Manager
Geologist	Wildlife Biologist
Graphic Designer	

#### **Examples of Science and Computer Science Careers**

### **Social Studies and Law**

People are essential to the success of conservation programs. Involve people in conservation by getting them motivated and excited about saving endangered special or protecting a threatened habitat. To successfully motivate people, it is important to understand human behavior and the ways people relate to the environment. Different people will do different things. We live in a heterogeneous world with people from many cultures and diverse backgrounds. As a result, we need to be sensitive to diversity in instituting conservation programs. Understanding human behavior and culture is an important component of conservation and environmental work.

People are affected by the social, economic and political activites where they live. These considerations play a part when motivating and educating people on the importance of conservation. Many environmental careers now deal specifically with human sociality and human society. If human behaviors, cultures and diversity are interesting to you, a career oriented in these disciplines may be appropriate.

#### **Examples of Social Studies and Law Careers**

Animal Control Officer	Historian
Attorney	Law Enforcement/Police Officer
Building and Facilities Manager	Lobbyist
Compliance Specialist	Location Analyst
Community Service Director	Natural Resource Manager
Congressman/Congresswoman	Paralegal
Contract Administrator/Specialist	Parks and Recreation Specialist
Corporate Recycling Manager	Policy Analyst
Corporate Relations Manager	Policy Specialist/Manager
Counselor	Program Coordinator
Economist	Project Manager
Emergency Manager/First Responder	Publisher
Environmental Quality Control Specialist	School Administrator
Environmental Lawyer	Socialist/Social Worker
Firefighter	Sustainability Officer
Forester/Forester Technician	Urban/Regional Planner
Governor	Volunteer Coordinator

The groups of career and job titles shown above can all be oriented to the environment and/or conservation. Some are self-explanatory, such as park ranger, while others are not so clear and may require some research, such as policy analyst. It is up to every individual in every job to raise issues with employers to keep the environment, wildlife and conservation at the forefront of everyday life.

# Planning a Career Path

Now you can begin to evaluate your own interests and skills with the careers in mind. Look at the qualifications and education necessary for the careers that seem interesting. With so many environmental career choices available, the selection process can appear daunting. After looking at career options, conducting individual research and thinking about your own experience, you can match your skills and interests with those lists for specific careers. This questionnaire will help narrow and prioritize your options. There are additional tools on websites that can take you further in the analysis process as you work toward your preferences.

Use the questionnaire below to help prioritize your skills and interests. Think about your skills and interests on the basis of your experience in school, clubs and at home. Examples include outdoor skills, first aid, writing, public speaking, sports and computers.

Rank each of the items below using the following scale:

1=Strong interest or highly skilled	4=Mild interest or minimal skills
2=Interested or skilled	5=No interest or no skills

3=Some interest or basic skills

A. Workplace Environment: How and where do you want to work? Feel free to add your own.

I want to work with people	I want to work with
I want to work independently	
I want to work as part of a team	I want to work with
I want to work outside	
I want to work with children	I want to work
I want to work with adults	I want to work
I want to work with disadvantaged or	
handicapped children/adults	I want to work

**B.** Interests: Some of the activities you may be involved in with an environmental career are listed below. Rank each item to prioritize your interests.

Research/analysis	Work outdoors
Writing	Work with my hands
Publicity	Politics
Science	Fundraising
Lobbying	Law
Activism	Computers
Education/teaching	

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**C. Skills:** Some skills that may be important in working in an environmental career are listed below. Rank each item to prioritize your skills.

Writing	Managing people such as store clerk
Research	Computer/Internet such as word
Public speaking	processing, web page design, etc.
Teaching	Art/drawing
Outdoor skills such as backpacking,	Working with animals or plants
canoeing, etc.	Working with children such as
Environmental education skills, such as knowledge of biology,	summer camp counselor, babysitter, etc.
ecology, etc.	Construction such as carpentry,
Fundraising	wood working, etc.

**D. Lifestyle:** An important consideration in looking at a career is the lifestyle attached to it. Some examples are listed below. Rank each item and add some of your own.

I want to live near the wilderness	I want a job with minimal
I want to have a house and a car	responsibility
I only want to work 40 hours per week	I want a job with a possibility for promotion
I am willing to work more than 40 hours per week	I want to make at least \$ per year.
I want flexible work hours	I want to work with
I want to work for the government I want to work for a large	I want a job that
I want to work for a non-profit or	I want a job
I want a job with lots of	I want to have
responsibility	I want to work

This questionnaire was adapted from Rick Curtis, Outdoor Action Program 1997, Princeton University.

Once you have prioritized your interests, use the ranked items to compare your skills and interests with those of particular careers. For example, if you like being outdoors and working with people, an environmental field guide takes groups of people through wilderness areas while educating them about the area's natural history, local flora and fauna. If you like being outdoors but prefer to work alone, a park ranger works to protect wilderness areas and may spend many days out in the wild far from other people.

Compare your ranked skills and interests against the requirements for careers that appear interesting to create an inventory of areas that need further research. Use the inventory to help identify strengths and weaknesses for places where more skills or experience could be acquired to win a specific job. Discuss with career counselors to see where volunteer opportunities or clubs may be available to develop or build skills. Talk with or interview those in careers that have the highest interest for you. The more you learn about the career, the better prepared you will be in achieving your career goals!

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## **Career Resources:**

#### Apollo Alliance www.apolloalliance.org/resources.php

This organization is dedicated to advancing a broad strategic agenda for good jobs and energy independence.

#### EPA Youth and the Environment Training and Employment Program

www.epa.gov/owm/mab/smcomm/youth.htm

#### Outdoor Action Guide to Outdoor/Environmental Careers

www.princeton.edu/~oa/jobs/careeroe.html

#### Care2 Job Finder http://jobs.care2.com/

Dubbed as world's largest listing of jobs with socially responsible companies.

#### Bronx Environmental Stewardship Training www.ssbx.org/best.html

Free "Green Collar Jobs" training initiative model that can be replicated in other cities. This model works primarily with youth of color.

### **Other resources:**

#### Environmental Career Opportunities. Washington, D.C.: Brubach Corp

A biweekly newsletter that lists 200+ current jobs in environmental policy, communications and advocacy, environmental assessment, engineering, research and education in nonprofits, corporations and the government.

#### National Wildlife Federation Conservation Directory www.nwf.org/ConservationDirectory

Lists international, national and regional organizations, agencies and officials concerned with natural resources use and management, including a summary of each body's mission and contact details.

Ella Baker Center www.ellabakercenter.org

The Will Steger Foundation www.willstegerfoundation.org promotes change through education and advocacy

#### Political Economy Research Institute www.peri.umass.edu

## Websites:

- www.environmentalcareer.com Look at this site for "cool jobs."
- www.ecojobs.com/index.php Large selection of careers with descriptions
- www.myfuture.edu.au/services/default.asp?FunctionID=5021&Action=List&IndustryID=1290 Australian jobs website–up as a "fact sheet" for each industry/career.



### More research:

Zint, M. and M. Hanson. 2002. "Exploring environmental careers". *Environmental Science & Technology* 36(1): 22A26A.

Zint, M. and M. Hanson. 2002. "Perspectives on the environmental career development of youth: Insights from a survey of U.S. environmental educators". *Applied Environmental Education and Communication* 1: 7988.

### **Books:**

*Intelligent Courage* by Michael Fraidenburg–offers interviews with environmental professionals about their experiences in the field.

Profiles include:

- Roger Contor, superintendent of North Cascades National Park
- Gloria Flora, supervisor of Lewis and Clark National Forest
- Andrea Mead Lawrence, U.S. Olympic alpine skier and environmental activist
- Bern Shanks, professor, conservationist, government advisor
- Tom Peterson, founder of Center for Climate Strategies
- Mike Dombeck, former chief of USDA Forest Service
- Phil Pister, fishery biologist
- Max Bazerman, Harvard professor of business administration
- The Directory of National Environmental Organizations. St. Paul, Minnesota: U.S. Environmental Directories, 1996.
  Lists national environmental organization that contains addresses, contacts, phone numbers and brief descriptions of their activities.
- Basta, Nicholas. The Environmental Career Guide: Job Opportunities with the Earth in Mind.
- The ECO Guide to Careers that Make a Difference: Environmental Work for a Sustainable World from the Environmental Careers Organization Island Press–contains profiles/conversations with experts from diverse racial and cultural backgrounds and diverse involvement in the environmental field.

# Glossary

**Albedo:** The tendency to reflect rather than absorb light. White areas reflect more light than dark areas.

**Base Load:** A base load power plant is one that provides a steady flow of power regardless of total power demand by the grid. These plants run at all times through the year except in the case of repairs or scheduled maintenance. Power plants are designed as base load, based on their low cost generation, efficiency and safety at set outputs. Base load power plants do not change production to match power consumption demands.

**Biomass:** In the context of energy production, biomass refers to living and recently living biological material that can be used as fuel or for industrial production. Most commonly, biomass refers to plant matter grown for use as biofuel, but also includes plant or animal matter used for production of fibers, chemicals or heat. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes organic material that has been transformed by geological processes into substances such as coal or petroleum. It is usually measured by dry weight.

**Carbon**: Carbon occurs in all organic life and is the basis of organic chemistry. This nonmetal also has the interesting chemical property of being able to bond with itself and a wide variety of other elements, forming nearly 10,000,000 known compounds. When united with oxygen, it forms carbon dioxide (CO<sub>2</sub>). When united with hydrogen, it forms various compounds called hydrocarbons which are essential to industry in the form of fossil fuels.

**Carbon Dioxide Emissions:** Carbon dioxide is emitted in a number of ways. It occurs naturally through the carbon cycle and through human activities like the burning of fossil fuels. Burning fossil fuels causes the Earth's temperature to warm and change over time. Carbon dioxide emissions are about 40 percent higher than they were before the Industrial Revolution and are at their highest levels in recorded history, covering over 650,000 years.

**Climate Change:** Climate change refers to long term changes in climate including average temperature and precipitation.

**Carbon Footprint:** Your carbon footprint is the sum of all emissions of  $CO_2$  (carbon dioxide), that were produced by your activities in a given time frame. Usually a carbon footprint is calculated for the time period of a year.

**Carbon Neutral:** Being carbon neutral involves calculating your total climatedamaging carbon emissions, reducing them where possible through different consumer and lifestyle choices, and then

balancing your remaining emissions, often by purchasing a carbon offset. A carbon offset zeros out (offsets) all or part of the carbon dioxide emissions of a party, by reducing the emissions—or increasing the carbon dioxide absorption—of another party. This reduces net greenhouse gas emissions with the aim of combating global warming. Carbon offsets can be purchased by individuals, businesses and governments from a variety of commercial and noncommercial organizations. Carbon offset providers often provide a "carbon calculator" for individuals to estimate the carbon dioxide emissions arising from their consumption of electricity, gas, air travel, etc. For example, planting trees may offset a CO<sub>2</sub> emitting activity to make it carbon neutral.

**Chlorofluorocarbons** (CFCs): CFCs are responsible for 15 percent–20 percent of the overall greenhouse gases associated with destroying the ozone layer and contributing to global warming. CFCs can be found in appliances responsible for cooling elements like air-conditioning units and refrigerators. Visit www.ciesin.org/TG/OZ/cfcozn.html for further details.

**Coral Bleaching:** The ocean is in contact with the atmosphere. As the atmosphere warms, so does the water. A coral reef is very sensitive to temperature change. It will only survive if the water temperature stays within a narrow range. If the water that is home to the coral reef heats up, the coral is placed under stress and the algae that gives the coral polyp its color leaves. Scientists have a number of theories on why this happens, but what is sure is that it is directly connected to climate change-induced increases in water temperature.

**Emissions:** In common usage, emissions refers to gases produced as a by-product of an individual process—for example, the engine exhaust of transport vehicles (cars, trucks, airplanes, trains and ships). As they occur on an industrial scale, even relatively harmless gases can have an undesired effect.

**Emissions Trading:** At the moment, it is cheaper for people to pollute the environment than it is to reduce emissions. That is why certain agreements have been made to ensure emissions targets are set. Some entities pollute more than others, and trading emissions credit is one way to level the playing field. Everyone involved in an emissions trading scheme can buy and sell pollution. Under an emission trading scheme, you might choose to reduce your emissions at home. Alternatively, it might be cheaper for you to choose to reduce your emissions elsewhere. If you do a good job of reducing your emissions, you can sell your credits. If you are in debt because you have not managed to reduce your emissions, you may buy yourself credits to make up the shortfall. A credit might be, for example, investing in the renewables industry in China and, in doing so, reducing your shortfall at home.



**Glacier:** A moving mass of ice that survives year-to-year. It is formed by the compacting of snow into ice and set in a motion outward and downward by the force of gravity and the stress of its accumulated mass. Glaciers are usually found in high altitudes and polar latitudes.

**Global Warming:** Global warming is the observed increase in the average temperature of the Earth's atmosphere and oceans in recent decades. The Earth's average near-surface atmospheric temperature rose  $0.6 \pm 0.2^{\circ}$ C in the 20th century. The prevailing scientific opinion on climate change is that "most of the warming observed over the last 50 years is attributable to human activities."<sup>1</sup> The increased amounts of carbon dioxide and other greenhouse gas emissions are the primary causes of the human-induced component of warming. They are released by the burning of fossil fuels, land clearing and agriculture, among other things.

**Greenhouse Gas Emissions (GHG):** These are gaseous components of the atmosphere that contribute to the "greenhouse effect." Although uncertainty exists about exactly how Earth's climate responds to these gases, global temperatures are rising.<sup>2</sup> Some greenhouse gases occur naturally in the atmosphere, while others result from human activities. Naturally occurring greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide and ozone. Certain human activities, however, add to the levels of most of these naturally occurring gases.<sup>3</sup>

**Greenhouse Gas:** An atmospheric gas that contributes to the greenhouse effect.

Ice Core: Core sample of ice removed from an ice sheet.

**Infrared Radiation:** The Earth's surface absorbs visible radiation from the sun and re-emits much of the energy as infrared back to the atmosphere. Certain gases in the atmosphere, chiefly water vapor, absorb this infrared, and re-radiate it in all directions, including back to Earth. This, the greenhouse effect, keeps the atmosphere and surface much warmer than if the infrared absorbers were absent from the atmosphere.

**Hurricane:** A tropical cyclone originating in equatorial regions and traveling north, northwest or northeast from its point of origin, and usually involving heavy rains and having a wind speed greater than 74 miles (119 kilometers) per hour, as defined by the Beaufort wind measurement scale.

**Methane:** An odorless gas, CH<sub>4</sub>, produced mostly by the decomposition of organic matter.

**Moulin:** A wide vertical shaft connecting the ice surface to the glacial conduit system. Moulins are created by meltwater and can be hundreds of feet deep.

**Ocean Absorption:** The sea absorbs  $CO_2$ . Colder seas absorb more  $CO_2$  than warmer seas. (So, as seas warm, less  $CO_2$  is captured.)

**Parts Per Million (ppm):** This is a way to describe a highly diluted concentration of substances, usually the concentration of something in water, air or soil. One ppm is equivalent to one milligram of a substance per liter of water.

**Peak Oil:** As a proper noun, Peak Oil or Hubbert's Peak, applied more generally, refers to a singular event in history: the peak of the entire planet's oil production. After Peak Oil, according to the Hubbert Peak Theory, the rate of oil production on Earth will enter a terminal decline.

**Plate Tectonics:** The Earth's crust is divided into about 12 large plates and several small ones that float and travel independently.

**Renewables:** Renewable energy sources are those energy sources that are not destroyed when their energy is harnessed. Renewable energy sources are distinct from fossil fuels, which must be consumed to release energy. Human use of renewable energy requires technologies that harness natural phenomena, such as sunlight, wind, waves, water flow, biological processes such as anaerobic digestion, biological hydrogen production and geothermal heat.

**Soil Respiration:** The soil emits  $CO_2$ . Warming may lead to rises in microbial activity that would cause more  $CO_2$  to be released than an increase in vegetation could absorb.

**Sustainability:** Sustainability is using processes and materials, in everyday life and work, in a way which would provide the best outcomes for the human and natural environments–both now and into the future. It relates to the continuity of economic, social, institutional and environmental aspects of human society, as well as the nonhuman environment. The intention is to configure civilization and human activity so that society, its members and its economies are able to meet their needs and express their greatest potential in the present, and in the long-term future, while preserving biodiversity and natural ecosystems. Sustainability affects every level of organization, from the local neighborhood to the entire planet.

**Typhoon:** A tropical cyclone occurring in the western Pacific or Indian Oceans.

1. IPCC, Climate Change 2001, Working Group 1, The Scientific Basis

2. EPA's Clean Air Markets-Climate Change

3. EPA's Clean Air Markets-Climate Change





The National Wildlife Federation (NWF) is committed to creating age and developmentally appropriate curricula and projects that educate youth about the causes of and remedies for global warming through its Climate Classroom initiative.

> To learn more and get involved see: www.ClimateClassroom.org



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