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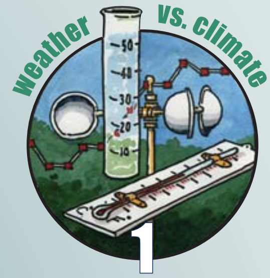

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To download electronic copies of this guide, visit ***www.dnr.wi.gov/eek/teacher/climatechangeguide.htm.***

For more paper copies of this guide, contact us at:

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Introduction

No longer is climate change only studied by scientists. Increasingly policy makers and citizens, including students, are discussing and grappling with serious climate change issues facing Wisconsin and the planet.

Students are ready to learn and explore this complex topic and its importance in their world. They are energy consumers today as well as tomorrow's voters. They have the ability to continue on the same track or to help slow climate change.

A Guide for Teachers to Help Students

This guide is a resource for Wisconsin's teachers to help students develop the knowledge and skills needed to become informed participants in society's climate change discussions and to take action.

Both the scientific aspects of climate change as well as social issues are covered. In addition to teaching facts, the activities in this guide are intended to provide students valuable life tools, like critical thinking, and encourage students to be active citizens.

12 Activities for Grades 7-12

The 12 activities in this guide are designed primarily for students in grades 7 to 12. The guide contains activities applicable to a variety of subjects including sciences, math, language arts, social studies, and art. Making this guide relevant for multiple subjects may increase its use and illustrate the many facets of complex problems like global climate change.

Each activity is designed to stand alone as an individual lesson, however the more activities students complete, the better they will understand the many aspects of climate change.

For More Information about Climate Change

The opening background section contains important general information about climate change and serves as a good resource. Teachers may want to distribute portions of the background section to students as supplemental information.

The guide's *Electronic Appendix,* referred to as the *e-Appendix,* is available on Wisconsin DNR's *EEK!* website for kids at *www.dnr.wi.gov/eek/teacher/climatechangeguide.htm.* It offers additional resources and materials, including valuable web links. Housing this *e-Appendix* online allows DNR staff to both keep this guide current and to share the experiences and ideas of educators as they explore climate change with their students.

Suggestions Welcome

Please share your experiences with this *Climate Change Activity Guide* with air education staff at the Wisconsin Department of Natural Resources *(DNRAirEducation@wisconsin.gov)*! Both positive and negative feedback will help staff improve future products.

After teaching one or more of these activities, please complete the evaluation form at the back of the guide. A "thank you" copy of ***Paradise Lost*** will be sent to the first 150 who send in an evaluation. Thank you.

"Carbon dioxide levels in the atmosphere are now higher than any time in the past 150 thousand years and by the end of the century could be three times higher than ever before. The physics of the greenhouse effects of carbon dioxide are well known."

– **John J. Magnuson**
Emeritus professor
University of Wisconsin–Madison

"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level."

– Intergovernmental Panel on Climate Change, 2007

"The scope and consequences of global warming are so massive that the responsibility for action rests not only with our leaders in Washington, but with all of us."

– **Jim Doyle**
Governor of Wisconsin

Background

How can there be global warming if it is snowing outside in April when it should be 50 to 60 degrees Fahrenheit? This is a very common question, and the answer lies in the difference between weather and climate.

Weather, which is highly variable, is made up of specific atmospheric conditions, including temperature, rainfall, wind, and humidity, that occur at any given place and time. ***Climate,*** much less variable, is the typical weather for any given area, averaged out over many years. As a perceptive middle school student said "Climate helps you decide what clothes to buy, weather helps you decide what clothes to wear."

A term often used synonymously with climate change is global warming, which refers to human-induced warming trends in the climate. According to a 2007 report prepared by top scientists from around the world, the Intergovernmental Panel on Climate Change (IPCC), the average global temperature has gone up approximately 1.5 degrees Fahrenheit since 1906 and, of the 12 years prior to the report (1995-2006), 11 were among the warmest on record.

Earth's climate has changed significantly before. Forty-five thousand years ago, Wisconsin was in the middle of an ice age. The climate was much cooler and drier then compared to now. So if the climate changes naturally, how do we know humans are playing a role in this current warming trend?

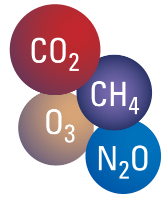
Causes of climate change on Earth

Climate changes naturally due to variations in Earth's orbit, solar radiation, and greenhouse gases. Greenhouse gases in the earth's atmosphere trap the sun's heat that would otherwise be released back into space. This warming, which provides us with our habitable planet, is called the greenhouse effect, although sometimes the term is used to refer specifically to the warming of recent years caused by human activities.

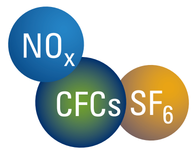
Over Earth's history, concentrations of greenhouse gases have changed naturally because of geologic and biologic events. The gases that contribute the most to the greenhouse effect today are water vapor, carbon dioxide (CO_2), methane (CH_4), and ozone (O_3). Other greenhouse gases include nitrogen oxides (NO_X), chlorofluorocarbons (CFCs) and closely related chemicals like hydrofluorocarbons, and sulfur hexafluoride (SF_6).

Lucky for us, greenhouse gases like CO_2 do exist naturally in our atmosphere or the earth would be too cold for human life. Most of today's atmosphere was formed through out-gassing from the earth's interior and subsequent chemical reactions, including oxygen production from photosynthesis. By examining historic data, scientists have found that atmospheric CO_2 concentrations surged with major volcanic eruptions and dipped with the spread of land plants.

During the past 150 years, beginning with the onset of the industrial revolution, humans began to emit large amounts of greenhouse gases, particularly CO_2, CH_4, and nitrous oxide (N_2O). According to a 2007 *IPCC Summary Report for Policymakers*, "Global atmospheric concentrations of CO_2, CH_4, and N_2O have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values, as determined from ice cores spanning many thousands of years."



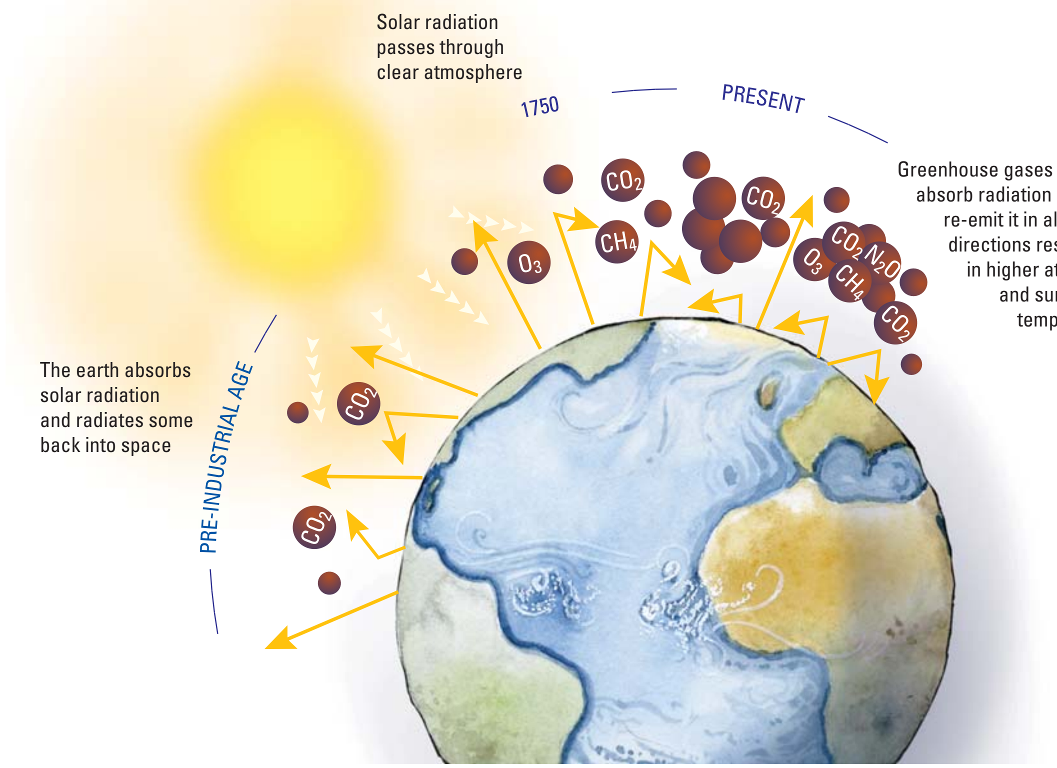
Primary contributors to the greenhouse effect are water vapor, CO_2 (carbon dioxide), N_2O (nitrous oxide), CH_4 (methane), and O_3 (ozone). Other greenhouse gases include NO_X (nitrogen oxides), CFCs (chlorofluoro-carbons) and closely related chemicals like hydrofluorocarbons, and SF_6 (sulfur hexafluoride).



Most human-induced greenhouse gas emissions come from the combustion of fossil fuels such as coal, oil, and natural gas. Fossil fuels are made from plants and animals that died millions of years ago. Their remains are buried in underground deposits, where geologic forces such as heat and pressure converted the remains into fossil fuels. Without human intervention, fossil fuels may have largely remained underground indefinitely, with the abundant carbon stored in them never entering Earth's atmosphere.

In addition to fossil fuel combustion, other human-induced, or anthropogenic, sources of CO_2 include the burning of solid waste, trees, and wood products, and as a result of other chemical reactions (e.g. manufacture of cement). Livestock manure, rice cultivation, biomass burning, and the decay of organic waste in municipal solid waste landfills are anthropogenic sources of CH_4 in addition to fossil fuel combustion. Other major sources of N_2O include crop production with heavy inputs of synthetic nitrogen fertilizers, livestock manure and sewage treatment, and the production of certain chemicals. Having too many of these gases in the atmosphere traps too much heat, causing warming.

Scientific studies have found a tight link between atmospheric CO_2 levels and average global temperatures, going back hundreds of thousands of years. The combination of this data with the known physics of the greenhouse effect, the observed rapidly increasing levels of CO_2 and other greenhouse gases from human activity, and the evidence of change in today's global weather systems forms the core evidence for human-induced climate change. Today the vast majority of scientists worldwide agree human activity is influencing Earth's climate and warming Earth.



Higher concentrations of gas molecules in the earth's atmosphere trap more of the sun's infrared radiation, contributing to the "greenhouse" effect.

Impacts on weather systems

Climate influences many complex and interrelated physical and biological systems. Thus, predicting exactly what will happen as a result of Earth's warming is both complicated and difficult. Forecasting localized impacts and changes is particularly difficult.

But scientists are predicting a number of impacts during the 21st century due to increases in greenhouse gases. Global temperatures are predicted to rise worldwide, with more warming in the northernmost latitudes and high mountains. The 2007 *IPCC Summary Report for Policymakers,* based on a wide variety of data and computer modeling, states "Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years." Due to the increase in global temperatures, glaciers will continue to melt and flow into the seas. Higher air temperatures will raise ocean temperatures. As water warms, its volume expands, a phenomenon called thermal expansion. With the combination of glacier melt and thermal expansion increasing oceanic volumes, scientists predict a substantial sea level rise in the 21st century.

Global weather patterns are predicted to shift due to climate change. Cycles of heavy rain and drought are likely to occur because warm air has a higher saturation point, meaning that it can hold more moisture than cool air. Warmer, moist air will cause heavy rains, but be followed by hot dry periods as warm air evaporates water from the land, leaving behind dry soils. Heavy rains will follow again, dousing parched ground with too much water, leading to runoff and topsoil erosion. Over time, this pattern will cause havoc on organisms unaccustomed to these extreme conditions and will also likely reduce the fresh water supply for drinking and irrigation.

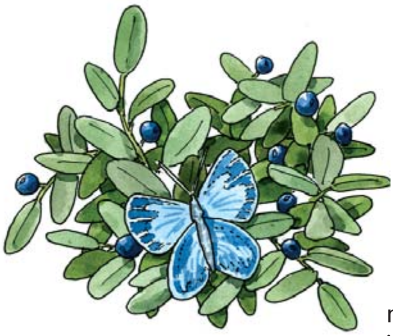
Scientists have also forecast an increase in extreme weather events, including the number of hurricanes due to the increase in temperature caused by climate change. Hurricanes and other tropical storms gain strength moving over warm ocean waters. The warmer the water, the more power a storm can generate and the stronger it will be when it makes landfall.

Due to climate and geographic variability, areas will be impacted differently. Some may experience more precipitation, others will get less. Some areas may see warmer temperatures year round and others may see seasonally elevated levels.

Impacts on global biological systems

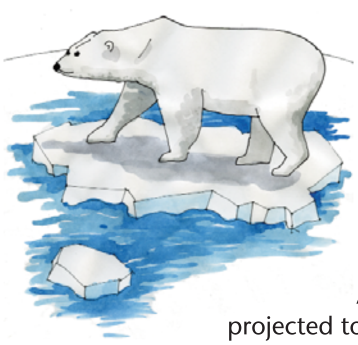
Temperature and other environmental factors such as water, light, nutrients, and competition control lifecycle events and growth. Recent warming in terrestrial ecosystems likely accounts for changes in the timing of lifecycle events, like earlier dates of flowering and spring migration. Some species that depend on each other, such as flowers and their pollinators, may be impacted more than others if their timing does not continue to coincide. Exotic invasive pests may become a bigger problem as changing environmental conditions tend to favor them and their ability to outcompete native plant and animal communities.

IPCC *(2007 Summary Report for Policymakers)* reports that terrestrial species have very likely already shifted their ranges. Also, observed range shifts of aquatic and marine organisms are probably due to changes in water temperature, ice cover, salinity, oxygen levels, and circulation. It is not known how many species will be able to successfully migrate to new areas offering appropriate conditions.

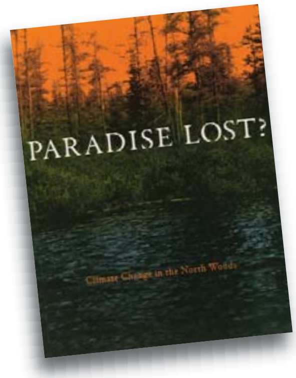


For many species, the challenge is greater than just "moving" to cooler temperatures. Climate shifts are predicted to occur rapidly compared to the rate it takes a species to adjust and evolve. Migrations might be less successful in more developed and urbanized environments where there are many barriers to species movement such as roads and developments. And, even if a species could change its range to a new place with suitable temperatures, the precipitation pattern, hours of daylight, available food, or soils in that new place may not be suitable. Aquatic species may face even greater challenges. Temperature, CO_2 levels and other impacts affect the pH and other habitat conditions of the water in which these organisms live. Aquatic species in isolated lakes are more limited in their physical ability to move to a new area. When species are unable to move to suitable conditions, or when no suitable conditions remain, species face decline or extinction.

Climate change could significantly modify agriculture. In the short-term, both temperatures and agricultural yields could rise due to longer growing seasons. Also, higher atmospheric levels of CO_2, which plants take in as they grow, may increase yields, although research is showing that plant responses may be only short-term. Scientists also predict that some areas, like the western United States, will receive less precipitation, so crop yields may decrease due to lack of soil moisture. Other areas may get too much rain for standard local crops, too much sun, or overly warm temperatures. Predictions indicate Wisconsin may get more rain in large spring and fall rain events, but have hotter drier summers, conditions that will demand a change in which crops are grown here. Much U.S. cropland lies in the section of the country predicted to have significantly less rainfall in the 21st century. Where will we grow our food?



While people living in the continental U.S. are predicted to be impacted by global warming, people in some other parts of the world are expected to "feel the heat" to a much greater degree. Arctic residents, including some Alaskans, are anticipated to experience the highest rates of warming. Communities located on small islands and near large Asian and African river deltas are projected to be especially sensitive to sea level rise, flooding, severe storms, and diseases related to wetter conditions. Many parts of Africa already suffer from water and food shortages and severe economic and social challenges. Climate change is likely to greatly exacerbate these conditions. Worldwide, people with fewer financial resources are likely to be less able to cope as the climate changes.



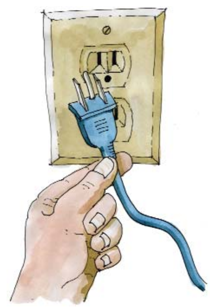
Impacts on Wisconsin

Wisconsin is not immune to the issues of climate change. Great Lakes water levels are predicted to drop below historic lows for two reasons: lower precipitation and higher temperatures causing increased evaporation. Ice cover over lakes and streams across Wisconsin also is predicted to decrease due to warmer temperatures. This again will lead to more evaporation of fresh water.

The loss of water depth and ice cover is an environmental concern that will be felt across Wisconsin, but it is also an economic concern. Wisconsin's economy relies heavily on its waterways for recreation, commercial fishing, and transport, all of which are susceptible to climate change. Wisconsin's economy is also rich in agriculture and forestry. As stated before, scientists predict an increase in temperatures and changes in rainfall, both of which can harm many crops and forests by changing species composition, increasing forest fires, decreasing yields, and increasing pests.

Solutions

In order to slow climate change, a consensus has emerged among scientists, policy makers, and the public that people need to reduce their reliance on fossil fuels. Using alternative energy sources that emit no or few greenhouse gases will allow people to shift to a new way of living that better protects the global climate. In addition to solar, wind, and hydroelectric, alternative energy sources, biomass, and biofuel are receiving increased attention. Plants grown for biomass and biofuels are active components of the carbon cycle. They take up and store, or sequester, carbon (CO_2) while growing and release carbon when used as energy or when the plants decompose naturally. Raw materials for biofuels can be re-grown in a few short years, as opposed to fossil fuels, which took millions of years to form and cannot be re-grown to take up CO_2. Biofuels made from plants that can be grown without high amounts of energy and chemicals may decrease use of petroleum products.



Reducing fossil fuel combustion by conserving energy is a way that people of any age can help. Electricity generation burns large amounts of fossil fuels and is the number one emitter of greenhouse gases in the United States. People can limit electricity use in their daily lives through simple steps such as turning out lights in unoccupied rooms, unplugging TVs and computers when they are not in use, and recycling. Transportation is the second largest source of greenhouse gases. Walking, bicycling, carpooling, combining trips (trip chaining), and using mass transit are easy ways to reduce vehicle emissions. Changing habits to keep home thermostats closer to outside temperatures and buying locally produced items that don't require transport over long distances will also help to reduce the emission of greenhouse gases. Even small changes in everyday life can make a difference.

Everyone, including young adults, can bring about change by being active and engaged citizens. They can encourage law makers to support policies that alleviate or lessen the impacts of climate change. They can encourage behavior changes in their families and peers. They can provide energy and creativity to tackle the shared challenges together.

1

What is Climate?

Define and discuss climate and how scientists estimate climatic conditions from many years ago.

This activity helps students understand the difference between weather and climate.

ee m s

This activity gives students hands-on experience with ice core analysis—a method used by scientists to get long-term climate data.

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a art–design
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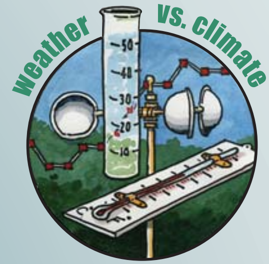
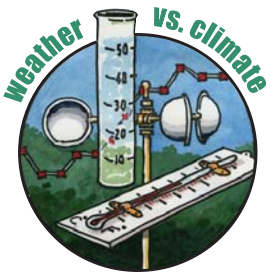




Weather vs. Climate

learning objectives

Students will:

- *Describe the difference between weather and climate.*
- *Graph data and describe the differences between different types of graphs.*
- *Explain the differences between individual data and averages.*

subjects

Environmental Education
Math
Science

WISCONSIN MODEL ACADEMIC STANDARDS

ENVIRONMENTAL EDUCATION
A.8.1, A.8.4, A.8.5, A.12.1, A.12.3, A.12.4, C.8.4, C.12.1, C.12.3, C.12.4

MATH
A.8.1, A.12.1, E.8.2, E.8.4, E.12.1

SCIENCE
A.8.3, A.12.1, A.12.7, C.8.2, E.8.1, E.8.3, E.8.4, E.8.5, H.12.6

materials

- ☐ Blank database charts and graphs and/or access to computer-based spreadsheet and graphing software
- ☐ Access to weather databases
- ☐ Worksheets included in this activity
- ☐ Graphs included in this activity or from other sources

Background

Weather is defined as specific atmospheric conditions including temperature, rainfall, wind, and humidity at a given place and time. Weather occurs over a short term (today, tomorrow, last week, etc.). The earth's weather has a high degree of variation.

Climate is defined as the average weather for any given area over many years. General weather conditions such as temperature, humidity, air pressure, precipitation, sunshine, cloudiness, and wind are averaged out over many decades. Climates also change with time (e.g. during the last ice age compared to the present).

In simpler terms, meteorologists point out climate is what you expect and weather is what you get. Or, as a perceptive middle school student said, "Climate helps you decide what clothes to buy, weather helps you decide what clothes to wear."

The earth's weather system is very complex and has a high degree of variation. To really understand what is happening to the world's climate, scientists look at weather data from around the world over long periods of time.

Relatively accurate recorded data is available for about the last 150 years. For data prior to that, scientists need to use "proxy data," data interpreted from other observations like tree rings and the composition of ice cores from Antarctica and Greenland. (For more details on how scientists estimate historic weather data from ice cores, see the *Ice Cores Activity*.)

Wisconsin lacks permanent ice layers to analyze, but historic records and current observations of weather-related events offer insight into changes in the state's climate. Weather events include the first and last days of frost, the dates of ice-on or ice-off for specific lakes, the duration of ice cover on specific water bodies, and any changes made to the state's plant hardiness zones (see references in *e-Appendix*).

Part A – **Weather in Wisconsin**

Students will gather specific historical weather data and averages for their locality and graph it.

Procedure

Preparation

1) Decide what weather data the students will graph. Many weather-related parameters can be used: daily maximum temperatures, daily minimum temperatures, daily mean temperatures, first date of frost, last date of last frost, rainfall, ice-on or ice-off dates, etc. *For illustration, this activity guide uses daily minimum temperatures (see Table 1).*

2) Chose at least two separate years to research weather data. Have one be the previous full calendar year. The second year can be any for which you can find historic data—students may enjoy looking up the weather for the year they were born or of some other time frame.

3) Once the two years have been chosen, have each student pick dates—then have them find weather data for those dates. Suggestions include their birthday, favorite holiday or other special occasions. *Note:* make sure the class gets a good spread of dates across the entire calendar year. *For illustration, this activity guide uses the 15th of each month for 2007 and 1992 (see Table 1).*

***Table 1:** Data sample of minimum temperatures from Madison, Wisconsin.*

DATE	Minimum Temperature (° F)		
	1992	2007	Historical Avg.
Jan 15	-6	12	9
Feb 15	30	-5	14
Mar 15	16	20	24
Apr 15	37	58	35
May 15	48	49	46
Jun 15	55	60	56
Jul 15	48	51	61
Aug 15	43	64	59
Sep 15	62	32	50
Oct 15	43	50	39
Nov 15	24	23	28
Dec 15	34	7	16

Investigation

1) Have students visit weather websites that provide both average and actual date-specific weather data. Weather Underground is particularly good for historical and average weather data. Have students find the site's web page with historical weather for their locality.

2) Ask each student to find the data (e.g. minimum daily temperature) for assigned dates (e.g. 15th of each month). Students should look up both the data for specific years ***and*** the historical averages for the assigned dates.

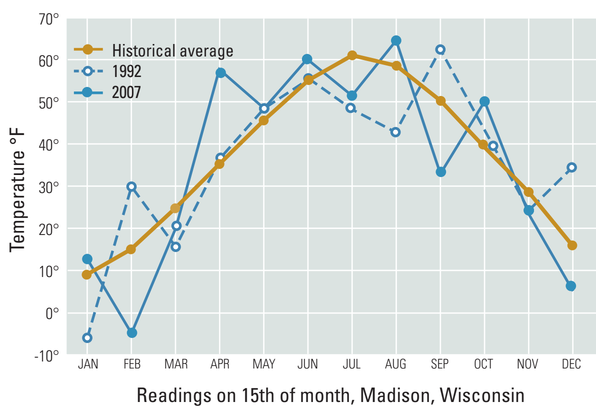
3) Instruct students to create a combined class data table—they can use paper *(see Table 1)* or a spreadsheet program like Excel or iWorks Numbers.

4) Next, have students graph their data. To illustrate different types of graphs, have them create line graphs, bar graphs or other types of graphs. (See the sample Graphs A and B for the Madison data.) Have students use a different color for graphing the data in each of the table's columns.

Students can graph their data on paper or electronically, using a computer spreadsheet program. Or use transparencies or sheets of clear acetate so different data sets can be laid over each other. (If you want to combine their graphs, give them graph paper with the axes pre-labeled so they all use the same scale, or let them discover why this is necessary.)

5) Have students fill out *Part A: Weather in Wisconsin Worksheet* and discuss.

***Graph A:** Sample LINE GRAPH of minimum daily temperatures from Table 1.*



Discussion Questions

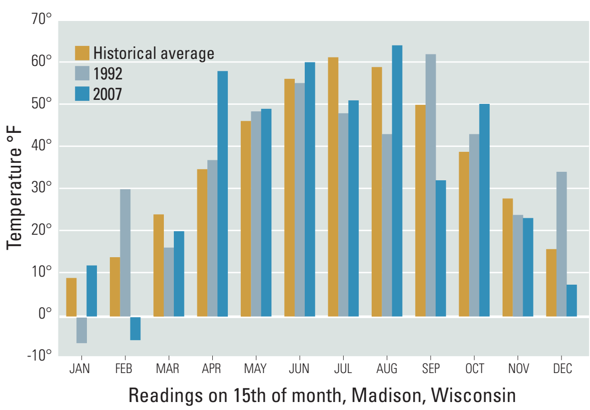
1) If you used data that included averages… How does the date-specific data compare to the averages? How do the curves for the data for a given year compare with the curve for the averages? What do the curves say about the differences between weather and climate?

2) Can students tell from the source of their data what and how many years' data were used to calculate the averages? Were the averages calculated over many years or just a few decades? How might that change their analyses?

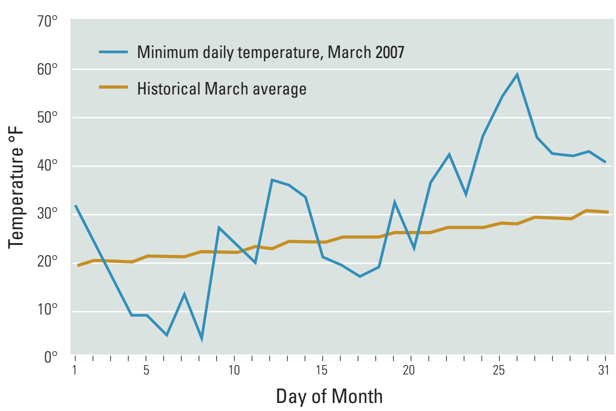
What meaning does this analysis have in determining whether the climate is changing? Can you tell from your graphs whether the global climate is changing? Why or why not? What can (or can't) you tell about climate change from just a few days' or years' weather data for one location?

3) How does the line graph compare to the bar graph or any other graphs you made? Which type of graph (line or bar) is best at illustrating the difference between weather and climate? Why?

Graph B: Sample BAR GRAPH of minimum daily temperatures from Table 1.



Graph C: *Sample for March in Madison, Wisconsin.*



Going Beyond

1) ***Looking at one month:*** To see even more variability and the folly of assessing climate change based on just a few days of weather, have the students find and graph the data (actual and average) for every day for one month. What does this say about variation between observed data and average data? About weather vs. climate? *(See Table 2 and Graph C for March 2007–Madison, Wisconsin).*

Table 2: Madison, Wisconsin example based on actual mean, maximum and minimum temperatures (°F) for March 2007 compared to the historical average.

	2007			HISTORIC AVERAGE		
DATE	Mean	Max	Min	Mean	Max	Min
1	35	39	31	28	36	19
2	27	31	23	28	37	20
3	21	25	16	28	37	20
4	20	31	9	29	37	20
5	19	29	9	29	38	21
6	14	23	5	30	38	21
7	18	23	13	30	39	21
8	18	32	4	30	39	22
9	35	43	27	31	40	22
10	36	48	24	31	40	22
11	34	48	20	32	41	23
12	45	53	37	32	41	23
13	53	69	36	32	41	24
14	45	56	33	33	42	24
15	27	33	20	33	42	24
16	27	35	19	33	43	25
17	29	40	17	34	43	25
18	32	45	19	34	44	25
19	44	55	32	35	44	26
20	34	45	23	35	45	26
21	49	62	36	35	45	26
22	52	62	42	36	45	27
23	46	57	34	36	46	27
24	56	65	46	37	46	27
25	66	77	54	37	47	28
26	69	79	59	38	47	28
27	56	65	46	38	48	29
28	45	48	42	39	48	29
29	48	54	42	39	49	29
30	48	52	43	39	49	30
31	47	53	41	40	50	30

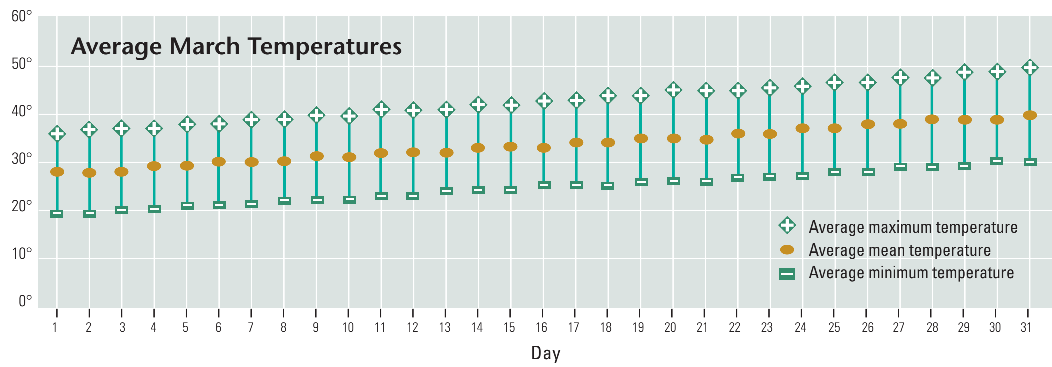
2) ***Looking at daily temperature ranges:*** First have students find the maximum, minimum and mean temperatures for every day of a specific month (sample for March attached). Students should obtain both the historical averages and the actual temperatures for a given year (sample is for 2007).

Next have them make two graphs—one for the averages and one for the actual year-specific data (Graphs D and E). Instruct them to just plot the points. Then, for each day, have the students draw a vertical line between the minimum temperature and maximum temperature, indicating the daily mean with a dot on that vertical line. Compare the daily temperature range in date-specific temperatures with the average range. What does this say about weather vs. climate? What would be another way to illustrate this comparison?

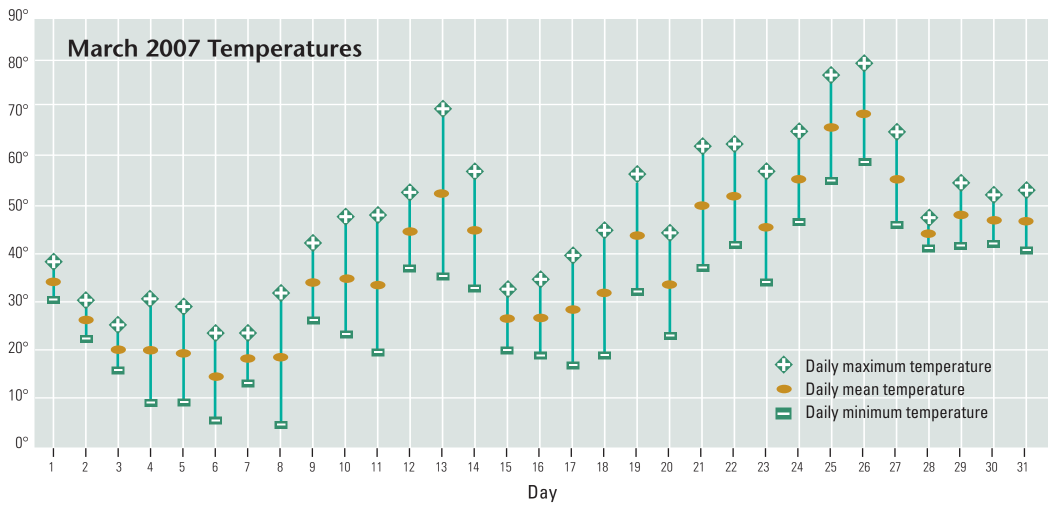
3) ***Collecting their own data:*** Have students collect their own weather data and graph it. Or start a long-term school project of collecting weather observations every year. This can be actual weather data, like temperature, or manifestations of weather like the date a lake freezes or thaws.

4) ***Weather-related phenomena:*** Discuss with students what weather-related phenomena might also serve as indicators for climate. Have the class graph and analyze the data for ice cover on Lake Mendota—the website of the University of Wisconsin Limnology Department has this data going back more than 150 years. Have students start their own project observing and collecting data on weather-related events (for biological events, see the activity on *Ecosystem Phenology* in this guide.

Graph D: *AVERAGE maximum, mean and minimum temperatures for Madison, Wisconsin.*



Graph E: *March 2007 maximum, mean and minimum temperatures for Madison, Wisconsin.*



Part B – Climate Trends

Students will look at and evaluate data and graphs depicting very long-term climate trends extending over hundreds or thousands of years to see what this information indicates about climate and climate change on Earth.

Procedure

Preparation

1) Find and decide what global climate change articles, data, or graphs you will use in class, or challenge students to find their own from internet searches or other sources. Internet searches provide many examples.

This guide provides examples and references in the *e-Appendix*. Three often-cited graphs illustrate:

- The average global temperatures since the mid-1850s as represented by the amount the yearly average global temperature was higher or lower than the 1961-1990 average.
- The average temperature of the Northern Hemisphere over the last two millennia based on actual and proxy data (see background section of this activity for an explanation of proxy data).
- Global temperature variation for the past 425,000 years, taken from ice core data collected at the Antarctic Vostok station and showing four ice ages.

Investigation

1) Share some graphs of global climate data with students or challenge them to find their own from internet searches or other sources. Divide students into groups, assigning each a different set of graphs to analyze. Where appropriate, have students read the affiliated articles that explain how the data was gathered.

2) Once all the groups have finished reviewing their graphs and completed the *Part B: Climate Trends Worksheet*, invite groups to share their findings and discuss any differences among them.

Discussion Questions

1) What do the x and y axes of the graph(s) each represent? What do the graphs say about Earth's climate and weather over time? Describe what they each tell you.

2) How are the graphs similar or different from the ones you made in *Part A: Weather in Wisconsin Worksheet*?

3) How do we know what the weather was like before records were kept? How was data gathered? What assumptions were made in estimating and graphing historic weather data? Do you think the analyses were valid? Why or why not? Would you suggest any changes to the procedures used?

4) How do the graphs help us understand the world's climate? Do they support the theory that human activity is causing changes to the world's climate? Why or why not?

5) What conclusions can we make from the graphs? What questions remain? What shifts, if any, do you see from the climate graphs?

Going Beyond

Look for graphs that illustrate temperature or other weather data over time compared to environmental data, e.g. CO_2 or CH_4 levels in the atmosphere. (See *e-Appendix* for sources.)

Ask students to look for relationships between the graphed weather and environmental parameters and whether or not they can draw conclusions about causes and effects from these graphs. What might they predict for the earth's future based upon the graphs?

Part A – **Weather in Wisconsin**

NAME ______________________________ CLASS ______________________

TEACHER ____________________________ DATE ______________________

1) *Define weather.*

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2) *Define climate.*

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3) *Fill out the provided data sheet and graph.*

4) *How do the types of graphs (e.g. line graph vs. bar graph) compare?
What does each show best? Is one better than the other for comparing weather data?*

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Part A – **Weather in Wisconsin** *(continued)*

5) *How do the date-specific data compare to the averages? How do the curves for a given year or month compare with the curve for the averages? What does this show related to the nature of averages?*

6) *How many years' data were used to calculate the averages? How important is this in estimating whether the climate might be changing?*

7) *What does this difference between averages and date-specific data say about the difference between weather and climate?*

8) *How might you design a study to collect data in your locality to track changes in weather patterns over a long period of time? Can you think of any ways to estimate weather from more than 100 years ago?*

Part B – **Climate Trends**

NAME ______________________ CLASS ______________________

TEACHER ______________________ DATE ______________________

1) *Evaluate graphs of long-range global weather conditions. What do the x and y axes of the graph(s) represent? What do the graphs indicate about climate and weather over time?*

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2) *How are the graphs similar or different from ones you made earlier based on actual weather data? How does this comparison relate to the discussion of weather versus climate?*

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3) *How do we know what the weather was like before records were kept? How do scientists analyze the accuracy and validity of such data?*

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4) *What conclusions would you make from the graphs you reviewed? What questions do you still have? What changes, if any, do you see in the world's climate from the graphs you examined?*

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5) *If you had graphs that compared weather data to atmospheric conditions, e.g.* CO_2 *concentrations in the atmosphere, what conclusions could you draw about the relationship between weather and atmospheric conditions? Does one cause a change in the other? Explain.*

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Ice Cores—Exploring the History of Climate Change

learning objectives

Students will:

- *Understand climate is a fluctuating system.*
- *Demonstrate how scientists estimate historical climate data using ice cores.*
- *Predict outcomes of a scientific investigation and then conduct the investigation.*
- *Analyze the results of their scientific investigation.*

subjects

Science

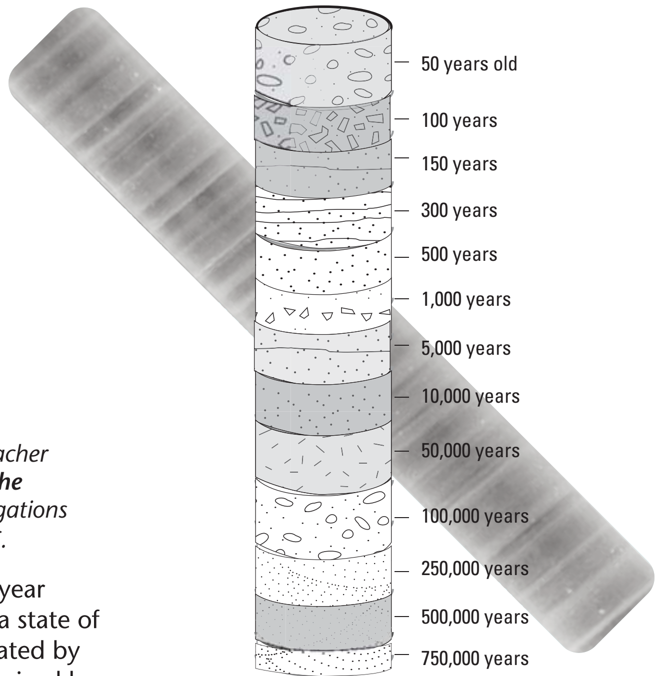
WISCONSIN MODEL ACADEMIC STANDARDS

SCIENCE
C.8.4, C.8.6, D.8.1, D.12.5, E.8.1, E.8.4, E.8.5

materials

- ☐ Plastic graduated cylinders (50 ml) – one for each group
- ☐ Food coloring – various colors
- ☐ Carbonated sparkling water
- ☐ Acid (vinegar or lemon juice drops)
- ☐ Particles (ashes, cat litter, or other dusty material)
- ☐ Freezer with enough space to store cylinders upright
- ☐ pH test kit (or phenolphthalein & sodium hydroxide) to measure pH
- ☐ Rulers
- ☐ Electronic balance
- ☐ Hot plates with water baths to melt ice core or warm tap water
- ☐ Worksheet included in this activity

AGE OF ICE CORE LAYERS



Background

*This activity has been adapted from teacher Tracey Leider of Oregon High School, **The Habitable Planet**, and Ice Core Investigations by Antarctic Climate & Ecosystems CRC.*

Throughout much of its 4.5 billion year history, Earth's climate has been in a state of fluctuation. Some eras were dominated by coldness while others were characterized by warmth. Some of these periods included drastic fluctuations while others remained fairly stable for millions of years.

Four major continental glaciations are recorded in North America. The last (Wisconsin) began about 70,000 years ago and ended 10,000 years ago. Much of Wisconsin's geological landscape was influenced by glaciation. The northern half of the state is mixed hardwood and coniferous forests. Farmland and prairies exist primarily in the southern half where the glaciers dropped sediment that made the land nutrient rich. The bluffs and narrow valleys of the Driftless Area, in the south-western corner of the state, are places where the last glaciers did not reach and, thus, the landscape was not scraped or leveled.

The polar regions of the world have held ice throughout and between these glacial periods. Like rings of trees in temperate parts of the world, ice layers in polar regions and glaciers also create layered historical records. Layers of snow become compacted into ice, which are laid atop previous layers of ice to create these records of the past.

To analyze historical climate changes, scientists drill down into the ancient ice where information about the atmosphere has been captured. Scientists extract the ice core and use it to analyze atmospheric physical and chemical characteristics to create scientific snapshots of Earth during single points in time.

Small bubbles in the ice hold trapped atmospheric gases from hundreds of thousands of years ago. When scientists analyze the composition of those trapped gases they are measuring the concentrations of gases in Earth's atmosphere when each layer was formed, including the concentration of carbon dioxide (CO_2), a greenhouse gas. In addition, the water in each layer of the ice holds oxygen and hydrogen isotopes. The relative concentrations of these isotopes will vary depending on the temperature when the layer was created. Thus, the scientists are able to determine the historical record of the temperature as well.

Perhaps the most famous study of this type is the Vostok ice cores from Antarctica *(see e-Appendix for references)*. These data are often cited in climate change articles. By showing a correlation between global temperatures and atmospheric CO_2 levels, scientists find evidence that changing the concentration of CO_2 in the atmosphere can change the global temperature and climate.

In this activity, students will not be able to measure directly the CO_2 of trapped atmospheric gases or the relative oxygen and hydrogen isotopes of the water. However, they can analyze other physical parameters to get a sense for how scientists learn about the past from ice cores and also the studies done related to climate change.

activity

ICE CORES

Exploring the History of Climate Change

Students will analyze fabricated ice cores and record their physical and chemical characteristics.

Procedure

Preparation

1) Home Assignment: Have students prepare for the lab part of this activity by learning how scientists analyze ice cores for information on changes in Earth's atmosphere over time. References to the Vostok ice cores and other information sources can be found in the *e-Appendix.* You can provide students with materials to read or have them do their own research on the topic. This preparatory work will give students a broader understanding of how this research is conducted and the opportunity to analyze evidence of the link between atmospheric CO_2 and global temperatures.

2) Make ice cores *(Note:* Allow up to 5 days for preparation of this activity before you present it to students)

- Several days before class, make an ice core for each group of 2-3 lab partners. Use 50 ml graduated cylinders or other long narrow containers to make the ice cores: they should be able to stand upright in the freezer. You will make the cores with at least 3 different layers. After mixing up and adding each layer to each ice core, you will need to freeze the ice core completely before adding the next layer, so plan several days of preparation time.
- Plan to give each layer a unique color (to help students separate the layers), volume (to simulate varying levels of precipitation), dissolved solids (to simulate both pollution and ash from volcanic eruptions), dissolved CO_2, and pH.
- Mix up a solution for the first layer. Add a small amount of solids (ashes, ground up cat litter, or other dry or dusty substance) to tap water and some food coloring for dye to this first layer. Record the amount of sediment you added and measure and record the pH of the solution. Stir the solution to suspend the solids and pour the same amount of the solution into each cylinder. Freeze overnight or until solid.
- Mix up the next solution, this time adding carbonated sparkling water to the tap water (perhaps 10% sparkling water and 90% tap), a different amount of solids, and a different color of dye. *(Note:* the solids could represent pollution or volcanic action, so you may want more solids in the topmost layers to represent pollution from industrialization as well as solids in an earlier layer to represent a geologic time with much volcanic activity.) Again, measure the pH and record the composition of this layer. (If the pH is not different from the first layer, try adding more sparkling water or some vinegar to reduce the pH.) Add this solution on top of each of the frozen cylinders. Refreeze overnight.

- Continue making additional layers, varying the parameters and freezing between each addition. To simulate increased CO_2 in the atmosphere, have the last layer be a solution of 50% carbonated sparkling water and 50% tap water. You could also add more solids to this layer to simulate increased pollution from industrialization.
- Bring the ice core samples to class (packing them in ice and dishtowels in a cooler helps protect them until class time). Distribute one ice core per 2-3 students.

Investigation

1) The class will investigate the chemical and physical characteristics of each layer.

2) Begin with a class discussion of ice core analysis and how ice core data is used. Refer to the research or readings assigned prior to this lab. Some general inquiry-based questions might include:

- What do scientists measure when they are studying ice cores?
- What types of atmospheric data might be useful if we're looking for evidence of climate change? What can be measured?
- How might scientists correlate a given layer of ice with a given time period? How would they know the age of each layer?

3) Students should:

- Separate layers
  - First tell students which colored layer represents the top, or most recent, layer of the ice sheet they are analyzing.
  - Remove the cores from the cylinder by pouring warm water over the cylinder or by setting it briefly in a warm water bath. At this point, only melt enough of the outer part of the core to remove it from the cylinder.
  - Gently break each ice core layer apart. Using a small saw or serrated knife will provide more accurate separation of the layers.
- Compare precipitation in each layer
  - Measure the mass of each layer and record the results on the *Ice Core Research Worksheet*.
  - Measure the volume of each layer and record the results.
  - *Optional:* Density can be calculated once the mass and volume are known.
- Compare pH and CO_2. First explain to the students that CO_2 in solution with water becomes carbonic acid, dropping the pH, so measuring relative pH should indicate relative levels of CO_2.
  - Before measuring for pH, have students predict which layers will have the highest and lowest pH and record their predictions.
  - Melt the ice and collect the resulting solution for each layer.
  - Measure the pH of the layer by using a pH test kit.
  - Alternatively, measure comparative pH by putting 5 ml of each layer in a separate test tube. Add a few drops of the indicator phenolphthalein (clear in acid, pink in alkali). Add measured amounts of sodium hydroxide solution to neutralize the acid. Stop as soon as the solution turns pink. Record the final volume of sodium hydroxide needed to neutralize the solution and compare results for different layers.
- Measure particulates
  - Before measuring for the suspended solids or particulates, hypothesize the relative amounts of particulates in each layer and record their predictions. Do students guess that the more recent layers will have more particles and pollution because of the industrial revolution?
  - Measure and record how many ml of each layer they will test for particulates. Evaporate this amount of each layer in a pre-weighted container. Reweigh the container to get a weight for the remaining solids.
  - Alternatively, weigh filters for each layer, recording the weight. Then filter the liquid in each layer, dry the filters, and reweigh the filters to calculate the weight of particulates.
  - Record results as grams of particulates per milliliter of liquid. Convert this to grams of particulates per liter.

Discussion Questions

On the board, large pieces of paper, or overhead projector, have all students report their results. Construct a class data table for recording volume, weight, density, pH, and particulates and have the students:

- Compare their group data to the overall class data.
- Determine sources of error for the overall experiment and per group. Were there better, more accurate ways to conduct the ice core experiment? How could the investigation have been done differently to improve results?
- What conclusions can they draw? Which layers represent wet or dry years? How do you know? Were some layers more acidic than others? Why and what is the relation to climate change? Did the level of particulates vary? What might be the sources of these particulates in the atmosphere?

Going Beyond

1) Have students research the methods used by scientists to figure out dates of ice core samples. Why would this be important for climate change research?

2) Add other parameters to the ice cores for the students to measure. For example, to simulate heavy metals in the atmosphere from pollution, you can add about 1% by volume of 0.1M copper chloride solution to a layer. Students can analyze layers for the presence of copper by adding a small amount of dilute sodium hydroxide to a portion of the melted layer and observing the result over a white background. The presence of copper will turn the resulting solution a faint blue. To detect a difference in color, students should compare the portion they treated with sodium hydroxide to the untreated portion. However, if you used dye in the layers this will be hard to detect, so you may want to add the copper chloride to a clear layer.

activity Ice Core Research

ICE CORES

NAME ______________________ CLASS ______________________

TEACHER ______________________ DATE ______________________

TEAM MEMBERS ______________________

ICE CORE SAMPLE

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You have been chosen to join an Antarctic expedition to study ice cores.

To prepare you will need to research and read what other scientists have found. Your team will examine ice core layers for volume, pH, and evidence of pollution. Then you will report your findings to a national scientific community (your class) at their annual meeting (next class period). You have to take detailed notes as you proceed so you can accurately report your findings and the possible implications you unearth. Good Luck!

1) From your reading and research, how do scientists learn about Earth's past from ice sheets and glaciers? What kinds of information do they gather?

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2) How do scientists estimate temperature and carbon dioxide levels from thousands of years ago, using their ice core analyses?

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3) How do scientists estimate the age of a given layer in an ice core?

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4) Measure each layer in centimeters and draw a diagram of your ice core in the space below.

worksheet

5) Based on prior knowledge and reading, predict which layers will have the highest and lowest pH and the highest and lowest particulate contents. What is the rationale behind your predictions?

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6) Separate each layer from others by gently cutting or breaking them apart.

7) Measure the mass of each layer on the balance to the nearest tenth of a gram. Record your results in the data table.

8) Measure the volume of each sample using the method provided by your teacher. Record the results in the data table. Calculate the density.

9) After predicting the relative pH for the various layers, measure and record the pH of the sample, using the method provided by your teacher. How does the measured pH compare with your predictions? Do the results surprise you? Why or why not?

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10) After predicting the pollution levels, weigh and record the amount of particulates or solids in each sample using the method provided by your teacher. Were your predictions accurate? If not, what might be a reason for the discrepancy? What can cause particles and soot in the air?

ICE CORE DATA for Sample # ____________________

Layer COLOR	Predicted relative pH H= HIGHEST L= LOWEST	Predicted relative particulates 1= LOWEST	Mass (g)	Volume of layer (ml)	Volume converted to liters	Density of layer (g/l)	Actual pH	Actual weight of particulates	Actual concentration of particulate matter (g/l)

2

Causes of Climate Change

Examine the pollutants that cause climate change, the sources of those pollutants, and ways to reduce their impact.

a art–design
ee environmental education
ss social studies
s science
m math
e english–language arts

This activity examines what pollution is, its sources, and how to calculate the quantity of emissions.

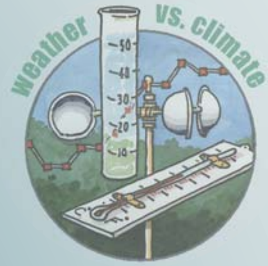
ee m s ss

This activity looks at the role energy use plays in climate change.

ee s ss

Students evaluate their lifestyle, identifing actions they can take to reduce their impact on climate change.

ee



2

The Chemistry of Climate Change

learning objectives

Students will:

- *Identify sources of air pollution.*
- *Identify solutions to air pollution.*
- *Distinguish between natural and human caused sources of air pollution.*
- *Define what makes pollution, pollution.*
- *Calculate the weight of various pollutants.*
- *Visualize the amount of air pollution emitted by a car each year.*

subjects

Environmental Education
Math
Science
Social Studies

WISCONSIN MODEL ACADEMIC STANDARDS

ENVIRONMENTAL EDUCATION
B.8.15, B.8.17, B.8.18, C.12.1, D.8.1, D.8.5

MATH
B.8.2, B.12.3, F.8.1, F.8.2, F.12.3

SCIENCE
F.8.10, G.8.3, G.12.3, G.12.5

SOCIAL STUDIES
D.8.11

materials

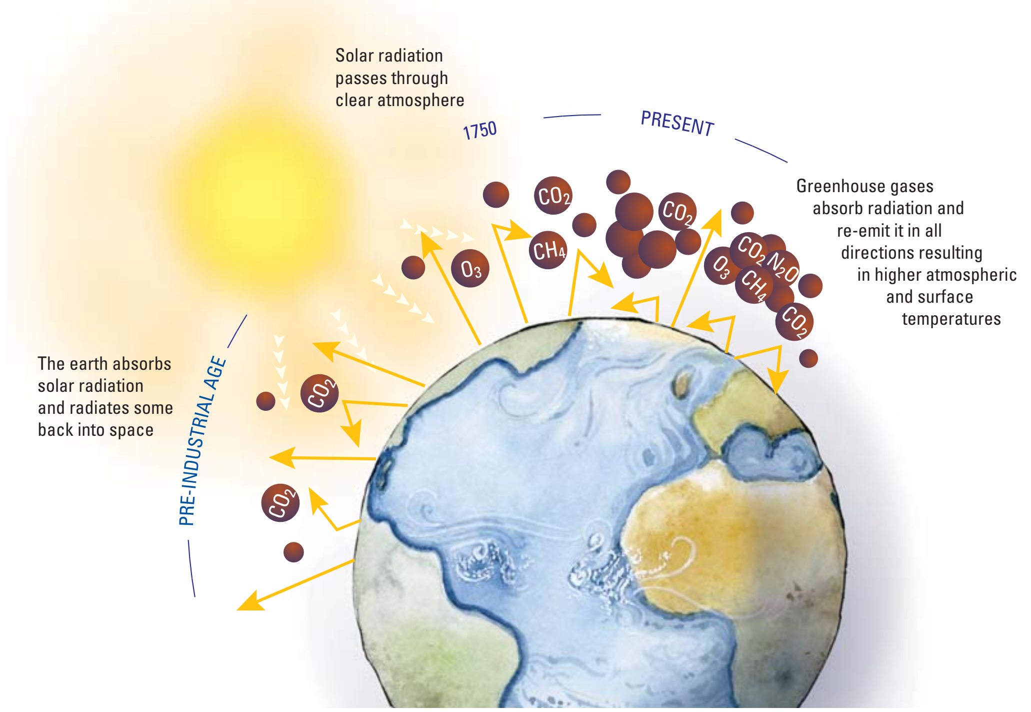
- ☐ Laminated Wisconsin DNR *Where's the Air?* poster
- ☐ Washable markers
- ☐ Many 2-liter soda bottles
- ☐ Periodic Table of Elements
- ☐ Worksheets included in this activity

Background

The thin layer of gases that surround Earth, otherwise known as the atmosphere, is changing. The current composition of Earth's atmosphere is mostly nitrogen and oxygen. It also contains water droplets, fine particles, argon, and very small amounts of carbon dioxide (CO_2), nitrogen oxides (NO_X), methane, and other gases. Most of these substances have been present in the atmosphere for millions of years and come from natural sources like volcanoes, forest fires, plants, animals, and decaying organic matter. But in today's atmosphere, the amount of some of these substances is much higher than it was hundreds of years ago due to pollution from our industrial revolution. We can see results of human sources of air pollution as smog over our cities, though many air pollutants are invisible.

One key component to our atmosphere that makes this planet livable is the greenhouse effect. This is a naturally-occurring phenomenon in which greenhouse gases—water vapor, carbon dioxide, methane, nitrogen oxides, and ozone—trap heat in Earth's atmosphere. The sun radiates heat toward Earth constantly. Earth absorbs some of that heat, but a large portion "bounces" off Earth's surface back towards space. The greenhouse gases present in the atmosphere trap some of this heat before it is radiated back into space. The greenhouse effect is responsible for maintaining Earth's temperature and is necessary for human survival.

The *Where's the Air?* poster lists natural and human sources of pollution. It is important to know the similarities and differences.



activity

CHEMISTRY OF CLIMATE CHANGE

Part A – What is Pollution?

Students will create a definition of pollution and determine the difference between naturally occurring and human-caused pollution using the Where's the Air? poster.

Procedure

What makes it "pollution?"

1) Working in groups, students will identify from the *Where's the Air?* poster, three sources of pollution.

2) With each source they should list the characteristics that make it "pollution." These could include:

- not biodegradable
- human-made
- negatively affects the quality of life (causes discomfort, ugly, smells bad, unhealthy, etc.)
- human beings have control over it
- contrasts with the natural landscape
- consumes an unreasonable amount of non-renewable energy
- occurs in quantities harmful to human health, i.e. damages respiratory system
- occurs in quantities harmful to animal and plant health
- occurs in quantities harmful to ecosystem health (may cause changes in climate or other natural phenomena or contribute to an unsustainable situation).

3) Have students refer to their lists and create a set of criteria that forms their definition of an "air pollutant."

Refining the criteria

1) Assign each group one of the human-produced sources of air pollution and one of the naturally-produced sources of air pollution from the poster. Have students apply their criteria to each. Would the item be a pollutant or source of pollution according to the students' criteria? Ask them to think about the part that human control plays in this question. Would they want to focus their pollution reduction on a natural source of pollution or a human source?

2) After they apply their criteria and decide whether the item is a pollutant or not, give them the option to revise their criteria. Students may feel that the biggest need is to defend their criteria. Impress on them that changing their minds after careful consideration is acceptable and to be expected in the process of critical thinking.

Reducing pollution

For the sources assigned above under *Refining the Criteria,* have the students answer these questions:

- Who is responsible for releasing this pollutant into the environment?
- Would it still be a pollution problem if released in smaller amounts?
- What is currently being done to control this pollutant? Who is doing it? What role does government play? Industry? You?
- How is this pollutant affecting global climate change?

activity

CHEMISTRY OF CLIMATE CHANGE

Part B – Sources and Solutions

Students will find the sources of air pollution, the solutions to air pollution, and how air pollution is transported.

Natural sources of air pollutants

EXAMPLES: volcanoes, geysers, plants, wetlands/swamps, animals

Volcanoes release tremendous amounts of gases and particles into the air. Decaying organic materials in oceans, swamps, and bogs release greenhouse gases like methane and carbon dioxide. Even cows belch methane. The easily recognized smell of a skunk and the scent from pine trees are caused from the release of volatile organic compounds (VOCs). Though we need photosynthesis to give us oxygen, all trees and plants release VOCs in varying amounts during the process. These sources are called "biogenic," and they release VOCs and other greenhouse gases that are part of the natural chemistry of Earth and its atmosphere.

Some biogenic pollution sources could have dramatically altered Earth's atmosphere at different times in the past. Volcanoes have been known to change weather patterns for years after erupting. Since little can be done to control natural pollution, and we need sources like plants for food, shelter, and oxygen production, our focus is on controlling human sources.

Human sources of air pollution . . . . . .

EXAMPLES: buses, tractors, gas stations, trash burning, sewage treatment plants, bakeries.

Air pollution from human sources tends to concentrate in urban areas where people live and work. Many of these pollutants come from the burning of coal, wood, oil and other fuels for electricity, transportation, and heat. Carbon dioxide, methane, and nitrous oxide are the three main pollutants causing climate change.

Carbon Dioxide (CO_2) enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g. manufacture of cement). Carbon dioxide is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.

Methane (CH_4) is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.

Nitrous Oxide (N_2O) is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.

For this information and more, see EPA's climate change web page, listed in the e-Appendix.

Due to easy transport, air pollution is more than just a local concern. Both natural and human sources of air pollution can be transported almost anywhere in the world on global winds. The regional air transport diagram on the back of the *Where's the Air?* poster shows the type of weather system associated with high levels of air pollution in Wisconsin.

Procedure

Sources of air pollution . . . .

1) Students working in small groups circle as many sources of air pollution as they can find pictured on the *Where's the Air?* poster.

2) Students will chart all of the sources of air pollution, the process that produces each, and the reason for the process.

SOURCE	PROCESS	REASON
car	*burning gasoline*	*transportation*

Some answers are listed on the back of the poster. These lists include both natural and human sources.

3) Students will then share their answers with the class. To motivate them, award 1 point for each pollution source found and 2 points for any original answer found by only one group. Recognize or award the group with the most points.

Solutions to air pollution . . . .

Students work in small groups and circle as many of the solutions to air pollution that they can find pictured on the *Where's the Air?* poster.

Groups create a chart of all of the solutions to pollution shown on the poster, and identify the action involved and who is doing the action.

SOLUTION	ACTION	WHO
biking	*reduced car use*	*commuters*

Again, some answers are listed on the back of the poster.

3) Students will then share their answers with the class. Again, award 1 point for each solution found and 2 points for any original answer found by only one group.

4) Students can expand their list of solutions to include any other solutions that are not on the poster. *Examples are:* education, working at home, landscaping, combining trips, reduced travel, cleaner fuels, etc.

activity

CHEMISTRY OF CLIMATE CHANGE

Part C – Pounds of Pollution

Students will calculate the pounds of pollution emitted by vehicles and visually represent it with 2-liter soda bottles.

Air pollution is a difficult concept to grasp. We often cannot see it, yet it affects our daily lives and contributes to global climate change. Transportation is one of the most important sectors contributing to air pollution. According to the U.S. Environmental Protection Agency (EPA), transportation accounts for about 29% of all greenhouse gas emissions. Air pollution often is referred to in terms of pounds. Air has weight, but do you know what *volume* of gas equals a pound?

Cars emit many air pollutants, including greenhouse gases. A car making an 18-mi round trip commute, 5 days/wk, 48 wks/yr, spews 4,500 lbs of CO_2, 160 lb CO, 16 lbs of VOCs, 16 lbs of NO_x, and smaller amounts of benzene, formaldehyde, particle pollution, and other toxic chemicals into the air.

Procedure

1) Calculate the volume of 1 pound of the air pollutant you are interested in:

$$\frac{454\text{ g}}{1\text{ lb}} \times \frac{1\text{ mole}}{\text{“x” g}} \times \frac{22.4\text{ L}}{1\text{ mole}} = \text{liters of gas/lb}$$

Explanation: 454 grams = 1 pound. To find out how many grams of pollutant are in a mole, calculate using values from the Periodic Table of Elements. Add together the grams per mole for each element in the compound. For example, one atom of oxygen = 16 g/mole; carbon = 12 g/mole. This totals 44 g/mole for a carbon dioxide molecule (CO_2 is 2 oxygen atoms plus 1 carbon atom).

Car emissions that contribute to climate change (and their weights per mole) are carbon dioxide (CO_2 = 44g), carbon monoxide (CO = 28g) and nitrogen dioxide (NO_2 = 46g).

At 0°C and one atmosphere of pressure, the volume of a mole of gas is 22.4 liters. Multiplying by this value converts a pound of gas into an equivalent number of liters.

Calculate how many 2-liter bottles are needed for the display using this equation:

$$\frac{\text{liters of gas/lb}}{2\text{ liters}} = \text{total bottles/lb of gas}$$

For example when CO_2, calculated to be 221 liters per pound, is divided by 2, you find it takes 115.5 bottles to represent a pound of CO_2. *(See sidebar for other answers.)*

Discussion Questions

1) How many bottles would be needed to represent the hypothetical car's *(see emission estimates above)* yearly CO_2 and CO emissions? *Calculations at right.*

2) Calculate how many bottles would be needed to represent the amount of CO_2 and CO your class members contribute to the atmosphere during one school week. Use the hypothetical car amounts above.

3) On a hot summer day in southeastern Wisconsin 261.95 tons of NO_x is emitted. If this amount were made up entirely of NO_2, how many soda bottles would this be? *Calculations at right.*

Going Beyond

1) Discuss how much air pollution students can save from entering the atmosphere by driving one trip less per week or day.

2) Before doing the *Pounds of Pollution* activity, have students track the miles they drive, or are driven, in a week. Use this to calculate the volume of CO_2 emitted. After the activity, have them track it again, perhaps having a class contest to see who can reduce their miles and emissions the most. (To reward car pooling and mass transit, divide the miles traveled by the number of occupants in the vehicle—not counting the driver if the driver is only along to give them a lift). Keep a chart of class results over time.

3) What other ways can students reduce air pollution?

4) Have students discuss the future of the air if we all continue driving the way we currently do. Have students compare how different driving behaviors or vehicles would impact the environment. (To do this, request a copy of the *eXtraordinary Road Trip* computer game from *DNRAirEducation @wisconsin.gov*.) How will this affect climate change?

causes of climate change

KEY TO NO. OF BOTTLES

CO_2 = 231 liters/lb = 115.5 bottles/lb

CO = 363 liters/lb = 181.5 bottles

NO_2 = 221 liters/lb = 110.5 bottles

ANSWERS TO QUESTION 1

115.5 bottles/lb of CO_2 x 4500 lbs emitted by the average car per yr = 519,750 bottles/year

181.5 bottles/lb of CO x 160 lbs emitted by the average car per yr = 29,040 bottles/year

ANSWERS TO QUESTION 3

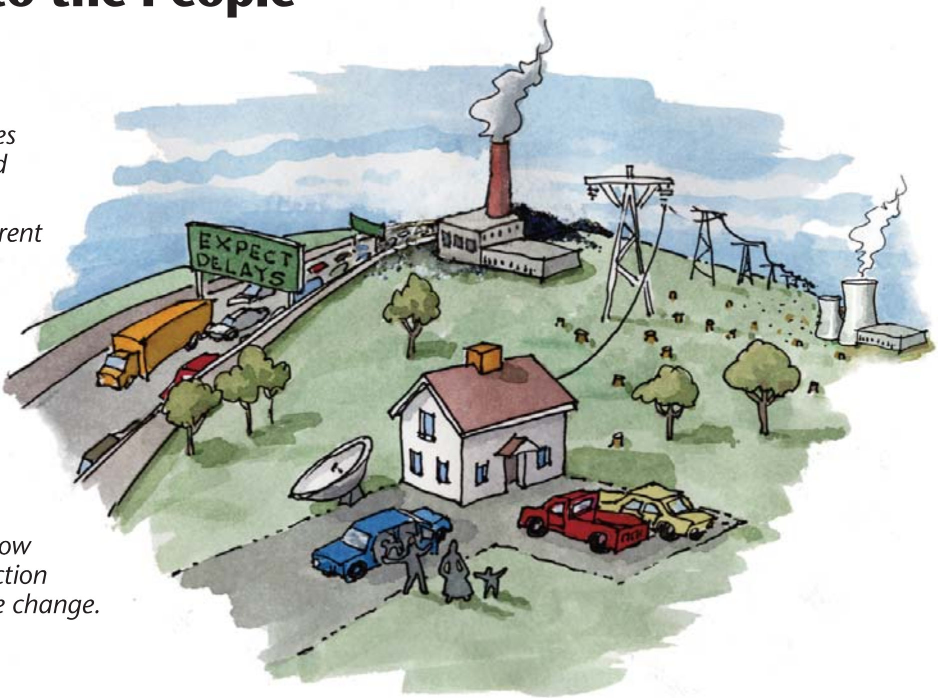
Multiply the 261.95 tons of NO_x by 2000 lbs/ton to get 523,900 lbs of NO_x. Multiply this by 110.5 bottles/lb of NO_2 and you get 57,890,950 soda bottles worth emitted on one summer day.

Power to the People

learning objectives

Students will:

- *Identify sources of energy used in Wisconsin.*
- *Research different ways power is produced and distributed in the state.*
- *Explain how energy production affects our environment.*
- *Understand how energy production affects climate change.*



subjects

Environmental Education
Science
Social Studies

WISCONSIN MODEL ACADEMIC STANDARDS

ENVIRONMENTAL EDUCATION
B.8.15, B.8.17, B.12.11, D.8.5, E.8.1, E.12.2

SCIENCE
E.8.6, G.8.3

SOCIAL STUDIES
A.8.1, A.8.10

materials

- ☐ Access to the internet (if not available, call your local utility company and ask for information on energy sources or power generation)
- ☐ Map of Wisconsin
- ☐ Worksheets included in this activity

Background

Where do we get our energy in Wisconsin? This activity will let your students investigate sources of energy in the state, discuss their efficiency, and examine how various types of energy production contribute to the greenhouse gases (carbon dioxide, methane, ozone, nitrous oxide, etc.) that cause human-induced global climate change.

Wisconsin's sources of power include:

Fossil fuel power

In a fossil fuel power plant, thermal/heat energy produced from burning the fuel (coal, natural gas, or petroleum) is converted to mechanical energy. Usually a turbine does this and then that mechanical energy is converted to electrical energy via a generator. Fossil fuel energy is inexpensive to produce when you compare the amount of energy that is created to the cost of the fuel. However, there are negative aspects of using fossil fuels. Burning fossil fuels creates pollution (CO_2, sulphur oxides (SO_x), and NO_x) that can contribute to smog, acid rain, and global climate change. Also, to obtain the fossil fuels, we have to destroy portions of our environment and disrupt landscapes. An example would be strip mining for coal.

Nuclear power

Nuclear energy is produced from controlled nuclear reactions. The most common method today uses nuclear fission, the splitting of an atom into separate parts. Many people consider nuclear power a "clean solution" to the energy crisis. However, pollution from nuclear power includes radioactive nuclear waste.

Renewable

Hydroelectric Most hydroelectric energy comes from dammed water. The energy is created by water following the rules of gravity. When the water behind a dam is released, energy is converted to electrical energy with the help of water turbines and a generator. Since hydroelectric dams do not burn fossil fuels to operate, they do not produce carbon dioxide to add to greenhouse gases in the atmosphere. However, there are other environmental impacts associated with building a hydroelectric plant, including hydrologic changes, water quality degradation, and blockage of fish migration routes.

Solar energy comes from the sun. Using solar panels or other technologies, the sun's rays are converted to electrical energy. Atmospheric conditions and the solar panels' positions on the earth relative to the sun can affect the amounts of solar power collected.

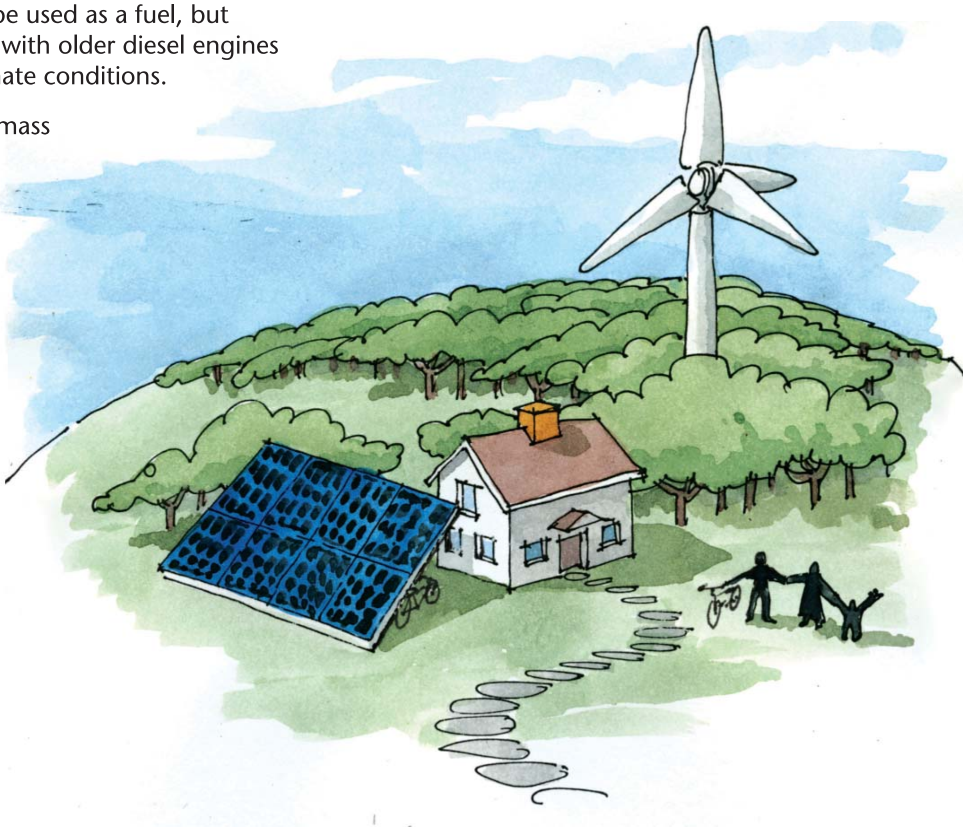
Wind energy generates electricity from the wind. Wind energy reduces greenhouse gas emissions when it offsets, or takes the place of, a fossil fuel power plant. Wind energy's negative environmental impacts can include impacts on migrating birds or bats and aesthetic impacts on neighbors.

Biofuels/Biomass These are solids, liquids, or gases from recently dead biological materials, most commonly plants. Biomass refers more specifically to the solids from recently dead biological materials. Firewood is an example of biomass used for energy. Fuel from sugar crops (sugar cane) or starch crops (corn) is called ethanol; fuel from non-edible plant sources like wood or grass is chemically identical but called cellulosic ethanol. Ethanol is used as a supplement to gasoline in cars. Vegetable oil can be used as a fuel, but usually just in cars with older diesel engines under specific climate conditions.

While burning biomass and biofuels does produce some air pollution, it has less impact on climate change than burning fossil fuels because of its shorter carbon cycle. Fossil fuels are made from plants and animals that have been dead and stored underground for many millennia, thus the name "fossil" fuel. Without human intervention, fossil fuels would continue to store or sequester carbon, preventing it from entering our atmosphere. Plants grown for biomass and biofuels are active components of the carbon cycle, taking up carbon while growing and releasing carbon when burned or decomposed. Unlike fossil fuels, biofuels can be re-grown quickly, providing food (corn, sugar) and timber and taking up CO_2 (a major greenhouse gas).

Geothermal energy is heat energy collected from beneath the earth's surface or energy absorbed in the earth's atmosphere or oceans. This naturally occurring energy is collected and used to make electrical energy. Emissions from the collection process are small and require no use of fossil fuel. Installing geothermal energy units can be rather expensive and homeowners may have problems with repairs due to the systems' uniqueness.

Energy conservation is the easiest way to limit the amount of greenhouse gases going into the atmosphere.



activity
POWER TO THE PEOPLE

Part A – Power in Wisconsin

Students will investigate sources of power in Wisconsin and determine their efficiency.

Procedure

1) Begin class in the dark today. If possible, close blinds and turn off lights. Ask students if they know where their electricity comes from. Is it from a coal-fired power plant? Hydro-electric? Wind energy? Is the plant nearby? Have this discussion in the dark.

2) Turn on the lights and point out the ease with which the room was supplied electricity. Where does the power originate? Explain that students will investigate this today in class.

3) Divide students into groups of three and hand out *Part A: Power in Wisconsin Worksheet.* Assign groups a power plant in your area or state to investigate. If you have not obtained printed copies of power plant information, allow students to use the internet. Students will work together to research sources of Wisconsin's electricity and electricity's influence on climate change in Wisconsin. Wisconsin's Office of Energy Independence, Wisconsin's Public Service Commission, and US Energy Information Administration are good resources.

4) When groups are finished, discuss their findings. Review percentages of energy source use and ask students to make hypotheses regarding the breakdown of use. Do the energy production resources need to be nearby?

5) When each group is finished, ask them to draw the location of the power plant they studied on a map of Wisconsin (either on a paper map or overhead transparency). When all groups are finished, use the completed map to show the locations of all power plants in Wisconsin.

6) Discuss how power plants affect climate change in Wisconsin.

7) Turn off the lights again. Ask students to think about worldwide energy usage and the climate change impacts of that energy use. When you turn them back on and, if time allows, have a brief discussion.

Discussion Questions

1) Why do you think power plants are located in certain areas of Wisconsin? Availability of resources? Socio-economic situation? Population density? Transportation patterns?

2) How efficient are these sources of energy?

3) In what way do they affect Wisconsin's environment?

4) How are these sources of energy linked to climate change?

5) What are some ways that you can conserve energy?

activity
POWER TO THE PEOPLE

Part B – Daily Energy Use

Students will create a log of the energy they use in their daily lives.

Procedure

1) Begin with the class imagining there has been a major power outage in their community, which will last one week. But community residents have decided to stay and try to continue to live their "normal" lives for this week. Have a discussion of how this will impact their lives. What activities will they not be able to do while the power is out? What will be some of the consequences of the power being out?

2) Discuss the link between climate change and energy production (see background material). Explain the first step in reducing our energy use, and thus our personal contributions to greenhouse gases and other pollutants, is to be aware of the way we currently use energy. Then, we can look for ways to reduce needless energy use.

3) Working in small groups, have students make lists of all the ways they can think of that they and their households use electricity in a typical week. Remind them to include things like charging their cell phones, iPods, and computer batteries. If they are on a

private well, they'd need to include the pump that delivers water from the well to the house. Even a gas stove, oven, or furnace has electric lighters and controls. To motivate the groups, award one point for every item they identify and two for any original item thought of by only one group. Recognize the group with the most points.

4) Have students pick 10 items from the list for which they will calculate energy use and evaluate how they can reduce that energy use. For each item, they should track the number of hours it is used for the next week. For some appliances, e.g. a refrigerator, the use should be assumed to be 100% of the time. For others, e.g. televisions, students should actually measure how many hours the device is turned on.

5) Next, students need to investigate the energy use of each item and fill out *Part B: Energy in Our Daily Lives Worksheet*. Some of their household items will have the energy use printed on them (e.g. light bulbs) or possibly in owner manuals (e.g. refrigerators or air conditioners). For those they cannot track down, the *e-Appendix* lists some references for average energy use. Students can try an internet search on <*energy* + *use* + *appliance*> to find their own resources, or they could visit an appliance or electronics store to investigate the range of energy used by different items.

6) Once students have the energy data, they can calculate their annual energy use for those items. If the rating is in watts or kilowatts, they will have to calculate the kilowatt-hours using the following formula:

Watts x (1 kilowatt/1000 watts) x hours used per day = daily kilowatt-hours (kWhr)/day

Students can then multiply this by days per year to calculate the annual use.

Some appliances, like refrigerators, may have listed their ratings in kWh per year already.

7) Now, using the cost per kWh from their home electric bill, students can calculate annual energy costs at current rate of use.

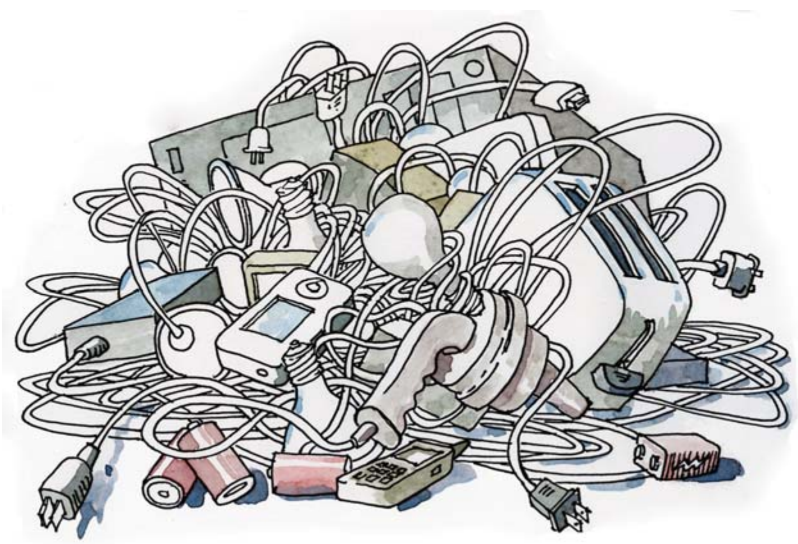
8) Students should look at their list and look for ways they can reduce their energy use, e.g. by using more efficient appliances or light bulbs or by reducing the number of hours they use an item. Additional work could include calculating energy savings and resulting emissions savings.

Going Beyond

1) Have students review and complete the Wisconsin DNR's Green and Healthy Schools assessment on Energy in the School.

2) Have students combine the two parts of this activiy by investigating a source of power, the energy plant's emissions, and how many emissions their own use contributes.

3) Students can track and graph their energy use over the school year. Prizes or recognitions can be given for those using the least energy or for "most improved."



causes of climate change

activity Part A – **Power in Wisconsin**

POWER TO THE PEOPLE

NAMES ____

____________________ TEACHER ____________________

1) What is the name of the power plant you are researching?

____

____

2) Where is the power plant located in Wisconsin? List town/city and two nearby towns/cities.

____

____

____

3) What kind of energy source does your power plant use? (coal, water, nuclear, renewable, etc.) Where is the source of the power plant's fuel?

____

____

____

4) What types of emissions come from this power plant and how do they affect climate change?

____

____

____

5) Does the power company offer renewable energy? If yes, what types?

____

____

6) What three energy-saving actions are you most likely to take?

____

____

____

____

worksheet

Part B – Energy Use in Our Daily Lives

NAME ____________________ CLASS ____________________

TEACHER ____________________ DATE ____________________

ENERGY USE LOG						
Appliance or Item	Power in kilowatts (kW)[1]	Hours item used each day (hr)	Daily energy use[2] (kW-hr)	Annual energy use (kW-hr/yr)[3]	Annual energy cost ($/yr)[4]	Ideas for how to reduce energy use from this item

[1] Power conversion formulas: watts ÷ 1000 = kilowatts; horsepower (hp) x 0.746 kW/hp = kilowatts; amps x volts ÷ 1000 = kilowatts
[2] Daily energy use formula: Power (kW) x Hours used per day = Daily energy use (kW-hr/day)
[3] Energy use/year formula: Daily energy use (kW-hr/day) x 365 days/yr = Annual energy use (kW-hr/yr)
[4] Energy cost per year formula: Annual energy use (kW-hr/yr) x Energy cost from bill ($/kW-hr) = Annual energy cost ($/yr)

How Green Are You?

learning objectives

Students will:

- *Understand how their personal choices can affect climate change.*
- *Make choices to reduce the amount of resources they consume over time.*
- *Educate others on ways to reduce their impact on climate change.*

subjects

Environmental Education

WISCONSIN MODEL ACADEMIC STANDARDS

ENVIRONMENTAL EDUCATION
B.8.15, C.8.3, D.8.1, D.8.3, D.8.5, D.12.2

materials

- ☐ How Green Are You? Worksheet

Background

An ecological footprint is a tool to measure how much land and water a human population requires to produce the resources it consumes and to absorb its wastes. By measuring the ecological footprint of a population (an individual, a city, a nation, or all of humanity) we can find out how we're impacting the planet. Measuring ecological footprints gives people information to help them take personal and collective action to live within the means of our planet. This activity flips the traditional notion of an ecological footprint on its side: it eliminates the negative connotation of how many resources we use and replaces it with positive reinforcement for the "green" actions we take.

Each day we make choices. Most days we make at least 10 choices before we eat breakfast. Those choices have an effect on our environment, positive or negative. We each have the responsibility to look at the choices we make and decide if they are the right ones for us and whether there is room for improvement.

activity

HOW GREEN ARE YOU?

Ecological Footprint

Students will complete the worksheet and discuss how their daily actions affect the planet.

Procedure

1) Have your students list the choices they made this morning before school. List them on the chalk board. Ask them to think about whether their choices may have impacted climate change. Here are some examples:

- Did they have the TV and the radio on at the same time this morning?

- Did they run the water while they were brushing their teeth or did they turn the faucet on only when they needed it?
- Did they leave the house with the lights still on in their room?
- Did they carpool or take the bus to school, or did they drive by themselves in a car?
- Did they pack a lunch with locally grown foods, which require less transportation?

2) Discuss with students how we all have the responsibility to make good decisions. Ask students to decide how they might have made better choices this morning for the planet. How could changing their choices affect climate change?

3) Remind students that life is all about choices. The choices they make affect the planet in a number of different ways.

4) Have students fill out the worksheet.

5) Discuss students' answers on the worksheet. Remind students that there are no right or wrong answers. Where do they think they could improve? Where do they think they are doing well?

Discussion Questions

1) What new habits can the students put into their daily routine to become more Earth-friendly? Do they think these would be hard changes to make?

2) Discuss ways of going "overboard" and expecting too much of yourself versus taking small steps to improvement. For example, stopping driving all together might be too difficult but perhaps you could cut out two unnecessary trips per week. Or rather than proposing to eliminate all fossil-fueled forms of transportation, decide to car-pool to school, ride your bike, or take public transportation when available.

3) Encourage students to come up with new questions to add to the worksheet. Remind students that when something seems too difficult to achieve, many people will be turned off and refuse to even try so they should pick tasks that will make a difference in the environment but not be unobtainable.

Going Beyond

Help raise awareness at home! Ask students to take the worksheet home and have their parents or siblings fill it out. What differences or similarities were among their answers?

causes of climate change

activity Ecological Footprint

HOW GREEN ARE YOU?

NAME ______________________ CLASS ______________________

TEACHER ______________________ DATE ______________________

Complete this worksheet by answering all of the questions and awarding yourself points. "Yes" answers receive all of the points listed, "sometimes/maybe" answers receive half of the points, and "no" answers receive zero points.

HOME SCORE ______________

1) *Do you turn off the TV and computer when you are done with them (4)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

2) *Do you turn lights off when leaving a room? (4)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

3) *Do you reheat leftovers in the microwave instead of the oven? (8)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

4) *Do you choose to open the windows on a nice day instead of turning on the air conditioner? (10)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

RECYCLING SCORE ______________

5) *Do you recycle all paper, glass, and plastic at home? (20)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

6) *Do you recycle when at school? (10)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

7) *If there is no recycling bin available when you are away from home, do you hold onto your trash until there is a bin available (i.e. bring your soda bottles and paper home to recycle)? (20)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

8) *Do you use both sides of a piece of paper before tossing it into the recycling bin? (4)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

TRANSPORTATION SCORE ______________

9) *Do you carpool, take the bus, walk, or bike to school? (6)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

10) *Do you trip-chain? (e.g. combine trips by going to the store on your way home from school instead of going home and then back to the store and then home again.) (10)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

11) *Do you turn your ignition off when you are parked or stopped for more than thirty seconds? (10)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

12) *If you are going to a friend's house just a mile or two away, do you leave the car at home and bike or walk there? (10)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

13) *Do you reduce driving on Air Quality Watch days? (12)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

ENERGY SCORE ______________

14) *Do you have compact fluorescent light bulbs installed in your home? (one point for each light bulb)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

15) *Do you use rechargeable batteries and/or recycle your batteries after use? (6)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

16) *Do you unplug your cell phone and I-pod chargers after they are done charging to reduce "phantom energy" loss? (4)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

17) *Do you turn the thermostat down in the winter and wear a sweater, and up in the summer and wear shorts? (6)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

worksheet

Ecological Footprint *(continued)*

WATER SCORE ____________

18) *Do you turn the water off while brushing your teeth? (6)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

19) *Are your showers less than 5 minutes? (10)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

20) *Do you wait to wash your favorite pair of jeans or other items until there is a full load of wash to be done? (4)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

21) *When able, do you choose organic foods? (20)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

22) *Do you use a reusable lunch bag and containers to carry food with you instead of disposable? (12)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

23) *When possible, do you buy locally-grown food instead of food shipped from elsewhere? (20)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

REDUCE & REUSE SCORE ____________

24) *Do you say "no thank you" to bags for items you buy at a store where you purchase only one or two things and can carry them without a bag? (16)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

25) *Do you carry reusable bags into the grocery store with you instead of taking new paper or plastic bags? (10)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

26) *Do you use refillable water bottles instead of one-time use plastic bottles? (4)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

27) *Do you check out books from the library instead of purchasing new ones? (4)*

☐ YES ☐ SOMETIMES/MAYBE ☐ NO

ADDITIONAL STEPS SCORE ____________

List up to four other environment-friendly steps you take (points indicated for each measure).

28) ________________________________

________________________________*(4)*

29) ________________________________

________________________________*(6)*

30) ________________________________

________________________________*(8)*

31) ________________________________

________________________________*(10)*

How Green Are You?

Count up your points in each category and then total them to find out which category you fit into.

HOME	________
RECYCLING	________
TRANSPORTATION	________
ENERGY	________
WATER	________
REDUCE & REUSE	________
ADDITIONAL STEPS	________
GRAND TOTAL	________

Keep up the good things you are doing to fight global climate change, and try some new tips too. Remember, no one can do it all, but you can choose to step lightly on Earth by picking sustainable ways of life and sticking to them.

0–50 You are a Green Newbie
Jump on in and learn more about the environment and what you can do to help fight climate change! Try some of the tips on this worksheet to become greener.

51–125 Greenie-In-Training
You have really put an effort into becoming green, but there is SO much more to do! Keep going strong!

126–200 *As a* **Green Machine,** *you really know what you're doing when it comes to protecting the planet! Keep up the good work.*

200+ You are the Green Guru! *You are treading very lightly on Earth! Way to go! Try teaching others about protecting the environment without pressuring them.*

3

Ecosystem Impacts of Climate Change in Wisconsin

Look at the methods of phenological ecosystem observation, why climate change matters in Wisconsin, and how it might change the Earth.

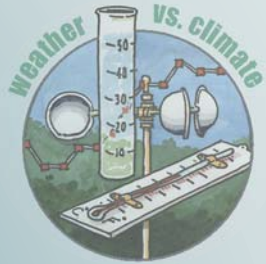
This activity introduces observation as a method for measuring how climate can affect species.

e ee s

This activity encourages thinking about ecosystem relationships and the impacts of climate change.

ee s ss

a art–design
ee environmental education
ss social studies
s science
m math
e english–language arts



3

Ecosystem Phenology

learning objectives

Students will:

- *Understand the methods of phenological data collection.*
- *Interpret and apply phenological data to make hypotheses about climate change in Wisconsin.*
- *Use a database to record phenological data.*

subjects

English–Language Arts
Environmental Education
Science

WISCONSIN MODEL ACADEMIC STANDARDS

ENGLISH–LANGUAGE ARTS
C.8.3, E.8.1, F.8.1, F.12.1

ENVIRONMENTAL EDUCATION
A.8.1, A.8.2, A.8.4, A.8.5, A.12.1

SCIENCE
A.12.1, C.8.2, C.8.3, C.8.8, C.12.1, E.8.3, E.8.5, F.12.8

"If you want an adventure, take the same walk that you took yesterday, and do so again tomorrow."

– John Burroughs

materials

- ☐ Writing journals
- ☐ Worksheet included in this activity

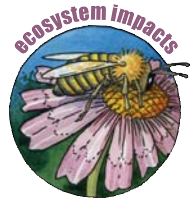
Background

Phenology is the branch of ecology that explores the seasonal timing of life cycle events. It often crosses multiple scientific disciplines by relating biological processes to weather conditions. Phenology includes the study of many events such as the migration of birds, the blooming of flowers and woody plants, animal reproduction, and the emergence of insects and other critters.

Just as there are regional differences in temperatures and other weather patterns, there are regional differences in biological events. Factors such as latitude, longitude, topography and the buffering of temperature changes by large bodies of water such as the Great Lakes contribute to these regional differences.

Because many biological events are triggered by or timed to climatic conditions, phenological observations of plants and animals can be an indicator of climate changes. They can also foretell the ecosystem impacts and disruptions caused by climate changes.

Phenology researchers record the timing of various biological events from year to year in a specific geographical location. If such observations are recorded over many years, using comparable techniques, the phenological data can paint a picture of the climatic conditions in that place over those years. Aldo Leopold, a notable Wisconsin ecologist and environmental writer, recorded years of phenology data. His observations supported his land ethic, harmony between



humans and ecosystems, a belief that made him one of the first stewards of conservation in the United States.

In order to effectively understand changes in the climate using phenology, day-to-day observations of animals, plants, weather, or other natural phenomenon are necessary over many years.

activity

ECOSYSTEM PHENOLOGY

Ecosystem Journal

Students make simple observations and create a journal so they can explore the links between the weather and the timing of events in the natural world.

Procedure

1) Begin the class by brainstorming what students think would be an easy way to observe and record climate change. Ask students, "Do you need expensive scientific equipment or an ecosystem biologist to help to record climate change?" Discuss with students how they can easily observe climate change from their own backyards by simply using their observational skills.

2) Have students discuss the concept of phenology. How is it defined and how is it recorded? Discuss some cyclical events that occur in the natural world. If any students have lived or visited elsewhere, you can discuss regional differences, e.g. between northern and southern Wisconsin, closer or further from one of the Great Lakes, in different parts of the country, etc.

3) Have students start and keep a journal to record phenologic events in their own neighborhood or outside their school. Let them choose which events they would like to record (examples include: date in autumn when leaves on a specific tree start to turn color, the first observation of a robin in spring, flowering of a species of plant, ripening of strawberries in the garden, the first sound of spring peepers).

4) Discuss in detail how exactly the observations will be made so subsequent classes can record data in a similar way. Discuss the importance of agreeing on specific procedures for observing and recording events if data are to be compared from year to year.

5) Have the students use the *Ecosystem Phenology Worksheet* to record their phenological data events. Students may then use a spreadsheet program (e.g. *Excel*) to enter the data.

6) Discuss the concept of creating a long-term school journal that can be used from year to year—like a biological time capsule. With students, develop a phenological list to use for each season of plant and animal behaviors and events. Have the class set up a system for having their journals carried on in the future. How many years will it be before today's kindergarteners would be entering their observations?

Discussion Questions

1) How do you think phenological data will help us further understand climate change in Wisconsin?

2) What might be some ecosystem and species-survival challenges if some parts of an ecosystem change the timing of their biological events, but others do not? *Hint, think about an insect that emerges on the same date every spring and pollinates a particular type of blooming plant. What happens if the plant blooms earlier, but the insect doesn't change the date it emerges?*

3) If students create a journal in which each subsequent class will record data, how many years of data do they think will be needed to judge whether there is a pattern of change? How would they know what may have contributed to any changes?

Going Beyond

1) Have students develop a Phenology Calendar focused on natural events in the schoolyard. Some annual events might include sounds of the first robin, first maple tree budding or showing color in the fall, first emergence of worms on the school grounds, etc.

2) Have students interview a family member, neighbor, or friend who could have observed natural events 40-60 years ago. Do they remember natural events happening later or earlier than they do now? Do they believe the climate is changing based on their own observations of the natural world?

3) There is a national phenology network about plants called *Project BudBurst.* The network asks citizens to contribute to their database. More classroom phenology activities for students of all ages can be found on their website.

Student Journal

NAME ______________________________ CLASS ______________________________

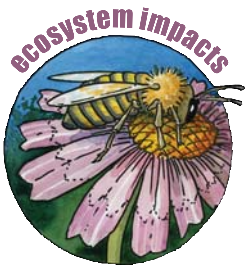
TEACHER ______________________________ DATE ______________________________

SPECIES	
DATE	*WEATHER*
BEHAVIOR/ACTIVITY OBSERVED	
OTHER OBSERVATIONS	

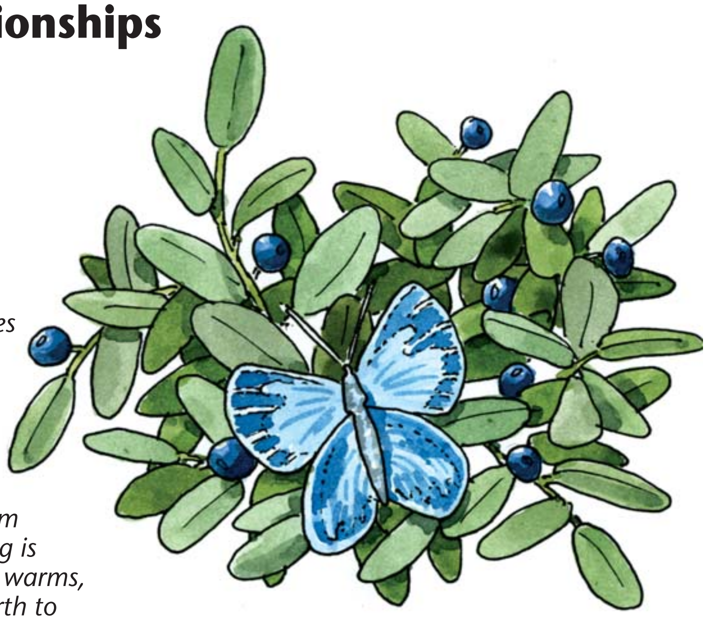
SPECIES	
DATE	*WEATHER*
BEHAVIOR/ACTIVITY OBSERVED	
OTHER OBSERVATIONS	

SPECIES	
DATE	*WEATHER*
BEHAVIOR/ACTIVITY OBSERVED	
OTHER OBSERVATIONS	

SPECIES	
DATE	*WEATHER*
BEHAVIOR/ACTIVITY OBSERVED	
OTHER OBSERVATIONS	



Ecosystem Relationships



learning objectives

Students will:

- *Understand that the living and non-living components of an ecosystem intricately rely on each other.*
- *Understand how global warming will result in changes to Wisconsin's climate and weather patterns.*
- *Predict the effects of climate changes on an ecosystem and species.*
- *Understand that an ecosystem responding to global warming is more complex than "when it warms, plants and animals move north to adjust to changing conditions."*

subjects

Environmental Education
Science
Social Studies

WISCONSIN MODEL ACADEMIC STANDARDS

ENVIRONMENTAL EDUCATION
A.8.2, A.8.5, A.8.6, B.8.5, B.12.3, B.12.6, C.8.2

SCIENCE
A.12.1, C.8.2, E.8.1, E.8.3, F.8.8, F.8.9, F.12.8

SOCIAL STUDIES
A.8.11

materials

- ☐ Blank paper
- ☐ Worksheet included in this activity
- ☐ Thermometer

Optional:

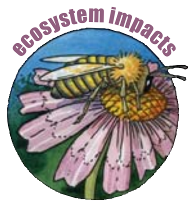
- ☐ Sling psychrometer
- ☐ Trowel
- ☐ Species identification guides
- ☐ pH kit
- ☐ Secchi disks
- ☐ Measuring tape
- ☐ Soil nutrient test kit
- ☐ Soil survey map
- ☐ Internet

Background

Trying to predict specific long-term climate change impacts on ecosystems, places where biotic (living) organisms interact with abiotic (non-living) factors of the environment, remains difficult. However, the sensitivity of various ecosystems can be predicted from studying the existing impacts of change on specific organisms.

Every organism needs certain conditions to thrive. For example, abiotic variables that are important for determining where individual terrestrial plant species survive include pH; soil texture; soil moisture; soil depth; nutrient availability; air temperature; humidity; precipitation; sunlight; space; landscape features; and disturbances like wind, fire, and flooding. Important biotic variables include competitors for resources, herbivores, pollinators, seed dispersers, and fungal associates. Species with small and isolated ranges and quite specific biotic or abiotic needs are often the most susceptible to decline, disappearing locally or extirpation, and even extinction when faced with land use changes or other stresses.

Knowing this, we can postulate that ecosystems with small or narrow ranges and/or those dependent on unique, fixed geologic features may be most susceptible to impacts from global warming. As temperatures and precipitation patterns change, such ecosystems may be ill equipped to persist in some of their former locations or unable to "move." Warmer temperatures may shift further north, but the plants that grow in them may not be adapted to the different bedrock and soil features of northern Wisconsin. Furthermore, other community members necessary for the survival of the plants may not shift to the same location. Some plants have evolved to require specific animals to pollinate them or disperse their seed. On the flip side, some animals require certain plants for food or cover. The loss of one of these species may result in the direct loss of the other. For example, larvae, or caterpillars, of the northern blue butterfly *(Plebejus idas nobokovi)* eat only dwarf bilberry *(Vaccinium caespitosum)*. These endangered species coexist as rare inhabitants of openings on sandy soils in Wisconsin.



activity

ECOSYSTEM RELATIONSHIPS

Part A – Ecosystem Diagrams

Students will reflect on a particular ecosystem and hypothesize what might happen as climate change influences it.

If environmental conditions change and certain locations become unsuitable for dwarf bilberry, the northern blue butterfly will also disappear from those sites.

Climate change will likely affect the balance between biotic and abiotic relationships in some of Wisconsin's ecosystems. Depending on how each variable responds, ecosystems may shift locations but some special habitats and species may be lost.

Note: As the specific climate changes and impacts remain sketchy, especially at a local level, this activity is not about teaching students exactly what will happen to Wisconsin's ecosystems. The purpose of this activity is for students to understand the complexities and interconnectedness of ecosystems and then to think critically about what might happen to plants, animals, and ecosystems with changing climate. The students reasoning and discussion is the focus not specific conclusions.

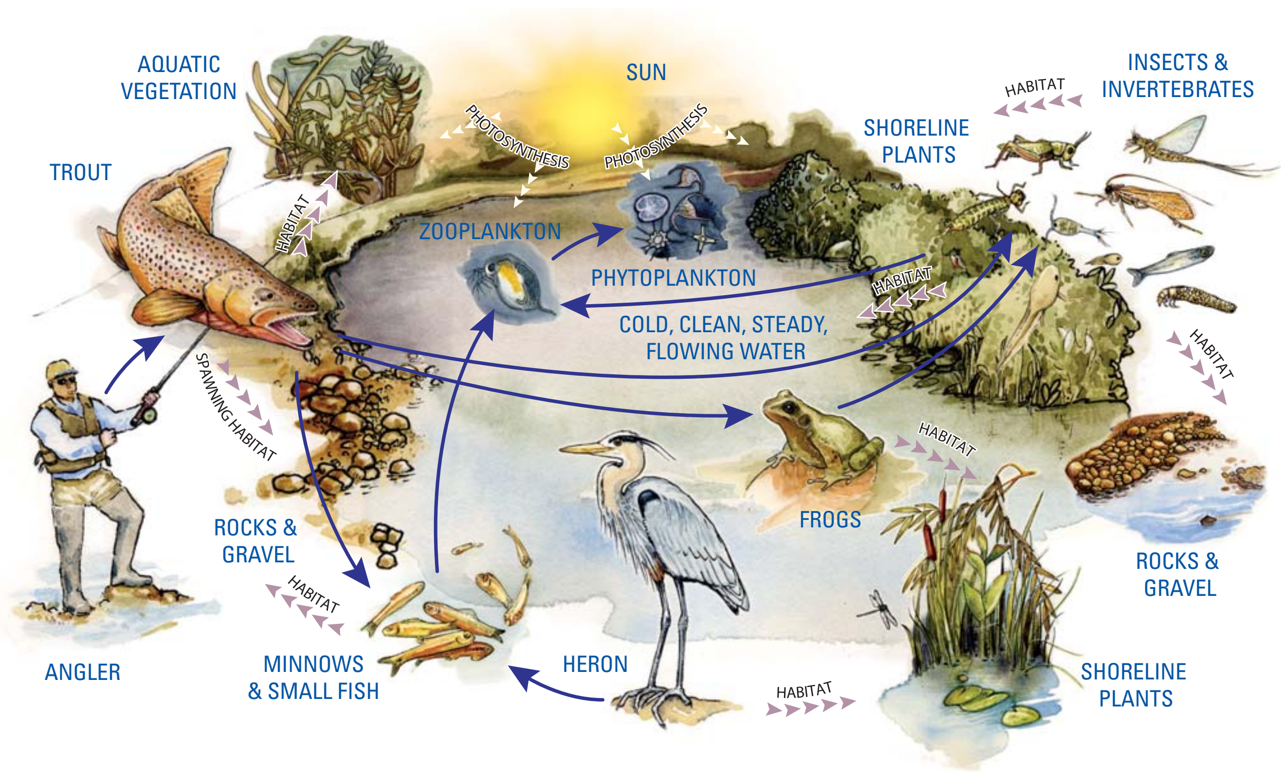
Procedure

1) Ecological communities develop because groups of organisms require similar environmental conditions. Key characteristics allow plants and animals to live in a certain habitat. Have students make a list of the factors that affect which organisms survive and where. Possible answers are listed in the second paragraph of this activity's background.

2) Choose a habitat type such as a prairie, coniferous forest, wetland, or lake. Have students diagram the main abiotic and biotic components of the ecosystem and draw connections between directly related parts (e.g. decomposers feed plants, plants use precipitation and sunlight, etc.).

3

Sample Ecosystem Diagram — Coldwater Stream



3) Ask students what they know about climate change. Why is it happening? How will the global climate be affected? What changes are predicted for Wisconsin? Have students research some predictions scientists are making for changes to Wisconsin's climate and weather patterns.

4) Based on the students' knowledge of climate change, how do they think it will affect the abiotic and biotic components of the ecosystem? What types of chain reaction effects might occur (e.g. changes in rain and evaporation rates decreasing soil moisture leading to less plant growth leading to less food for herbivores and carnivores)? Refer back to your ecosystem diagram.

activity

ECOSYSTEM RELATIONSHIPS

Part B – Measuring Ecosystems

Students will measure variables in a specific ecosystem and hypothesize what might happen as climate change influences it. We suggest conducting Part B the day after doing Part A. You may need two days to complete Part B—using the first class period for steps 1 to 3.

Procedure

1) Choose a natural area of the habitat type discussed in *Part A*. Based on equipment availability, the students' skill and knowledge, and the amount of time available, decide the desirable level of detail for characterizing this ecosystem. Possible variables will depend on the study area but may include:

- amount and pH of precipitation *(from actual measurements or weather records)*
- air temperature and humidity *(from actual measurements or weather records)*
- soil texture, moisture, depth, nutrients, temperature, and/or type *(refer to soil survey map)*
- adjacent land use and land cover *(e.g. residential area with impervious surface and lawns or agricultural fields)*
- abundance, number, or identification of herbivores, carnivores, or insects above and/or below ground or in the water *(for aquatic systems)*
- abundance, number, or identification of forbs, grass-like plants, shrubs, trees, animals, and fungi *(for terrestrial systems)*
- water temperature, clarity, depth, width, pH, flow; stream water and sediment inputs; and the abundance, number, or identification of aquatic plants *(for an aquatic system)*

Some variables may be better determined in the classroom but most require field work.

2) Divide students into small groups and assign them each one or several ecosystem variables. If your students do not already know how to use the equipment you are assigning them, you may want to teach the class as a whole about each piece of equipment in the classroom or field prior to letting them work independently.

Alternative: With younger or more inexperienced students, or very technical equipment, you may decide to keep the class together and do more of a demonstration in the field rather than the small group activity.

3) Ask students to complete the *Measuring Ecosystems Worksheet.* Students should record as many observations as they can about the variables they are studying and take measurements if equipment is available (i.e. use a sling psychrometer to measure relative humidity, a thermometer to measure temperature, a tree guide to determine species present, etc.).

4) Based on the students' knowledge of climate change gained during the *Part A* classroom discussion, how do they think climate change will affect the study variables? For example, will soil moisture be higher or lower or more variable? Will the amount or composition of prairie plants change? Will water clarity be better or worse or more variable? Ask students to do internet research to help with their predictions as homework or if time allows.

5) Back in the classroom using the *Part A* ecosystem diagram, have students present their observations and predictions about their variables to the class and indicate them on the ecosystem diagram (e.g. draw more rain if precipitation levels are expected to increase, cross off pine trees if they are expected to decline). After everyone has presented, discuss how predicted changes

in one variable (e.g. soil moisture) will affect other variables (e.g. decomposition) and indicate potential increases or decreases in related factors on the ecosystem diagram. Remind students that local species have evolved over thousands of years to be well suited to our climate and other members of the ecological community. If your students studied particular species, ask them to consider relationships between the species. By the time you finish with the diagram, it will likely be very complicated and difficult to understand, just like ecosystems being impacted by climate change.

6) Ask students—as climate change affects this ecosystem, how will the overall landscape look different? (e.g. If the climate warms, will all of the species head north? Why? What barriers might inhibit species migration—soil type, presence or absence of surface water, impervious surface, roads, etc.)? Discuss ways Wisconsin ecosystems and natural resources may change in the future due to climate change. Is it possible for a plant or animal to become more plentiful? If so, which ones would students predict to become more plentiful? or less plentiful? Impress on students that these predictions are hypotheses, which is ok, because it is difficult to know for certain the exact effect climate change will have on Wisconsin. The critical concept is for students to be aware of and understand that climate change will affect where they live too!

activity

ECOSYSTEM RELATIONSHIPS

Part C – **Unique Ecosystems**

Students look for unique areas in Wisconsin and predict how climate change may impact them. Part C should be preceded by Part B or an in-depth lesson on ecosystem ecology so that students understand the types of variables they should consider.

Procedure

1) Provide students with resources to investigate specific Wisconsin natural features. The *Wisconsin Land Legacy Report* published by the Department of Natural Resources is an excellent resource for this.

2) Have students, individually or in groups, pick a specific place to research. You may want to encourage them to pick nearby areas and even to visit the sites, if possible.

3) Have the students postulate if and how climate change may impact that special place and explain why they think those changes may occur.

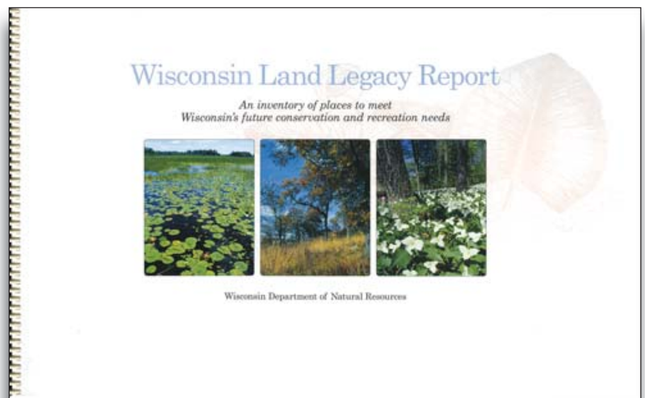
4) Students should either write a report or make a presentation on their investigations.

Going Beyond

1) Have the students focus on a particular species of animal or plant, perhaps one that is endangered in the state. How might this organism's population change with the change of Wisconsin's climate?

2) Explain to students that the vegetation types in northern and southern Wisconsin vary greatly. Northern Wisconsin is dominated by coniferous forest while southern Wisconsin is a mix of deciduous forest and prairies. Where these vegetation types mesh, near the middle of the state, there is a unique combination of species. Ask students why they think these vegetation types are located in different parts of the state and how climate change might affect them.

3) Have students develop a long-term research project to observe and record changes in the local ecosystem. Ask them to develop some hypotheses that project what they think might happen over a longer period of time.



*To request a free copy of the **Wisconsin Land Legacy Report,** email the Wisconsin Department of Natural Resources: DNRAirEducation@wisconsin.gov. Also, refer to the Alphabetical Listing of Wisconsin State Natural Areas (see e-Appendix for link).*

ecosystem impacts

activity Part B – **Measuring Ecosystems**

ECOSYSTEM PHENOLOGY

NAMES ____

______________________ TEACHER ______________________

1) What is the definition of ecosystem?

____

____

2) List the variable(s) you have been assigned and the data you collected.

____

____

____

3) How do you think the variable(s) might change 100 years from now? How might climate change play a role?

____

____

____

4) How will climate changes and shifts in your variable(s) affect other components of the ecosystem?

____

____

____

5) How will this location change? Do you expect that similar local locations will change in the same way? Will the same ecosystem even exist here? If not, what might replace it? How could these changes affect local citizens' jobs or hobbies?

____

____

____

6) How will the changes you described in question 5 affect you personally? How might your life or lifestyle or activities change?

____

____

____

worksheet

4

Social & Cultural Perspectives on Climate Change

Explore various perspectives on climate change and the potential impacts on people and society.

a art–design
ee environmental education
ss social studies
s science
m math
e english–language arts

This activity compares media coverage of climate change from a variety of sources.

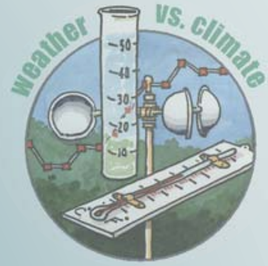
e ee ss

Look for articles, ads, and opinions on climate change and discuss findings

This activity is a role play in which students are community members who have a dialogue about how climate change will affect them.

e ee s ss

Represent a member of the Wisconsin community in a dialogue about the complex social, ecological, and economic implications of climate change.



4

Climate Change in the News

learning objectives

Students will:

- *Read, review and critique the way newspapers report on climate change.*
- *Describe how different locations and regions view the issues and effects of global climate change.*

subjects

English–Language Arts
Environmental Education
Social Studies

WISCONSIN MODEL ACADEMIC STANDARDS

ENGLISH–LANGUAGE ARTS
A.8.4, A.12.3, A.12.4, E.8.2, E.12.2

ENVIRONMENTAL EDUCATION
C.8.4

SOCIAL STUDIES
E.8.3, E.8.8, E.12.6

materials

- ☐ Newspapers from around the state, country, or globe
- ☐ *News Analysis Worksheets* provided in this activity

Background

Depending on where you live, the local media can have a profound effect on what and how information gets reported to you. Small town weekly papers tend to focus on issues closer to home while papers with larger circulations focus on local as well as state, national, and international issues.

Climate change can be a large and complex issue to cover. Climate change affects all of us and is an important issue that may be reported on differently according to the circulation size of the newspaper and the target audience.

activity

CLIMATE CHANGE IN THE NEWS

News Analysis

Students will look through magazines and newspapers from different areas for articles, advertisements, and opinions on climate change for discussion.

Procedure

1) Collect an assortment of newspapers from different regions of Wisconsin, the United States, and the world. Many larger newspapers can now be found on the Web. Divide students into groups. Assign each group a different news publication. Have each group search for articles, opinions, and advertisements directly or indirectly related to climate change. Students should read the items found and write down specifics and key points to be shared later (use attached *News Analysis Worksheet*).

2) Students should also get a sense of the relative amount of coverage of climate change in each publication by counting the number of articles mentioning climate change and comparing it to the total number of articles.

3) Once everyone has finished their review, ask each group to share their findings and discuss whether there were differences among the publications. Follow the discussion questions below.

Discussion Questions

1) What, if any, were the differences between the urban and rural papers?

2) What, if any, were the differences between papers from various regions of the US? Discuss how they were different.

3) What differences were noticed between publications from the US and foreign newspapers?

4) What types of advertisements were found in each newspaper? How many focused on eco-friendly products?

5) Does the paper have an editorial slant (e.g. conservative vs. liberal, business-focused, etc.)? How do you know? If there is a slant, how might it affect the coverage? Does the paper have an editorial position related to climate change and, if so, what is it? How do you know?

6) How many editorials were in the paper on climate change issues? Were they positive or negative? In what ways?

Going Beyond

1) Have students look up news articles from 10, 15 or 20 years ago. How many articles on climate change were found in the older newspapers? What information was the same? What information was different?

2) Discuss how to research articles online. What are some good methods to use for online news article searches? How do you know that what you are reading is from a credible source? How much easier or harder is it to find good information online?

3) For breaking news on climate change go to the website of the Newseum (see *e-Appendix* for link) and click on Today's Front Pages to view the front page covers of newspapers from all over the world. Compare.

4) Use this activity as a model and apply it to other news and communication media: magazines/periodicals, radio news, network TV coverage, cable TV coverage, podcasts, radio, TV talk shows, e-zines, blogs, etc. Have each group watch a different news channel for a week or compare across media (e.g. radio vs. TV vs. newspaper vs. news magazine) and then discuss the difference the medium makes in conveying messages.

5) Try incorporating newspapers or other media that target a specific segment of the population and then compare. How does the news differ between ethnic groups (e.g. a Hmong radio station in Milwaukee vs. a Hispanic newspaper) or different "user" groups (e.g. *Outdoor News* vs. business newspapers like the *Wall Street Journal*)?

activity News Analysis

CLIMATE CHANGE IN THE NEWS

NAMES ____

____

____

TEACHER/CLASS ______________________________ DATE______________

PUBLICATION NAME____

CIRCULATION ☐ URBAN ☐ RURAL ☐ REGIONAL ☐ NATIONAL ☐ GLOBAL ☐ OTHER (DESCRIBE)

____

TOTAL NUMBER OF ARTICLES ____

NUMBER OR ARTICLES RELATED TO CLIMATE CHANGE______________________________

ARTICLE TITLE	***DATE***
	PAGE NO.
SYNOPSIS	

ARTICLE TITLE	***DATE***
	PAGE NO.
SYNOPSIS	

ARTICLE TITLE	***DATE***
	PAGE NO.
SYNOPSIS	

worksheet

NAMES ____

____

____

TEACHER/CLASS ______________________________ DATE______________

PUBLICATION NAME ______________________________

CIRCULATION ☐ URBAN ☐ RURAL ☐ REGIONAL ☐ NATIONAL ☐ GLOBAL ☐ OTHER (DESCRIBE)

____

TOTAL NUMBER OF ADVERTISEMENTS ______________________________

NUMBER OF ADVERTISEMENTS RELATED TO CLIMATE CHANGE ______________________________

ADVERTISEMENT/SUBJECT	*DATE*
	PAGE NO.

ADVERTISEMENT/SUBJECT	*DATE*
	PAGE NO.

ADVERTISEMENT/SUBJECT	*DATE*
	PAGE NO.

ADVERTISEMENT/SUBJECT	*DATE*
	PAGE NO.

ADVERTISEMENT/SUBJECT	*DATE*
	PAGE NO.

Community Conversation

learning objectives

Students will:

- *List potential social, economic, and ecological impacts of climate change in Wisconsin.*
- *Understand and describe how climate change may affect people differently and list some of the various concerns.*
- *Recognize complex topics like climate change have many perspectives and no one solution.*
- *Describe difference between debate and dialogue and why one might choose each.*
- *Practice active listening skills.*
- *Use internet research skills.*

subjects

English–Language Arts
Environmental Education
Science
Social Studies

WISCONSIN MODEL ACADEMIC STANDARDS

ENGLISH–LANGUAGE ARTS
C.8.1, C.8.2, C.8.3, C.12.2, C.12.3

ENVIRONMENTAL EDUCATION
B.8.15, B.8.16, B.8.17, B.12.11, C.8.3, D.8.1, D.8.7, D.12.6, E.8.2, E.12.1

SCIENCE
A.12.2, A.12.5, H.12.1, H.12.4, H.12.5, H.12.7

SOCIAL STUDIES
B.12.9, E.12.9

materials

- ☐ Chairs and small center table

Support materials that are included in this activity:

- ☐ *Community Profiles/Roles*
- ☐ *Dialogue Prep Handout*
- ☐ *Revolving Conversation Guidelines*
- ☐ *Before-the-Conversation Worksheet*
- ☐ *After-the-Conversation Worksheet*

Background

Real-world problems like global climate change are complex. They are as much about society, economics, and culture as they are about science. They tug at people's values and demand changes in how we live. They affect people's livelihoods, hobbies, lifestyles, and health.

These issues are like the folded landscapes of gorges and ravines, with many twists and turns, no straight paths, and the inability to see all points of view from any one spot.

There are many views about climate change and its impacts and no one single action or clear path to take.

When complex problems face society, many types of discussions occur. The more controversial the topic, the more likely the discussion seems to take a debate-like form, with lots of talking and little listening—or people only listening to others who think like they do. If we can change the nature of the discussion, we can learn and make better, more-informed decisions.

This activity provides some formats to increase listening, learning, and mutual discovery through dialogue and conversation. No one strategy, agreement, or solution may evolve, but everyone can be better informed on the scope of the issue. Students get the opportunity to see many of the nooks and crannies of climate change—a first step in figuring out what to do to address the issues.

activity

COMMUNITY CONVERSATION

Discovery Through Dialogue

The class or a group of people adopt roles in the state's community and then carry on a dialogue that encourages listening and learning from each other.

Procedure

Preparation

1) Copy, cut out, and distribute the *Community Member Profiles* to students.

List of people for community conversation:

- Cranberry farmer in Wood County in central Wisconsin
- President of large insurance company whose world headquarters are in Wisconsin
- Sugar maple farmer in southern Wisconsin
- Head of the Wisconsin division of a large paper manufacturing plant
- Aquaculturist
- Parent of two young children—an avid angler, hiker and cross-country skier
- Environmental activist
- Owner of a snowmobile sales and rental shop
- Snowboard instructor
- Head of the state Department of Tourism
- Commercial fisherman on Lake Michigan
- Lake biologist
- Head of an electric power plant
- Beekeeper
- Avid gardener
- Washington Islander
- SCUBA diver
- Baseball bat manufacturer
- Apostle Islands park ranger
- Air conditioner store owner
- Zookeeper
- American Lung Association volunteer
- Head of Wisconsin DNR
- Recycling business representative

2) Distribute the *Dialogue Prep Handout* on debate, dialogue, and active listening. Have a class discussion exploring the difference between debate and dialogue and how to listen actively.

3) ***Home Assignment:*** Students should conduct some research to better understand how climate change might affect the persona they have been assigned. What will this person care about? What will they want done? What will be their main concerns about climate change? Each profile has some hints about the character and where students can go to start their research.

For students not already familiar with web searching strategies like using quotation marks for exact phrases, plus or minus signs, etc., most internet search engines have a help feature that explains the conventions they use. This activity provides profiles of the community members including suggested searches for research. If students type into the search engine box everything between the < > marks just as it appears on the profiles, the search should be successful.

4) Hand out the *Before the Conversation Worksheet* and have them fill it out before the conversation begins.

5) Review the description of the revolving conversation/discussion format. Make copies of the *Revolving Conversation Guidelines* to hand out on the day of the conversation. (*Note:* handouts and instructions for two additional discussion formats—a small group world café and one-on-one interviews are available in the *e-Appendix*—should you prefer to use them.)

6) The day of the conversation, arrange the room or meeting space appropriately for the selected discussion format (check the description in the *Revolving Conversation Guidelines* handout).

Investigation . . . .

1) Before starting the conversation, remind students of what dialogue is and how this exercise will give them all a chance to practice dialogue and active listening. Let them know you expect them all to take part both in the talking and the listening. If you haven't already done so, hand out the *After-the-Conversation Worksheet.*

2) Provide students with the *Revolving Conversation Guidelines*. Give them time to read the handout. (*Note:* you can provide this ahead of time, but sometimes participants "over prepare," coming with prepared statements and pre-conceived notions. Then the conversation does not flow as well nor do the participants listen to each other as well.)

3) Before starting the discussion, remind students they are representing the views of the community member profile that was assigned to them, not their own views.

4) Have the participants start by sitting in chairs around, but *not at* the central table.

5) Serve as the convener and introduce the topic—explain the meeting format and rules. Make sure all understand the instructions. Then walk away and sit in one of the outer chairs and wait for the conversation to start when someone takes the first center chair. (*Hint:* ahead of time, you could ask or assign a couple students to take center chairs if, after a half minute or so, no one else has.)

6) When the allotted time is almost over, enter the conversation around the middle table and warn the participants the time is almost up. Encourage anyone who has not yet had a chance to share their perspective to do so before time is up.

7) When the time is up, enter the conversation around the table again. Thank everyone for participating and close the conversation.

Discussion Questions

1) Hold a class discussion about the conversation itself. Possible questions:

- Did you learn things about the effects of climate change you didn't know before the conversation? What are some examples?
- How did it feel to join the conversation and speak up? How did it feel to sit and listen?
- How was this conversation different than if we had held a debate between two perspectives (e.g. a scientist or environmentalist concerned about climate change and a person who doesn't agree that climate change is happening)? What might this dialogue conversation accomplish that a debate would not? What might a debate accomplish that this conversation did not?

2) Have students fill out the *After-the-Conversation Worksheet*. Collect the *Before-* and *After-the-Conversation Worksheets* to evaluate.

Going Beyond

1) Have a whole school or multi-class discussion.

2) Try using one of the other discussion formats, as found in the *e-Appendix*.

3) Take this activity into the community. Have students interview actual community members, report back to the class, and write a report or article about what they learned.

4) Host a large community conversation using one of the formats and welcoming community members to join a discussion about climate change and their community.

Dialogue, Debate & Careful Listening

Many times when people with differing opinions discuss topics they use debate. This often means each person is only interested in getting his or her point across and not in listening to the ideas of the other people in the conversation. Under this mode, little learning can or does happen. No one comes to understand each other. Rather, each tries to persuade the others, but because they are also more concerned with what they will say rather than really listening, there is not even much chance of persuasion.

There is another way. By engaging in dialogue and practicing good listening, everyone in a conversation can learn something from each other. Each can come to better understand the needs and ideas of others. And the group can develop a more informed and more satisfactory appreciation of the situation. If they are trying to make a decision, they will make a decision that meets more people's needs *(see table).*

Dialogue is rooted in respectful listening and thinking FIRST then respectful talking. In dialogue, the participants do NOT think about what they will say while they are listening. Rather they focus on what each other is saying and try to understand it. They ask follow-up questions to make sure they understand and to explore deeper rather than to point out flaws. In some Native American traditions, they use the idea of a "talking stick," which is some object that the person who is speaking holds. The talking stick reminds those not holding it to be listening carefully rather than either talking or thinking about what they will say.

Good dialogue depends on "active listening." There are three levels of listening, which we all use from time to time:

Background listening occurs when there is sound or conversation and you are aware of it, but your awareness fluctuates… the sound comes in and out of your awareness.

Passive listening occurs when information is being directed at you, but your interest fluctuates—your attention goes in and out of focus and you only hear parts of the information or conversation.

Active listening occurs when you sincerely want to hear and understand what is being said; you keep your focus on what is being said and try to thoroughly understand. Some approaches or characteristics of active listening include:

- Pause and be silent before you respond, take a few seconds AFTER a person has stopped talking to think about what you will say.
- Ask follow up questions… are you sure you know what the person meant or are you making assumptions? Ask questions like: "Can you tell me more about that?" "Help me to better understand why you feel that way?" "I'm not sure I understand what you are trying to accomplish, can you explain it to me?"
- Confirm what you heard. For example, if you aren't positive what the person was saying or meant, rephrase it and check if you have it correct: "I think I heard you say __________, did I get it right?"
- Recognize not just the words the person is saying but the emotion or feeling that might be going with it… you might even respond by showing your understanding of how something must feel: "Wow, that must be really scary" "I cannot imagine how difficult that must be" "Boy, that must make you feel really good" or, if you are unsure, consider asking "How did/does that make you feel?"

Active listening is VERY powerful. When you really actively listen to someone, it shows them respect. As you practice active listening in your every-day conversations, you may be amazed at how people respond to you. You will understand other people better and, as a side benefit, you may find they listen to you more too and come to trust and respect you more.

	DEBATE	DIALOGUE
PREMISE	There is one "right" or "best" answer or option	Listening together may increase mutual respect and reveal common ground
STYLE	Combative – attempt to prove the other side wrong	Collaborative – attempt to find common understanding
GOAL	Prove my point or disprove yours	Determine what, if anything, we will do next
LISTEN	To find flaws and search for weaknesses	To understand
RESULT	Win/lose	Mutual understanding and respect, may act, may continue exploring

activity Revolving Conversation Guidelines

COMMUNITY CONVERSATION

You will be having a special kind of community conversation about climate change that involves using a meeting technique called "revolving conversation."

The ***Revolving Conversation*** is designed to:

- Give participants an opportunity to hear about all the ideas and perspectives in the room, thereby enlarging their understanding of the issues.
- Give everyone in the room a chance to talk with others and have everyone hear what they have to say.
- Combine the conversation characteristics of a very few people talking with each other with the need for a larger number of people to be part of the conversation.

This meeting technique is not designed to make decisions. Instead it might be used first to get a better sense of what everyone thinks and all the perspectives BEFORE a group tries to decide what to do.

How it works

The room is set up with a small table in the center and four chairs (the "inner" chairs) around it. All the other chairs (the "outer" chairs) are placed in concentric circles (with room for aisles) around this central table and four chairs. There should be enough chairs for everyone who is expected to come to the conversation (can be dozens or even hundreds). If a large crowd is expected, a multi-directional mike should be taped down to the table in the middle.

At the beginning of the conversation, all the participants should be sitting in the outer chairs (any of those surrounding, but not at, the central table). A convener would start the conversation by coming to the center and describing the topic and purpose of the conversation, telling everyone the meeting rules, and then walking away from the center and joining the others in the outer chairs. After this point EVERYONE plays by the same rules during the conversation.

A potential description of the conversation topic about climate change might be:

"We're here today to talk about climate change—what you know, what you don't know or would like to know, how you might be impacted, what concerns you have, what you think should be done or what you will do."

The Meeting Rules

- Anyone can say anything they want. They can even clap or boo. BUT to do so they MUST be sitting at one of the four chairs at the table in the center of the room.
- Anyone can come to the center, take an empty chair and join the conversation. If no one else is at the table, it's a monologue. Otherwise it's a conversation among the 2-4 people at the table. Anyone can join the conversation as often or as frequently as they want.
- If you want to join the conversation but all four chairs are taken, come to the center and stand just to the side of the table. This will signal those at the table that each should evaluate whether or not he or she needs to stay at the table right then or whether to give up the seat to one of those waiting. More than one person can be waiting by standing to the side at any time.
- If you want to join the conversation to talk with a specific person already at the table and if all four of the chairs are full, you should stand directly behind the person with whom you want to talk. This will signal the other three that each should evaluate whether to give up his or her chair to you.

Everyone in the room, including those at the table, should practice active listening. This conversation should be a dialogue not a debate.

When the time is running out, the convener will once again come down and take an inner chair (waiting for one to open up if needed). The convener will warn when time is almost up and suggest that anyone who still has something they want to say should come down and join the conversation. The convener leaves the center to allow the last comments to be made. After an appropriate interval, the convener re-enters the center and closes the meeting by thanking the participants and reflecting briefly on the conversation that just occurred.

handout

activity Before the Conversation

COMMUNITY CONVERSATION

NAME ____________________ CLASS ____________________

TEACHER ____________________ DATE ____________________

Instructions: *Read the card that describes the person you will be playing during the conversation. Do some research to learn more about climate change and how this person may be affected by it. In class, you will be expected to participate in a conversation about climate change, but you'll be acting as if you are this person.*

Fill out the questions below BEFORE the Community Conversation. Read the questions on the ***AFTER the Conversation Worksheet*** *so you can think about them during the conversation, but do not answer them until the conversation is over.*

1) *Who from the community will you be playing?*

____

2) ***IMPACTS*** *How will climate change affect this person? Consider the person's business or livelihood, recreation and hobbies, expenses, transportation, etc.*

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3) ***CONCERNS*** *What will be some of the concerns this person has about climate change?*

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4) ***IDEAS FOR ACTION*** *Will this person have some ideas about what should be done? If so, what ideas will he/she have?*

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____

____

social perspectives

activity After the Conversation

COMMUNITY CONVERSATION

NAME ______________________________ CLASS ______________________

TEACHER ___________________________ DATE _______________________

Instructions

Review the questions on this page BEFORE you participate in the Community Conversation.

Continue to think about them as you participate—both by talking and by listening. Fill out this worksheet when the conversation is over. You will be handing in both parts of the worksheet.

1) Were you able to express your character's concerns and/or ideas? Did you feel listened to? Why or why not?

____

____

____

2) Other than the concerns you already identified for your character in the BEFORE part of the worksheet, what other concerns did you hear about from other people in the conversation? List at least three.

____

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3) Other than the ideas you had already identified for your character in the BEFORE part of the worksheet, what other ideas for action did you hear about from the other people in the conversation? List at least three.

____

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____

4) Is it obvious from the conversation what steps and actions should be taken to slow climate change? Was there agreement in the group?

____

____

How hard will it be to slow climate change? Why?

EASY		AVERAGE		EXTREMELY DIFFICULT
1	2	3	4	5

____

____

____

worksheet

Community Profiles *(page 1)*

Cranberry farmer

Cranberry farmer in Wood County in Central Wisconsin

Wisconsin is the country's top producer of cranberries.

Cranberries are grown in bogs, which are a type of wetland. You can start learning more about what is needed to grow cranberries from the Wisconsin State Cranberry Growers website.

Learn more from recent news articles about the impacts of climate change and weather on cranberries.

Try an internet search on: <cranberry + "climate change">. Along with other resources, look for a November 2007 story from the *Christian Science Monitor.*

A cranberry farmer will obviously worry about his/her cranberry crop. But a farmer will also have hobbies.

Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect that hobby?

Sugar maple farmer

Sugar maple farmer in Southern Wisconsin

Wisconsin is the nation's fourth largest producer of maple syrup, which is harvested in the spring from tapping sugar maple trees across the state.

Scientists believe changes in Earth's climate will affect the growing patterns of plants—what plant species can grow where, including the sugar maple. Plants all have specific requirements for growth—soil types, temperature ranges, and precipitation amounts.

Learn more about sugar maples and climate change by trying an internet search on: <"sugar maple" + "climate change">.

Along with other resources, look for a U.S. EPA download (www.epa.gov) on sugar maple habitat shifts, an October 2007 National Public Radio *Morning Edition* story, and a June 2007 report from USDA's National Agricultural Statistics Service.

A sugar maple farmer will obviously worry about whether his/her trees will continue to produce enough maple syrup. But a farmer will also have hobbies. Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect that hobby?

President of a large insurance company

President of large insurance company that has its world headquarters in Wisconsin

Wisconsin is the world headquarters for several large insurance companies. When big storms or other disasters hit, insurance companies pay the costs for their customers to rebuild or fix their buildings and houses.

One of the expected effects of climate change is more big storms and severe weather—hurricanes, floods, droughts, etc.

Learn more about insurance and climate change by trying an internet search on: <insurance + "climate change">. Along with other resources, look for an August 2007 *Scientific American* article, a January 2008 National Public Radio *All Things Considered* story, and an August 2006 KPFA radio story.

An insurance company executive is going to be thinking about insurance claims and opportunities from climate change. But he/she will also have hobbies. Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect that hobby?

Head of paper company

Head of the Wisconsin division of a large paper manufacturing company

Wisconsin is the nation's leading producer of wood pulp, used to make paper and paper products.

Concerns over climate change and the costs and sources of fossil fuels (gas, oil, coal) have led people to look for other sources of energy. One of these is "biofuels," fuels made from plant matter such as corn, switch grass, or wood pulp. Corn has been criticized as a source because, among other reasons, it takes so much energy to grow. But paper pulp has some potential, thus potentially creating a large new market for Wisconsin's paper pulp industry.

Producing paper and paper pulp requires trees. Paper companies own forested lands and lease the logging rights on other land to cut trees they need to make paper and stay in business. But scientists believe climate changes will affect the growing patterns of plants and trees. Plants all have specific requirements for growth—soil types, temperature ranges, amounts of precipitation.

Learn more about climate change, biofuels, and paper pulp by trying an internet search on: <"climate change" + pulp + forest + biofuel>. Along with other resources, look for an August 2007 University of Wisconsin news story on insects and climate change and a Swedish Forest Industries Federation report *Forests and the Climate.*

Fish farmer

Aquaculturist with trout pond

An aquaculturist is someone who raises fish for food, bait, stocking waterways, or fee fishing. In Wisconsin, aquaculture is a growing industry with an annual value of about $9 million per year, producing mostly trout, tilapia, bass, various baitfish, and small fish for stocking waterways.

Warmer water temperatures could mean longer growing seasons, thus increasing the rate at which fish grow. At the same time, some fish species are particularly sensitive to temperature extremes. Water temperature changes can affect fish growth and mortality. As temperature increases, dissolved oxygen in water tends to decrease and more sensitive species cannot get enough oxygen from the water to survive. Changing precipitation patterns—big storms and more droughts or floods—could also impact aquaculture operations. Large rains can cause ponds to overflow while drought can decrease the availability of fresh water.

Learn more by trying an internet search on: <"climate change" + aquaculture + "fresh water">.

A fish farmer will obviously worry about his/her fishery. But a farmer will also have hobbies. Pick an outdoor hobby for your character, maybe something you like to do. How might climate change affect that hobby?

Parent & outdoor enthusiast

Parent of two young children. Avid angler, hiker, and cross-country skier

Wisconsin is a great state for year-round outdoor recreation, offering more than 15,000 lakes and countless streams for fishing. More than 2,700 miles of hiking trails and nearly 700 miles of cross-country ski trails are located on state lands (plus many more under other ownership). Many parents who enjoy outdoor recreation encourage their kids to do the same.

Warmer or sporadic temperatures could affect the fish species able to thrive, the length of ice fishing season, and skiing conditions. Insect populations may also increase, potentially making all types of outdoor recreation less enjoyable. Also, children are at higher risk than adults from many insect-borne diseases and pollution-related illnesses that are more likely to strike when kids are outdoors.

Learn more by trying an internet search on: <"climate change" + snow + "great lakes"> and, along with other resources look for a Michigan Sea Grant article.

Activist for the environment

Environmental activist

Wisconsin has a proud heritage of being an environmentally conscious state. Several famous environmental and conservation leaders have roots in Wisconsin—Gaylord Nelson, the founder of Earth Day; Aldo Leopold, the author of *A Sand County Almanac;* John Muir, the founder of the Sierra Club; Sigurd Olson, author influential in protecting wilderness areas; and Pearl Louise Pohl, an environmental educator, to name a few.

Environmentalists care about clean air, water, and land; protecting human health; promoting environmental stewardship; and maintaining healthy ecosystems. They are involved in trying to change behaviors and laws to better protect the environment and to reduce pollution and other negative human impacts on the earth. Climate change could have a significant harmful impact on the state's, plants, animals, and waterways.

Learn more with an internet search on: <"climate change" + ecosystem + impacts + Wisconsin>. Along with other resources, look for a report on impacts in the U.S. and Great Lakes by ClimateHotmap, a report of Great Lakes region impacts by the Union of Concerned Scientists, and work by the Wisconsin Initiative on Climate Change Impacts.

An environmentalist, like everyone else, will have hobbies. Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect it?

Shop owner

Owner of a snowmobile sales and rental shop

The first snowmobiles were built in Wisconsin. Eagle River, Wisconsin, calls itself the Snowmobiling Capital of the World. During the 2001-2002 season, a Department of Tourism study estimated $249.5 million dollars were spent in association with snowmobiling in the state.

Warmer overall temperatures and more extreme weather events are predicted as part of climate change, which may worsen snowmobiling conditions or reduce the season length. Snowmobilers often run on deeply frozen lakes, but routes could be limited as temperatures warm. If snow conditions decline, snowmobile shops and other tourism-related businesses can expect less business. Especially in northern Wisconsin, declines in winter tourism have a significant impact on the local economy. The International Snowmobile Manufacturers Association states snowmobile sales have fallen every year but one since 1997.

Learn more by trying an internet search on <snowmobile + "climate change" + Wisconsin>. Look for an article by Jeff Alexander (January 28, 2008) on climate change and ice and snow cover.

Snowboard instructor

Snowboard instructor at Wisconsin ski resort

Snowboarding is a fairly new sport inspired by surfing, skateboarding, and skiing. In the U.S., snowboarders comprise approximately 20% of visitors to ski resorts. Wisconsin boasts more than 30 areas for snowboarding and skiing.

Warmer overall temperatures and more extreme weather events are predicted with climate change. This may shorten the snowboarding season or worsen conditions which will reduce snowboard instructors' business. Hotels, restaurants, and stores that depend on tourists will suffer too. Particularly in northern Wisconsin, the loss of winter tourism has a significant impact on the local economy.

Learn more with an internet search on: <snowboard + snow + "climate change" + Wisconsin>. Among other resources, look for an article by Jeff Alexander (January 28, 2008) about climate change and ice and snow cover, an article by Emily Rabin in *ClimateBiz* (February 2006), and an economic letter from the Federal Reserve Bank (August 2008).

Commercial fisherman

Commercial fisherman on Lake Michigan

Commercial fishing on Lake Michigan is a multi-million dollar industry in Wisconsin. Lake whitefish and chub are the largest component of catches in recent years. Both species prefer cold, deep waters.

Warmer temperatures may be problematic for commercial fishermen targeting coldwater fish. Coldwater fish may relocate to deeper waters than those typically fished with nets if Lake Michigan warms. Lake whitefish reproduction will likely decline as well. When thick ice cover is not present, wind mixes up lake bottom sediments, covering their eggs. Climate change may make the lake more hospitable for exotic species that lead to reductions in native species populations. Pollutant concentrations in the water may increase. This could impact fish health, consumption, and sales. Climate change is also predicted to bring about more extreme weather events. Storms and flooding may limit safe boating days and change stream inputs. Timing and quality of runoff can affect fish survival. On the other hand, climate change may have some positive effects. Populations of warm water fish that also have commercial value may grow and the fishing season may lengthen due to warmer weather.

Learn more by searching the internet for <fishing + "Lake Michigan" + "climate change">.

Head of state tourism

Head of the Tourism Department for the State

Tourism and recreation account for approximately $7 billion in revenue annually in Wisconsin. Common activities for tourists include boating, fishing, hunting, snowmobiling, skiing, and visiting attractions across the state.

Climate change may alter the types of activities and therefore the regions of Wisconsin that the state's Department of Tourism promotes. Since tourism is a big industry in Wisconsin, such changes could have major impacts on the livelihoods of people across the state. Winter sports will probably be most affected by climate change because of warmer temperatures and more sporadic snow. The distribution of plants and animals may shift. Aquatic and terrestrial habitats may support a new mix of species, affecting activities like fishing, hunting, and bird watching. Diseases spread by insects, pollution, and heat-related illnesses may increase.

To learn more, search the internet for <tourism + Wisconsin + "climate change">. Among other resources, look for a Union of Concerned Scientists report.

Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect that hobby?

Lake biologist

University of Wisconsin lake biologist

Lake biology is a study of aquatic organisms, water quality, and interactions between a lake's organisms and their environment.

Research is continuing on how human-induced climate change is likely to affect natural systems. Water quantity and quality will be impacted by temperature and precipitation pattern changes. Scientists have already observed increasing water temperatures and decreasing periods of ice cover. Lake levels are expected to drop. Certain cold water species like trout may disappear locally due to changing conditions while other species such as warm water bass, algae, zebra mussels, and exotic sea lampreys might increase in abundance. Insects and diseases may also increase, making the outdoors a more hazardous work place for lake biologists. Costly and time-consuming lake restoration projects could become more common in an effort to maintain functioning lake communities.

Learn more with an internet search on: <lakes + "climate change" + Wisconsin>. Among other resources, look for the Environmental Protection Agency's trail cards about climate change and wildlife and for an article by the Union of Concerned Scientists.

Pick an outdoor hobby for your character. How might climate change affect that hobby?

Head of power plant

Head of an electric power plant in Wisconsin

The U.S. consumes more electricity per year than any other country. We depend on electricity to keep our food safe, lights on, computers and appliances working, and houses warm or cool. Generating electricity from fossil fuels like coal is the number one source of greenhouse gas emissions. Coal accounts for 70% of the energy used in Wisconsin to produce electricity.

Electricity use may shift with climate change. Hotter summers may result in more air conditioning while warmer winters will mean reduced heating. Thermal power plants, including coal-burning and nuclear plants, are less efficient as temperatures warm. Hydro-electric power plants may be less effective if stream levels drop. Warmer temperatures also affect transmission lines, increasing blackouts. To combat climate change, alternatives to fossil fuels may be favored and electric power plants would need to invest in new technologies. Because building new power plants is very expensive, electric utilities encourage energy conservation—they actually can make more money if people use less energy!

Learn more by searching the internet on: <electric + generation +"climate change">. Along with other resources, look for an August 2008 article in *Geotimes* and for energy statistics from Wisconsin's Office of Energy Independence.

Avid gardener

Gardening enthusiast

Gardening can be a relaxing and inexpensive hobby. It can also be a costly and time-consuming hobby if plantings include species requiring frequent watering, fertilizing, or being inside for winter. Before buying plants, gardeners refer to plant hardiness zone maps to determine which plants will survive their winters.

Between 1990 and 2006, plant hardiness zones were changed across much of Wisconsin to reflect warmer average minimum temperatures in winter. This means less hardy plants can now survive here. The ranges of unwanted weed species are likely to shift and even expand with the changing climate. Climate change will also alter precipitation patterns—long dry periods will increase the need for watering while intense rains may drown some plants. Native plant gardening is growing in popularity because species that evolved here require less maintenance, but climate change could make Wisconsin inhospitable for some of our own native plants.

Learn more by doing an internet search on: <plants + hardiness + "climate change" + Wisconsin>. Along with other resources, look for a 2007 article about gardening in the *New York Times* by Shailia Dewan and an Arbor Day Foundation animation of the hardiness zone changes.

Beekeeper

Wisconsin beekeeper and honey producer

Honey bees produce honey, but also are critical for pollinating crops to produce seeds and fruits. The honey bee is Wisconsin's state insect.

Climate change is predicted to include overall warming and more extreme weather events. Honey bees are very sensitive to spring cold snaps. They rely on plant pollen and nectar for food. If blooming times are out of sync with bee activity, both plants and bees are likely to suffer. Wild bees and managed honey bees are disappearing at unprecedented rates. As of 2008, the cause of bee colony collapse is still uncertain but some theories include long distance movement of bees, pesticides, genetically modified organisms, mites, diseases, and malnutrition. Climate change may exacerbate bee colony collapse by increasing stress and decreasing food availability, weakening their immune systems. Climate change may make honey and beeswax production more difficult and lead to the decline of important pollinators.

To learn more try an internet search on: <bees + "climate change">.

Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect that hobby?

Island resident

Washington Islander

Washington Island is in Lake Michigan off the tip of the Door County peninsula. Year-round residents and visitors depend on a ferry to get themselves and any goods or supplies to and from this Wisconsin island.

Water levels in Lake Michigan have been dropping for a number of years and, in 2007, were nearing historic lows. The cause is unknown: some believe climate change has increased evaporation from the lake, especially in winter as there is less ice cover, as well as decreased rainfall to replenish the lake. Other theories include natural lake level fluctuations and water loss from dredging a river to Lake St. Clair and Lake Erie.

Low water levels mean the channel for the ferry has to be dredged, which is both expensive and disrupts the lake bottom affecting water quality and aquatic habitat.

To learn more try an internet search on: <"Lake Michigan" + "lake level" + "Washington island">. Look for a January 2008 *Washington Post* story on Great Lakes water levels and a July 2001 *Milwaukee Journal Sentinel* article on Lake Michigan levels receding.

Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect that hobby?

SCUBA diver

Avid recreational SCUBA diver

SCUBA stands for self-contained underwater breathing apparatus. In Wisconsin, recreational SCUBA divers enjoy exploring shipwrecks and caves and viewing underwater creatures. But many SCUBA divers love to dive in warm seas viewing colorful coral reefs. Coral reefs are formed by many tiny organisms (coral polyps) that secrete calcium carbonate to form hard exoskeletons that make up the structure of the reefs. Corals often have special relationships with algae and fish, making the reef a rich biodiverse ecosystem essential to a host of other marine organisms. They are critical to many fish species we use for food and are a source of compounds used in medicine.

Coral reefs are sensitive to a variety of environmental factors including physical disturbance, excessive nutrients, salinity, and pH. Coral polyps are extremely sensitive to temperature and are already living very close to their upper temperature limits. Global warming may lead to widespread coral death and degradation with the subsequent collapse of coral reef ecosystems. A report by the World Wildlife Fund estimates 24% of coral reefs are already at imminent risk of collapse.

Learn more with an internet search on: <"coral reef" + "climate change">. Along with other resources, look for an article at *Encyclopedia of Earth* about climate change and coral reefs, an April 2005 *Science Daily* story, and a report from the Pew Center about climate impacts on coral reefs.

Baseball bat manufacturer

Wisconsin-based baseball bat manufacturer

Professional baseball players only use solid wood bats. Today wood bats are made from white ash or sugar maple trees. Both tree species grow in Wisconsin, although sugar maple, the state tree, is more common. Maple bats are increasing in popularity and may soon become the primary option because of a devastating pest killing ash trees across the country.

In addition to ash being under attack by exotic beetles, climate change is also predicted to make ash a less suitable wood for baseball bats. Warmer temperatures and longer growing seasons will likely result in a softer wood rather than the hard, dense wood optimal for bats. Maple wood may suffer similar consequences and maple tree range in the state may decline. Wood bat manufacturers may need to import their wood from colder climates or shift production to use different materials. Baseball and other warm weather sports may become more popular as the summers get longer.

To learn more search on: <"baseball bats" + "climate change">. Look for a July 2007 *New York Times* article.

Park ranger

Apostle Islands park ranger

The National Park Service (NPS), according to its mission, "preserves unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations." One of its northernmost parks, Apostle Islands National Lakeshore, consists of 12 miles of mainland Wisconsin along Lake Superior and 21 islands. Park rangers carry out a variety of duties including education, fire control, park management, and campground operation.

Climate change will make it difficult for the NPS to achieve its mission. Northern parks, like the Apostle Islands, are expecting to see greater warming than southern parks. Plant and animal species' life cycle events are expected to occur earlier, and it is feared that crucial relationships between species may get out of sync (e.g. predator/prey, flower/pollinator). Species distributions may shift northward or some species may disappear, changing the overall character of parks. The summer recreation season at the Apostle Islands may lengthen but insect pest populations are also expected to increase. Shoreline park facilities may need to be updated to accommodate predicted lower water levels. Extreme weather events that are expected with climate change would impact park visitor experiences and may damage park buildings and roads.

Learn more with an internet search on: <"climate change" + "Apostle Islands" OR "Lake Superior">.

Store owner

Air conditioner store owner

Air conditioners use 5% of the electricity produced in the United States. Due to fossil fuel combustion for the electricity, and because they contain potent greenhouse gases, fluorocarbons, air conditioners make significant contributions to climate change. In order to combat climate change, greenhouse gas emissions will need to be drastically reduced.

However, warmer temperatures predicted due to global warming will likely result in greater demand for air conditioners in homes and businesses. Air conditioner sellers may experience increases in business but see a change in the products requested. Energy efficient units, like those qualified as Energy Star, may sell better and air conditioner sales and repairmen may need to meet higher environmental standards.

Learn more with an internet search on: <"air conditioning" + "climate change" + Wisconsin>. Among other resources, look for an *International Herald Tribune* article about global warming and air conditioning in Italy and a Pew Center report from November 2006.

Zookeeper

Director of a large urban zoo

Well-managed zoos are concerned with the conservation of species worldwide and teach the public about species and conservation needs. Zoos may also lead off-site research to determine how animals behave in their natural environments. Zookeepers perform a wide range of duties including feeding, cleaning cages, monitoring animal health, performing research, and working with the public.

Climate change is predicted to result in the extinction of many animals. Animals living in the coldest regions near the poles will likely find it difficult to survive because they cannot migrate to reach optimal temperatures and their habitat range will decrease significantly. In 2008, polar bears were listed as federally threatened because the Arctic sea ice habitat is declining. As animal populations decline, zookeepers may be even more critical in preventing species extinctions through their research and breeding programs. Zookeepers' day-to-day jobs may also become more challenging with global warming as they attempt to mimic the animals' natural habitats to keep their animals healthy and safe.

Learn more with an internet search on: <zoos + "climate change">. Along with other resources, look for an article about the National Zoo's research on migratory birds and climate change.

Head of DNR

Head of Wisconsin Department of Natural Resources (DNR)

The primary mission of Wisconsin's Department of Natural Resources is to protect and enhance natural resources for current and future generations. The DNR is responsible for managing 1.4 million acres of state-owned land, maintaining a clean environment, and providing outdoor recreation opportunities. The agency balances the interests of multiple groups (e.g. loggers, snowmobilers, birders, anglers, factory owners, local citizens) and the health of natural resources during decision making.

Warming and extreme weather events predicted because of climate change may cause shifts in terrestrial and aquatic habitats, put endangered species further at risk, impact outdoor recreation, and increase problems such as damaged timber and exotic invasive species. DNR is in charge of regulating air pollution emissions that will likely be key in reducing greenhouse gases. The agency may also play a role in finding solutions, perhaps biofuel production or sequestering carbon on public lands.

Learn more with an internet search on <Wisconsin + DNR + "climate change">. Along with other resources, look for an article from *Wisconsin Natural Resources* magazine about warming trends.

Nonprofit agency volunteer

American Lung Association volunteer

Founded in 1904 the American Lung Association is a voluntary organization that works "to prevent lung disease and promote lung health." The organization conducts research, advocates for laws, communicates with doctors and patients, and educates the public about respiratory health. Along with some paid staff, there are more than 200,000 volunteers.

Warmer temperatures are predicted due to climate change. Hot weather can prove especially dangerous as it can convert air emissions into unhealthy ground-level ozone. Warmer temperatures can also lead to increases in forest fires, a source of airborne toxins. Plant pollen may increase and aggravate asthma and allergies. Climate change is also expected to bring more extreme weather events. More flooding could cause a rise in the species and abundance of molds, which can cause asthma and infections. To increase energy efficiency, buildings may be better insulated. As ventilation is reduced, mold and radon can become bigger problems. Radon is the main cause of lung cancer in non-smokers.

Learn more with an internet search on <"respiratory health" + "climate change">.

Recycling business

Owner of a recycling business

Recycling is the reuse of materials to make new products. Wisconsin's recycling law bans the incineration or landfilling of many items such as yard waste, tires, newspaper, glass, aluminum, and some plastics to encourage recycling. Recycling reduces waste, leads to the production of less air pollution than making products with unrecycled materials, and saves energy. Using recycled materials reduces electricity consumption and, thus, greenhouse gas emissions from the burning of fossil fuels. It also lessens emissions of greenhouse gases from incinerators and landfills.

As climate change awareness increases, more products may be recycled in an effort to reduce the production of greenhouse gases. Perhaps the use of recycled materials will be required for some products. This would increase the demand for recycled materials and the value.

Learn more with an internet search on <"climate change" + recycling>. Along with other resources, look for information on the University of Michigan's website.

activity Community Profiles *(page 9)*

COMMUNITY CONVERSATION

Tree farmer

Wisconsin woodland owner and tree farmer

Tree farmers can refer to people who plant a single tree species such as balsam fir Christmas trees or manage their land for renewable forest products. Wisconsin's 16 million acres of forestland cover nearly half of the state. Individuals and families hold the largest portion (57%) and 260,000 private, non-industrial landowners own 9.7 million acres of woodland.

Climate change will bring warmer temperatures and more extreme weather events. Potential negative impacts include changes in the species of trees found in our natural forests, more drought and heat stress on forests, increased pest problems, and increased tree damage from wildfires and storms. Potential positive impacts of warming include new opportunities to sell trees for alternative energy or to be paid to maintain trees to lessen greenhouse gases; increased tree growth due to higher concentrations of carbon dioxide, a gas that plants need for photosynthesis; and longer growing seasons.

Learn more with an internet search on: <forest + "climate change">. Along with other resources, look for a story by the Union of Concerned Scientists about forests and climate change.

Pick an outdoor hobby for your character, maybe something you also like to do. How might climate change affect that hobby?

Epidemiologist

Wisconsin Department of Health epidemiologist

Epidemiologists study the health and illnesses of populations. They work to protect public health and prevent illness.

Climate change will cause warmer temperatures and more extreme weather events. In Wisconsin, warmer temperatures and longer warm-weather seasons may increase the spread of diseases carried by animals, like Lyme disease and West Nile virus. Warmer temperatures will likely increase the range and spread of diseases more typically affiliated with tropical areas. Extreme weather events may lead to increases in waterborne diseases and communicable diseases. Communicable diseases usually associated with cold weather may decrease. The changing climate will result in new plants moving into an area and other plants disappearing, possibly triggering more allergies in some people and fewer in others. As the climate changes, epidemiologists will likely be challenged to keep up with rapidly changing disease patterns. Their research and recommendations for illness prevention may become more critical to everyone's well being.

Learn more with an internet search on: <disease + "climate change">. Along with other resources, look for an article in the *Canadian Medical Association Journal* (March 11, 2008) about disease distribution.

Sphagnum moss harvester

Wisconsin sphagnum moss harvester and supplier

Sphagnum moss grows in marshy areas. Its ability to hold 20 times its weight in water makes it invaluable in the garden/nursery business. Wisconsin—the only state that produces sphagnum moss commercially—produces 300,000 bales annually. The harvest runs from spring until marshes freeze in the fall. Central Wisconsin has beds of sphagnum that remained from a sprawling marshland created when the glaciers receded.

Sphagnum's relationship to climate change is unclear and under study. Warmer weather may lead to more rapid decay of this dominant plant of peat lands, producing more greenhouse gases.

Or, a warmer climate may increase the growth and accumulation of peat, thereby decreasing greenhouse gases. Scientists have used sphagnum moss as an indicator of climate change, studying the changes of its range. In sub-Antarctic areas, higher than average temperatures and wind speeds and lower than average humidity and precipitation are destroying moss beds.

Learn more with an internet search on: <"sphagnum moss" + Wisconsin + "climate change">. Among other resources, look for a February 1994 article by Gignac and Vitt.

Student

High school student from your neighborhood

Students are our future. Their actions, choices, and future roles in society will either further exacerbate human-induced global climate change or, conversely, will reverse the process and protect our planet and society. Each student has his or her own hobbies, life-style choices, and hopes for a personal and professional future. What are yours?

What impacts do you have on the global climate right now? Human-induced climate change is caused by increases in greenhouse gases, mostly from energy use—gasoline-powered vehicles and the electricity it takes to heat our water; keep our lights on; warm and cool our houses; and run our computers, TVs, and other appliances. The effects of climate change aren't as simple as warmer winters and hotter summers. Expect more violent storms, changes in plants and animals around you, changing patterns of pests and disease, more expensive energy and transportation, etc.

To learn more about how climate change may affect you, try some internet searches on "climate change" combined with words that reflect what you like or would like to do. To understand how you can make a difference, search for "climate change" and words like "greener" or "solutions" or "actions."

5

What Can I Do?

Use hands-on opportunities to get inspired, take action, and make a difference.

a — art–design
ee — environmental education
ss — social studies
s — science
m — math
e — english–language arts

*This activity builds on the **Paradise Lost** exhibit of climate change-inspired art projects.*

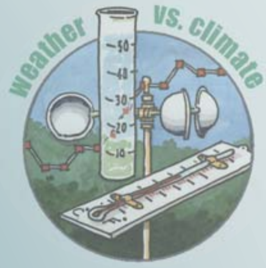
a

A service learning activity in which students create an advocacy campaign about an aspect of climate change.

ee ss

In this activity students make pledges to help the environment. "Pledge-leaves" are put on a tree where they serve as reminders of pledges made.

ee



making a difference

Science Inspires Art Inspires Society

learning objectives

Students will:

- *Use the arts as a way to teach about our environment.*
- *Use their creativity and knowledge to create an art project that communicates their own thoughts and feelings related to climate change.*

subjects

Art & Design Education

WISCONSIN MODEL ACADEMIC STANDARDS

ART & DESIGN EDUCATION
E.8.1, E.8.3, E.8.5, E.12.3, G.8.1, G.8.4, K.8.1, E.12.1, E.12.5, G.12.1, G.12.4, K.12.1

materials

- ☐ *Paradise Lost* examples
- ☐ Paper
- ☐ Glue
- ☐ Markers
- ☐ Other art items the students may need

Background

Art is a great way to educate others. Review *Paradise Lost* book or website. *Paradise Lost* is a book and traveling exhibit with a corresponding website that uses art not only as a tool to express ones feelings on climate change, but also to teach others about climate change. Using their own creations as communication tools, artists from all over Wisconsin came together to present their interpretation of climate change and how it will affect each one of us.

For more information on climate change, for ideas for art projects, and a link to the *Paradise Lost* website, visit the *e-Appendix.*

making a difference

activity

ART INSPIRES SOCIETY

Art Project

Using their own inspiration, skills and knowledge, students will create an art project related to climate change and then explain what the piece means and how it relates to climate change.

Procedure

1) Have students research climate change to spur ideas for their own art project. Students can attend a guest speaker presentation on climate change, read articles on climate change, watch a documentary, or visit a museum or art gallery with a focus on climate change. Encourage students to think outside the box while researching and come up with creative ways to learn about climate change.

2) Ask students to pick any topic related to climate change and design an art project around it. Ask students to be as creative as possible and stretch their imagination in coming up with an art project that depicts climate change in some way. Ideas for projects could include a painting, song, drawing, poem, poster, collage, photo, recyclable material sculpture, etc.

3) Have students write an explanation of their art piece. Why did they choose their medium? What information are they communicating to the public? How does their piece communicate to the public? What do they want people to know or learn after reviewing their artwork?

4) When all art projects are completed have students share and explain their pieces to the class.

Going Beyond

1) Display the art pieces in a school display case. Leave them up for a few weeks to generate discussion among the students and teachers. Encourage other teachers to take their classes on a mini-field trip to view and talk about the collection.

2) Have an "art gallery night," setting up pieces in the gymnasium or cafeteria and inviting parents, teachers, and students for collection viewing.

3) Use one or more of the pieces in a follow-up activity, *Artsy Activism*, to create awareness and stir people to action.

4) Save the pieces for Earth Day (April 22nd) and display them throughout the school. Invite the community to come view the students' work.

5) Get involved in an Earth Day event in your community. Contact the coordinator and find a location at the event to display the students' work. The community will enjoy seeing the local students' art pieces, and the students will have the opportunity to further educate through their art.

Artsy Activism: A Service Learning Activity

learning objectives

Students will:

- *Research and understand the causes of climate change.*
- *Demonstrate their knowledge of climate change by creating a school-wide education campaign to reduce global warming.*
- *Evaluate the results of their campaign.*
- *Educate their community about effects of climate change and what they can to do reduce global warming.*

subjects

Environmental Education
Social Studies

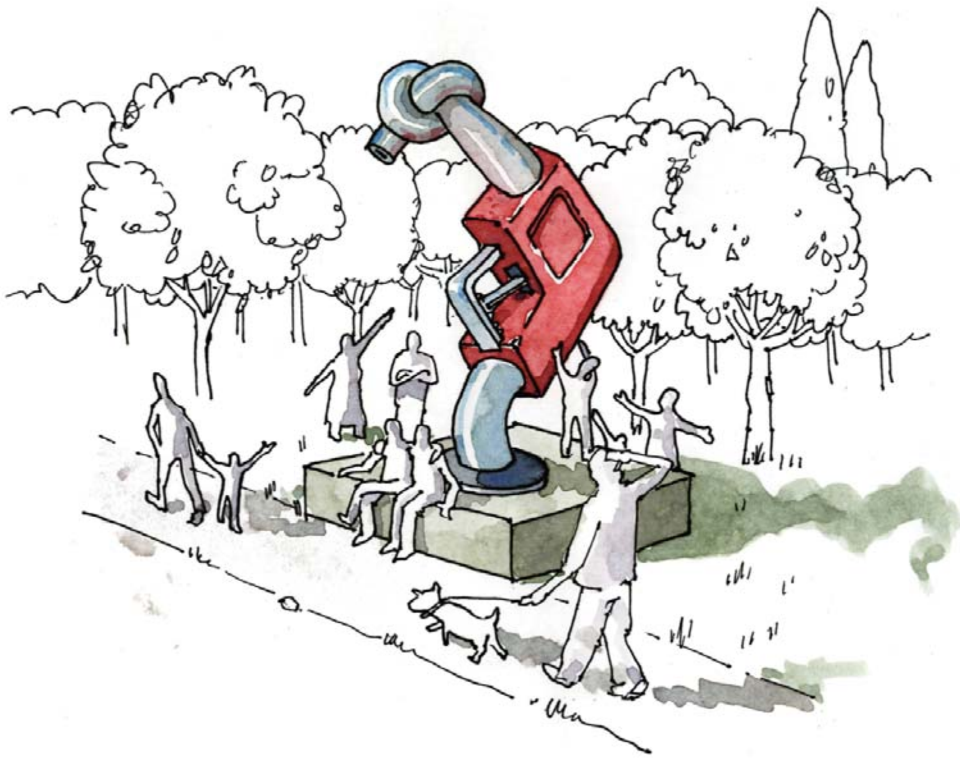
WISCONSIN MODEL ACADEMIC STANDARDS

ENVIRONMENTAL EDUCATION
D.8.5, D.8.6, D.8.7, E.8.1, E.8.2, C.12.4, D.12.2, D.12.5, D.12.6

SOCIAL STUDIES
C.12.8, C.12.10

materials

- Chalk board, poster board, or other materials the students choose
- Worksheets included in this activity



Background

A great way to learn about climate change is to research the topic and then teach others. Through small group campaigns that the students design, they will get the word out about climate change and the actions we can take to reduce global warming.

activity

ARTSY ACTIVISM

Climate Change Campaign

Each student group will create a climate change campaign for school-wide implementation.

Procedure

1) In small groups, have students list what they know about the causes of climate change. Next, brainstorm ways to educate the rest of the school about climate change and the actions individuals can take to reduce global warming.

2) Have students research and discuss their ideas for activities. If the students are having trouble coming up with an idea for their campaign, suggest possible campaigns from the list below. (Additional resources are available on the *e-Appendix*.)

3) After selecting a campaign, have students answer the questions on the *Campaign Preparation Worksheet* before designing and publicizing it.

4) Before embarking on the campaign, students should identify what they hope the campaign will accomplish and how they will evaluate whether it has met their goals. They should also determine how long their campaign will last. They may need to collect baseline data BEFORE starting the campaign in order to evaluate its success. For example, if they are hoping to reduce the number of cars being driven to their school, they will first have to measure how many are being driven there BEFORE the campaign.

5) After completing the campaign, ask students to evaluate it by completing the *Campaign Follow-Up Worksheet*. In addition, they should evaluate whether the campaign met their goals and what they would do differently if they repeated it. Students should report the results of their campaign evaluation to the other groups.

Ideas. . . . .

- Create door hangers to remind occupants to turn the lights off when exiting the classroom.
- Place signs in the cafeteria to remind students to bring their own reusable containers for lunch.
- Promote a waste-free lunch week at school. (Check out the Waste Free Lunches website or go to the e-Appendix for links).
- Hang posters on school doors promoting an activity that will reduce everyone's carbon footprint.
- Have a "leave the car at home day." Encourage students, faculty and staff to walk, bike or bus to school.
- Hang up posters or hand out flyers at school functions such as sporting events, academic events, or music performances that encourage families to participate in the campaign.
- Print all take-home papers and brochures for school events on recycled paper and print a note on the back about why the school is using recycled paper.
- Start an anti-idling campaign at your school. Visit EPA's website and search "school bus anti-idling."
- Start a "Change a light, change the world" campaign to replace incandescent bulbs with fluorescent bulbs at home or school. Visit Energy Star, and search "change a light change the world."

Going Beyond

After students have evaluated their school campaign, have them decide how they could take their campaign into their community. Discuss how the community might change as a result of climate change.

making a difference

activity Campaign Preparation

ARTSY ACTIVISM

NAME ______________________ CLASS ______________________

TEACHER ______________________ DATE ______________________

*Please answer these questions **before** you begin your campaign.*

1) Campaign Title ______________________

2) Campaign Theme ______________________

3) How will the campaign relate to climate change? ______________________

4) What do you hope will be the positive outcomes of this campaign? ______________________

5) What do you think will be the negative outcomes? ______________________

worksheet

Campaign Preparation *(continued)*

6) *Are there any measurable outcomes? And how will you measure them? Do you have any specific goals? (For example, increase in pounds of recyclables, overall decrease in waste disposal)*

7) *Who do you think will be the most likely to participate (students, teachers, other faculty, visitors, etc.) and why?*

8) *Who do you think will be the least likely to participate and why?*

activity Campaign Follow-up

ARTSY ACTIVISM

NAME ______________________ CLASS ______________________

TEACHER ______________________ DATE ______________________

*Please answer these questions about your campaign **after** it is completed.*

1) Campaign Title ______________________

2) Campaign Theme ______________________

3) How did the campaign relate to climate change?

4) What are the positive outcomes of this campaign?

5) What, if any, are the negative outcomes?

6) Are there any measurable outcomes? (For example, increase in pounds of recyclables, overall decrease in waste disposal)

7) Did the campaign meet your goals for it?

worksheet

8) *What was the hardest part of implementing this campaign?* ______________________________

9) *Who participated the most (students, teachers, other faculty, visitors, etc.) and why?*

10) *Who participated the least and why?*

11) *Was following the campaign guidelines (e.g. recycling more, reusing paper, waste-free-lunch) easier or harder to do than you thought in the beginning? Why?*

12) *What did you learn from this campaign?*

13) *How would you improve the campaign if you were to do it again?*

Tree of Pledges

learning objectives

Students will:

- *Pledge behavior change(s) that will lessen their impact on the environment.*
- *Recognize their role in taking care of Earth.*
- *Engage their peers and teachers to make commitments to reduce negative environmental impacts.*
- *Discuss the importance of individual behaviors in reducing the negative effects of climate change.*

subjects

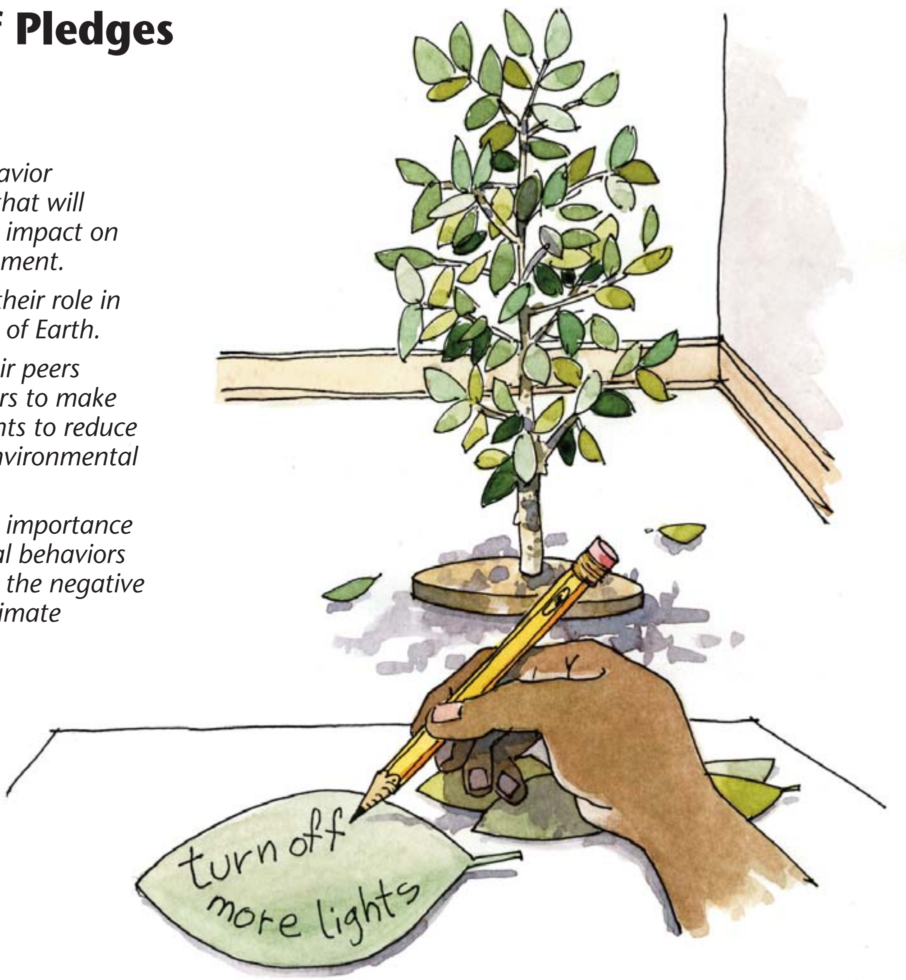
Environmental Education

WISCONSIN MODEL ACADEMIC STANDARDS

ENVIRONMENTAL EDUCATION
B.8.10, E.8.1
C.12.4, E.12.2

materials

- ☐ *Paradise Lost*
- ☐ Tree branches
- ☐ Large pots
- ☐ Potting soil
- ☐ Green paper
- ☐ Wire or string
- ☐ Markers
- ☐ Scissors



Background

During the past 100 years, human behaviors have been affecting our world's climate. As human activity increases greenhouse gases, and the greenhouse effect subsequently warms the planet, Earth's climate and climate patterns are changing. Climate change impacts people, economies, and ecosystems. Behavior choices, large or small, can affect the degree of climate change. Talk to your students about these large and small choices, their impact on our Earth, and ways to reduce negative impacts. Small changes may not seem like they could make a difference, but over time and in combination with others doing the same actions, even small contributions add up. Every little bit helps.

Review the *Paradise Lost* website: see the *e-Appendix for the link*.

The idea for this activity came from Mark Charon, artist at the North Lakeland Discovery Center in Manitowish Waters, Wisconsin. He created a "tree" that traveled along with the rest of the art pieces in the *Paradise Lost* exhibit. At each exhibit location, people were able to add their personal pledge to fight climate change, as well as read and learn about other people's pledges.

activity

TREE OF PLEDGES

Personal Pledges

Students will construct a "pledge tree," add personal pledges to the tree, and focus on keeping their pledges.

Procedure

1) Have your students design a "tree" (trunk and branches) without leaves for display in a common area. The tree could be made of real branches and twigs, wooden 2x4s and dowels, metal welded together, or anything else they imagine. "Plant" your "tree" in a pot and place soil around it to keep it upright.

2) Next, have students make leaves upon which pledges can be written, e.g. cut out "leaves" from green paper. Near the base of each leaf, punch a hole through the paper with a hole-punch.

3) Tie a 6" piece of string or a long twist-tie through each leaf hole.

4) Have students take one leaf apiece and write their own pledge on how they plan to fight climate change. For example, turn lights off when not in use, replace incandescent light bulbs with compact florescent bulbs, unplug cell phone and MP3 chargers when not in use, educate others on climate change, eat more locally-grown food, drive less, etc.

5) Next, have students hang their leaves on the tree.

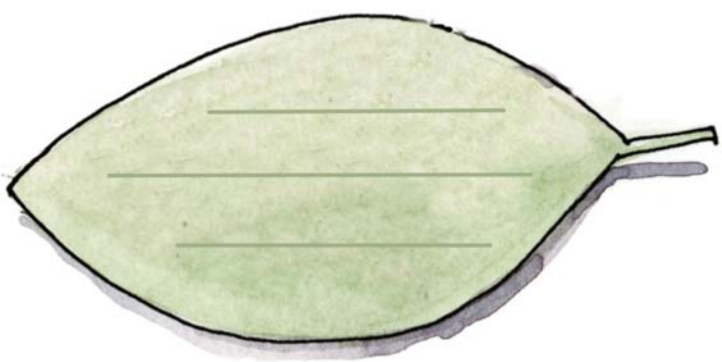
6) After the tree is filled with leaves, ask students to read the responses and discuss the different options for reducing greenhouse gases or the impacts of climate change. Are there any that you as a teacher can implement in your classroom to set an example? Which ones can the students take home and do with their families? Are there any that can be implemented school-wide? What about community-wide?

Going Beyond

1) Place the pledge tree in a common area of the school. Alongside the pledge tree provide a supply of blank leaves, cut from green paper with stems of twist ties or string. Allow all students and faculty to make their own pledges and attach them to the pledge tree.

2) Have a student pick a leaf off of the pledge tree each day or week and read the pledge with the morning announcements for the entire school. Bigger impacts result when the entire school focuses on one pledge at a time. For example, students can remind each other to bring a reusable lunch bag or reusable water bottle.

3) Record some or all of your tree's pledges on our "virtual tree of pledges" on the EEK! website. Go to *http://dnr.wi.gov/eek/*. Compare your leaves to the others on the virtual tree. Did you add any new ideas to the virtual tree? Did the virtual tree provide new ideas that weren't on your tree?



CLIMATE CHANGE: A Wisconsin Activity Guide

DEPARTMENT OF NATURAL RESOURCES

We'd love to hear how the *Wisconsin Climate Change Guide* is working for you.
Please send evaluations to: Air Educator; Bureau of Education and Information; P.O. Box 7921; Madison, WI 53707-7921 or EMAIL *DNRAirEducation@wisconsin.gov* or FAX 608-264-6293.

For the first 150 who return an evaluation, we will show our gratitude by sending a FREE copy of the book ***Paradise Lost*** (valued at $10 – referred to in the *Science Inspires Art Inspires Society* and *Tree of Pledges* activities). **Thank you!**

CONTACT INFORMATION TO RECEIVE A COPY OF *PARADISE LOST*:

NAME ______________________________

STREET ADDRESS ______________________________

CITY ____________________ STATE __________ ZIP __________

1) Grade(s) taught using guide ______________________________

____

2) Subject/s taught (e.g. English, math) using guide ______________________________

____

3) Overall, how would you rate this activity guide to others you have used? ***Why?***

INFERIOR 1 2 3 4 5 SUPERIOR

____

____

4) Was the activity appropriate for the grade level/s you teach?

TOO BASIC 1 2 3 4 5 TOO ADVANCED

5) Were the learning objectives accomplished during the activity/activities?

NO OBJECTIVES MET 1 2 3 4 5 OBJECTIVES MET & EXCEEDED

6) Did your students enjoy the activity/activities?

HATED IT 1 2 3 4 5 LOVED IT

7) Did the background materials provide enough information for you to easily and successfully understand each activity and answer students' questions? Any specific comments?

VERY INADEQUATE 1 2 3 4 5 TOO MUCH INFORMATION

8) Were the activities written so you could easily understand and successfully complete each? ***Specifics?***

VERY INADEQUATE 1 2 3 4 5 TOO MUCH INFORMATION

____

____

CLIMATE CHANGE: A Wisconsin Activity Guide

You can also find the evaluation form in the *e-Appendix: www.dnr.wi.gov/eek/teacher/climatechangeguide.htm.*

9) *Please grade (A-F) each activity you used.*
Provide grades for the activity overall, the procedure, and (if used) the ***Going Beyond*** *section.*

ACTIVITY	OVERALL	PROCEDURE	GOING BEYOND
WEATHER V. CLIMATE ***Weather in Wisconsin***	______	______	______
WEATHER V. CLIMATE ***Climate Trends***	______	______	______
ICE CORES ***Exploring the History of Climate Change***	______	______	______
THE CHEMISTRY OF CLIMATE CHANGE ***What is Pollution?***	______	______	______
THE CHEMISTRY OF CLIMATE CHANGE ***Sources and Solutions***	______	______	______
THE CHEMISTRY OF CLIMATE CHANGE ***Pounds of Pollution***	______	______	______
POWER TO THE PEOPLE ***Power in Wisconsin***	______	______	______
POWER TO THE PEOPLE ***Daily Energy Use***	______	______	______
HOW GREEN ARE YOU? ***Ecological Footprint***	______	______	______
ECOSYSTEM PHENOLOGY ***Ecosystem Journal***	______	______	______
ECOSYSTEM RELATIONSHIPS ***Ecosystem Diagrams***	______	______	______
ECOSYSTEM RELATIONSHIPS ***Measuring Ecosystems***	______	______	______
ECOSYSTEM RELATIONSHIPS ***Unique Ecosystems***	______	______	______
CLIMATE CHANGE IN THE NEWS ***News Analysis***	______	______	______
COMMUNITY CONVERSATIONS ***Discovery through Dialogue***	______	______	______
SCIENCE INSPIRES ART INSPIRES SOCIETY ***Art Project***	______	______	______
ARTSY ACTIVISIM ***Climate Change Campaign***	______	______	______
TREE OF PLEDGES ***Personal Pledges***	______	______	______

10) Did you use the e-Appendix? ☐ *Yes* ☐ *No* *If yes, please share any comments.*

11) Any important components of climate change in Wisconsin that this activity guide did not address?

12) Any other suggestions for improvement?

13) Any parts that you particularly liked?

14) Other comments?

Thank you for taking the time to send us your evaluation.

evaluation