

Global Warming and Biodiversity

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Overview

Global warming has become a complex issue in our society as well as a seemingly misunderstood, misrepresented series of interconnected scientific concepts. This is an important local and global environmental issue for many people and yet an apparent fiction to others. The overall awareness of this issue is very broad in scope, existing at a world-wide level. Politicians have used this issue to polarize sympathetic groups. Scientists have worked diligently over the past few decades to discover and validate facts about how humans are having an impact upon global climate change and the notion that the earth recently is progressively warmer. Organizations such as the Intergovernmental Panel on Climate Change (IPCC) have been formed so that the fundamental science at the heart of the global warming debate has a vehicle to proceed in spite of political or societal disruptions that may distract the necessary research.

The goal of this unit is to assist teachers as they guide students in unpacking some of the important aspects of global warming and to provide students with a framework in which to formulate their thoughts and beliefs about global warming. The lessons are teacher friendly and can readily be implemented by novice and experienced teachers alike. The unit is designed for about 250 minutes or roughly 6 class periods. The amount of instructional time required for the lessons is flexible according to the needs of the students, out of class homework assignments, and the constraints of your district's curriculum pacing. The topic is relevant to nearly any content area. This content of this unit is focused primarily on environmental studies, earth science, and biology. The lessons are intentionally biased toward a biological perspective but the techniques utilized and the overall lesson flow can easily be adapted to other content areas. The unit was written to satisfy Pennsylvania state assessment anchors that deal with the impact of human behavior on the environment.

The major activity presented in this unit is based upon structured internet research as students are extremely comfortable with using technology to search for information. This unit will require students to locate general kinds of information within specific website locations. Thus, the internet is utilized but in a structured and guided fashion. Homework assignments allow students the opportunity to explore the myriad of additional websites that are associated in

some manner with global warming. There are options for a culminating activity that transpires after the research is complete. The first is a multi-paragraph paper that directly deals with the issue of the effect of climate change on the biodiversity of Pennsylvania. The second option is for groups of students to create, display, and explain a poster dealing with biodiversity and global warming. Students would need to display their posters to their peers and be a part of a student gallery walk. The poster/gallery walk option is more time intensive but also more engaging for the students. The unit has been taught to urban, general biology students. They were asked to write a multi-paragraph paper as a final activity and they were very successful overall in the activity.

Students will also be exposed to the local potential impact of global warming as it relates to the biodiversity of Pennsylvania. In doing so, the unit will present the history of global warming research and the continued efforts towards a deeper scientific understanding of the issue. The unit will not directly present the author's position on the issue; only that the author agrees that continued gathering of data is necessary to determine if the world community is facing a potential crisis. The theme, therefore, will be on impact education with students defining their roles in ensuring a healthier biodiversity for our home state of Pennsylvania.

I believe that the global warming topic provides teachers with a pathway to connect several disciplines as well as providing a vehicle for looking at the role and function of scientific models and systems. The potential applications for this topic seem to be limited only by time and the teacher's imagination. Students are passionate at this age and this kind of controversial issue lends itself well to teaching science content as well as critical thinking skills.

Rationale

Simply stated, global warming is defined as the increase in the mean temperature of the earth's surface and that warming is most likely attributed to the increase of specific gases known as greenhouse gases.(1) Green views global warming as having a long research history but currently based on more defined scientific parameters; thereby, he claims that global warming is a scientific theory with two essential "observations" or premises.(2) The first observation is that certain gases change the way the atmosphere retains heat and the second is that human beings cause those gas levels to rise due to their industry or recreation. To begin to understand global warming, component gases and particles found in the atmosphere must be considered. Students should come to the classroom with basic knowledge of the Earth, the atmosphere, and how climate evolves and cycles. A review of the atmosphere would include reminding students that there

are layers of gases surrounding the Earth. These gases are invisible to the naked eye, for the most part, with nitrogen and oxygen comprising over ninety-nine percent of the atmosphere. Other gases found in the atmosphere are carbon dioxide, methane, nitrous oxide, and ozone. Particles found in the atmosphere are aerosols and halocarbons. Water vapor is one of the main greenhouse gases with about 0.4 percent of all the molecules in the air. (3) The quantity of water vapor in the air varies and is dependent upon the location. Students will eventually come to understand that some of these gases may hold heat and others may create a cooling effect. Water vapor is the classic example of a molecule that plays a role in both directions depending upon the specific process it happens to be undergoing.

What is Climate Change?

Certain scientists look to the past to discern patterns in climate and how it has changed over time due to significant geological events or environmental changes on the Earth. This type of scientific undertaking is known today as paleoclimatology. (4) This record of the Earth's climate history shows dramatically different stages of climate change that have lasted for different lengths of time. For example, glacier eras can last for periods of 100,000 years whereas milder climate swings are seen as lasting anywhere from 10,000 to 20,000 years. (5) This means that the climate of the Earth is not stable but has cycled through a variety of stages over the long periods of time since the atmosphere was formed.

Geological events, such as continental drift are associated with climate change. Over 50 million years ago Antarctica was still connected to the larger land mass known as Pangaea. Fossil evidence from the edges of this continent shows that there were deciduous and coniferous trees present. (6) This suggests that the difference in temperature from the equator to the poles was less than it is today. Coming from the isolation and glaciation of the Antarctic is the formation of sea currents around the now separated landmasses. There is also evidence that the Gulf Stream also intensified from a current at this time. The point to note is that these major geologic events have impacted climate change as they became the basis for our climate today.

What sources influence climate change?

The most obvious influence in climate is the power of radiation from the sun. Areas that are located at the equator receive more direct radiation from the sun and are therefore hotter than areas distant from the equator. The sun puts forth a continuous amount of radiation and that expressed by a solar constant whose value is approximately 1370 Watts per square meter of the earth. Radiation from the sun has a number of potential destinations. Some of the solar radiation is absorbed by the atmosphere, some is able to penetrate the atmosphere, reaching the Earth and become somewhat absorbed by the ground. Radiation that is not absorbed by the earth is reflected back into the atmosphere. If there are certain gases within the atmosphere, then the radiation becomes trapped and will cause re-radiation of energy thereby creating a greenhouse effect. The result of trapped radiation is an increase in atmospheric temperature as well as heating the surface of the earth to some extent.

The sun also has sunspot cycles every eleven years. These cycles cause a fractional fluctuation in the amount of solar output. The resulting temperature change from this kind of output is around .2 degrees Celsius.

Orbital cycles of the earth will also play a role in climate change. The ellipticity of the earth fluctuates from circular to elliptical approximately every one hundred thousand year. Tilt changes can also cause a cycle of climate effects as the earth tilts in a range of 21.5 degrees to 24.5 degrees. This cycle has been estimated to occur every forty-one thousand years. Another series of cycles are named after the Serbian mathematician Milutin Milankovitch. Milankovitch calculated the small changes in the earth's orbit that were caused by gravitational pulls from other planets.(7) These changes were termed orbital perturbations and they are attributed to slight changes in the distribution of incoming solar radiation. Another German climatologist named Wladimir Koppen then realized that these changes had an influence on the climate fluctuations.(8) Both of these men were able to calculate back in time and in doing so are credited with updating the astronomical theory of the ice ages.(9)

It seems that these influences are ones that are predictable and scientists are able to record their impact on the overall climate story of the earth. Are these cycles enough to cause a disruption of the delicate balance in the earth's climate system? In any case, they are variables in a complex and interconnected system that can be considered internal to the system. They are natural cycles. Other variables influence climate from outside of the system, such as the effects of human actions.

The History of the Theory of Global Warming

Maslin claims that scientists are predicting that global warming could warm the planet by between 1.4 and 5.8 °C in the next 100 years, causing increased problems for the human race. (10) With such a claim, surely there must be convincing evidence to provide support. Global warming research has been going on for fifty to one hundred years but not always under the current namesake. One of the pioneers to study relationships in this area was the Swedish scientist Svante Arrhenius . In 1896 Arrhenius had calculated, and Thomas Chamberlin independently verified, that human activity could substantially warm the earth by the addition of carbon dioxide to the atmosphere. (11) At that time these scientists felt that the contribution of humans was not excessive and turned their attention to studying climate issues in geology or astronomy. This kind of thinking caused the advancement of scientific data sets to be delayed for years. However, in the sixties and beyond there was an increased amount of data generated in the area of climate change and the contribution of humans.

By the event of the Second World War, there were massive technological improvements and new ways to measure climate variables, such as atmospheric levels of carbon dioxide.(12) New information around water vapor and radiation absorption lead even more scientist to conclude that carbon dioxide would play a role in trapping radiation, leading to warming of the earth. At the same time, studies of the oceans revealed that carbon dioxide is absorbed by the oceans in large amounts but it also returns much of what it has absorbed. This information lead scientists to the conclusion that the oceans were not going to be a total sink for anthropogenic carbon dioxide as it was once hoped. Out of this time of scientific discovery emerged Charles Keeling who used the most modern technology available to measure the concentration of atmospheric carbon dioxide in the geographic locations of the Antarctic and Hawaii. The results of his work, known as Keeling CO₂ curves, have shown increases in concentrations since they were first measured n 1958.(13) The Keeling curves have become one of the foundations for the study of global warming.

Maslin asserts that there was enough scientific data by the 1960's to state with confidence that carbon dioxide would have a future role in the warming of the earth. (14) The delay in recognizing the global warming threat could have been that the power of the global mean temperature data set was not yet sharply rising as the 70's actually showed a cooling. Another reason for delay may have been that the public awareness over global warming had not risen to any heightened level of concern. It was not until the 1980's as the global annual mean temperature began to increase steeply that earlier work was given credence. The global warming theory was no longer dormant and continues to be a controversial issue in American society.

Gathering Evidence for Global Warming

The theory of global warming is based in evidence from a variety of temperature measuring techniques that are then correlated other readings of temperature and other significant greenhouse gas data. Ground-based temperature measurements are gathered from thousands of land stations around the world. According to Green, there are literally millions of individual temperature readings being taken every year using a regular glass thermometer. (15) The largest collection of surface temperature data is maintained by the United States National Oceanographic and Atmospheric Association.(NOAA) Because temperatures fluctuate during times of the day and by location of the readings, the temperature data for a specific area is represented by the way it differs from an average temperature observed for that location over a long period of time. These temperature value are called anomalies and therefore do not represent actual temperatures, but rather the temperature for that area was warmer or cooler than average for the time in which the reading was taken. The argument is that trends have shown that the earth's atmosphere is warming up over time. The Intergovernmental Panel on Climate Change (IPCC) investigators concluded that since the year 1850 the warming trend ranges from 0.4 °C to 0.8 °C. In other words, the average temperature of the earth's atmosphere near the earth's surface was between 0.4 °C to 0.8 °C warmer than it was in the year 1850.(16)

Other sources of data collection for temperature include taking measurements form weather balloons, ships, and satellites. Each of these methods contributes temperature data to once again create temperature anomalies. Of these methods, the satellite data is National Climate Data Center.(NCDC) Reports from the satellite data, given in 1998 by the NCDC has shown that the planet is warming overall but not in an even manner. (17) The Northern Hemisphere appears to be warming more rapidly than the Southern Hemisphere. There are parts of the United States that seem to be cooling. The night warming is greater than warming during the day and also greater in summer than in winter.

Additional methods for collecting temperature information from over a span of many years are found in boreholes, ice cores and tree ring analysis. A borehole is when investigators bore a deep hole in ice, soil, or mud. Scientists will look at the different layers of the soil with the geological lens and determine conditions of time periods of the past. Ice cores are thin, long cylinders of ice that have within them trapped bubbles of the air from time periods long ago. Gas types from the cores are representative samples of the atmosphere that existed when the air was

originally trapped. With this core, researchers can also uncover temperature patterns and carbon dioxide concentrations of various times. Tree rings reveal temperature change according to their size in any given growth season. The warmer the temperature, the greater the size of the growth ring. Climate investigators have been able to estimate temperatures from as far back as 1000 A.D. for some tree species. (18) Temperature estimates from tree rings suggest that there is temperature warming in the Northern Hemisphere but inconclusive data for the Southern Hemisphere.

Relative sea level is yet another indicator of global warming in that the melting of ice sheets and precipitation increases have contributed to the overall rise in sea levels. The IPCC has compiled data from the past 100 years and it shows that the global sea level has risen in the range of 4 to 14 cm. (19) In 1990 the IPCC scientist predicted three possible outcomes in the amount of sea level rising that would occur if the production of greenhouse gas emissions increased, stayed the same, or were to be less than we currently produce. The range in global sea level increase would be anywhere from 30 cm at the best to as much as 100 cm if greenhouse gas emissions were to increase.

How Reliable is the Evidence?

There are many concerns raised not only about the methods and instrumentation used in collecting temperature data but also about what the information gathered actually means. Critics of the measurement process have said that the land temperature readings secured are exaggerated because many of the collecting stations are close to large cities. The term for such a condition where the temperature is higher near a city than in its surrounding area is called the 'urban heat island'. (20) Early investigators were not familiar with this condition and therefore their information can be considered potentially biased. On the other hand, IPCC investigators claim to have taken into account the urban heat island effect and stand by their calculations as being an accurate reflection of temperature changes over the past century. Another response to the claims of temperature change over the past 150 years is that this period of time is very minimal as relative to the four billion years of the earth's evolving temperature changes. One analogy given for this line of argument is that of all of the earth's history of climate change and squeezed it into a twenty-four hour period, human direct measurement of climate change would occupy only the last three one thousandths of a second. (21) This argument sounds valid on the surface but it does not take into account the short span of time it has taken humans to overpopulate and exploit the resources of the earth. There is no question that humans have contributed to climate causing variables in mass quantities in an

extremely short period of time. It is like reaching the peak of a majestic mountain after many months of climbing, with great effort required in repelling back down.

What Information Can Be Considered Accurate?

When talking about what can be relied on in the area of global warming data, the Intergovernmental Panel on Climate Change (IPCC) comes to mind. The IPCC or was established in 1988 jointly by the United Nations Environmental Panel and World Meteorological Organization in response to growing international concerns about the potential of global warming. (22) The purpose of the IPCC is to assess the state of knowledge on the many aspects of climate change including scientific, economic, environmental, and any possible response strategies. The IPCC is organized into three working groups plus a task force to calculate the amount of greenhouse gases (GHG) produced in each country. Each working group is headed by individuals of a developed country and a developing country. Each group has a specific focus in relation to climate change and greenhouse gas (GHG) emissions. One point to be made is that IPCC also provides governments with the relevant scientific findings, socio-economic information, and the risks of global climate change.

The IPCC also compiles research on the main GHG, their origin and their warming potential. (23) The latest reports from the organization were published in 2001 and involved 400 experts from 120 countries in the direct writing, editing, and finalizing stages. Another 2,500 experts participated in the review process. All in all, the IPCC is a clearing house for the most recent and accurate information on climate change worldwide. As far as scientific information is able to be considered meaningful, the reports from the IPCC seem to be what the science community considers accurate.

Kenneth Emanuel, in his book entitled *What We Know About Climate Change*, discusses two categories of findings that are handed down from the IPCC. (24) The first category refers to findings that are not in dispute. Some examples are: 1.) greenhouse gases such as carbon dioxide, methane, ozone, and others are increasing due to fossil-fuel consumption, 2.) carbon dioxide has increased nearly 35% from its pre-industrialized level, 3.) the earth's average surface temperature has increased by about 1.2 °F in the past century, 4.) sea level has increased about 2.7 inches, and 5.) the arctic ice has decreased by 15 to 20% since its first measurement in 1978. (25) The second category is described as those findings that most scientists agree with but that are disputed by some. The following are listed as examples of the second category: 1.) the global mean temperature (GMT)

is now greater than at any other time in the last 1,000 years, 2.) most of the GMT variability is caused by four factors: variability of solar output, major volcanic eruption, and greenhouse gas emissions, 3.) as a result of the thermal expansion of sea water and the melting of the polar ice caps, sea level will increase six to sixteen inches, 4.) incidence, intensity, and duration of both floods and drought will increase. (26) The majority of the disputed points about global warming seems to arise from the attempts to predict what might be the possible outcomes if the current or increasing levels of GHG, as well as other important climate variables, are entered into computer models of future climate systems.

The Use of Computer Models to Predict Future Climate Change

Emanuel can be quoted as saying that “Computer modeling of global climate is perhaps the most complex endeavor ever undertaken by mankind”. (27) After reading certain IPCC publications about climate change, I certainly believe and can relate to this statement. As stated in an IPCC historical overview chapter of their fourth assessment report, a parallel evolution of computer models that are both increasingly more complex and have better resolution capabilities have increased the quality of numerical weather prediction. (28) Not to misrepresent the value of simpler models, the IPCC describes their models as being more layered or hierarchical in nature. The concept of model hierarchy is also associated with the idea of scale. Global models are complemented with more regional models that are able to give better resolution in a given area.

With the advancements of supercomputing and the experience of using models for many years, the scientific community is honest about the perceived corrections that accompany the use of any model for predicting climate change. Because of the complicated interactions of the many variables involved in climate change, without the knowledge of how the system will respond to each variable as a whole, the IPCC has documented these prediction problems with the hope that they can be resolved as time passes and technology continues to improve. The bottom line is that the IPCC has the responsibility to gather and analyze new and existing scientific data that has emerged as well as the modeling methods in which the data will be used to predict the future of climate change. It seems, therefore, that the scientific measurements taken for such GHG as carbon dioxide or methane are reasonably trustworthy sets of data in the eyes of the IPCC. The acknowledged problems, however, arise when those data sets are part of the models that will be used to predict future climate change.

Predicted Potential Impacts of Increased Global Warming

As previously mentioned, the fundamental problem that the IPCC has with predicting potential impacts from global warming is that there are so many complexities in trying to reach a reasonable outcome. The solution to the problem, simply stated, is that the IPCC runs many different scenarios around a particular condition number of times. This produces a range of outcomes. The goal is that the reality of the future will fall within the range that was forecasted. With that being said, there are a number of key areas where the IPCC is concerned about potential impact of climate change. These areas of concern are the mean temperature of the earth, the coastlines, storms and floods, human health, biodiversity, and agriculture. (29) Of these areas, I would like to focus on the topic of the impact upon biodiversity with a concentration on the local region of Pennsylvania.

Content and Performance Objectives

The educational activities associated with this unit are an integral part of the Pittsburgh Public School Core Biology Curriculum. The topic for the classroom lessons focus on the local potential impact of global warming on the biodiversity of Pennsylvania. In general, students will first be completing a larger unit entitled “How have human actions affected biodiversity in Pennsylvania?” The larger unit deals primarily with issues of wetlands and water systems. I would like to enrich that unit by concentrating on the plant and animal diversity and the potential impacts of global warming if the mean temperature of our state were to increase.

This unit, as written, will address two key environmental standards as they relate to biodiversity. The standards are based on the tenth grade level, which is the level at which my Biology course is taught. The first standard deals with environmental health. (4.3.10.C) Students are expected to be able to explain how biodiversity is an indicator of a healthy ecosystem by the end of their lessons. The second key standard that is integral to the unit is titled ‘humans and the environment’. Students will be expected to analyze how human activities may cause change in an ecosystem. (4.8.10.C) A complete list of standards covered in this unit is located in the appendix. Students will use their prior knowledge of the role biodiversity plays in an ecosystem and then explain how that set of conditions will be impacted if there is significant global warming in our state. It is my hope that taking a local flavor for this issue will lead students to take action on ways in which they could make a positive difference on this issue.

Strategies

There are two different content sets that students will need to acquire and eventually marry if they are to understand biodiversity as it relates to global warming. Students will have already learned about the cycling of matter and energy through a community. The majority of newly acquired knowledge will be on the idea of climate change in general and global warming in particular. The following instructional methods may be incorporated into the classroom lessons in order to assist students in reaching the objectives. Available time and purpose for the lesson will determine the best strategies for the particular lesson.

- ❖ Teacher Lecture with coupled internet images and animation.
- ❖ Basic gas demonstrations/experiments using carbon dioxide.
- ❖ Reading Strategies: Guided reading, concepts map, note taking, personal vocabulary.
- ❖ Writing Skills: *Write Tools* format for summary and multi-paragraph informational writing.
- ❖ Library Research: Webquest or similar organized internet data search.
- ❖ Students presentations (Power Point or poster/ gallery walk)
- ❖ Evaluation

Classroom Activities

Classroom activities will require anywhere from seven to ten class periods. This is the amount of time that would be required to reach any depth of understanding about global warming as there is an abundance of literature on the subject. Likewise, the reading tends to be scientific data and corresponding analysis. Additional skill set development for the students will be necessary in order to teach students to differentiate important data from information that does not pertain to their focus. This activity will incorporate district initiatives as the material is by its nature rigorous and will require the students to be accountable for the knowledge that they are gaining. The first activity will be an introductory lesson that will determine how much the students know about global warming.

They will complete a KWL chart, write a short brainstorming list, or write paragraph based on a prompt.

The next activity planned will be a library research activity where the students will be given a number of websites to gather specific information to collect. The object of the research is to gather information on greenhouse gases and their potential impact on the earth. There will also be information gathered as to what the critics of global warming argue. As the unit progresses, students will be expected to read and summarize articles as homework. The library also has a smart board available for teacher's to use with classes who are there. I will choose a difficult of significant area of research or experimentation to deliver in this manner.

As written in the curriculum, students will be able to create a poster that illustrates their stance on the issue. These posters will be placed in the hallway and become accessible to their peers. This will be a way in which students can take action at the school level to show their beliefs and concerns. Students will be encouraged to create power points also, but they will still need to create a poster. There will be a rubric for grading the posters that the students will have prior to their activity. The students will be asked to clearly illustrate the role of global warming on the biodiversity of Pennsylvania.

An integral piece to the poster activity will be to have a gallery walk. This is where there is one student or two left at the poster to answer questions from the rest of the walkers. Each group of students that are left behind will rotate into the walk when the group mates are finished with their viewing of the other posters. The gallery walk highlights that science sometimes leads to scientific consensus, different views of the same idea, or just plain disagreement with the existing theory. In many ways this parallels how science is done in the real world, as scientists are required to defend their reasonable ideas and are under the scrutiny of their peers in the scientific community.

I have found in my experience that teenagers are generally open minded and very passionate about global issues, whether they are scientific or not. This is a good age and a timely way to introduce the complicated nature of such issues to high school students. I believe that students who are exposed to multi-faceted and complex issues will be the ones who will be able to decide in the future where they stand on issues as voting citizens. Maybe we are planting a rudimentary skill set or an emotional seed that will one day grow into a source of conviction that leads to them taking positive actions on issues of their time

Classroom Lessons

The Research Paper is one option for a culminating activity for this unit. The following outline was presented to the class prior to the activity.

Global Warming Research Paper Biology 1

Directions: Use the information from the questions that you answered in the library. Write a five paragraph paper on what you have learned about global warming. Use format below to help you organize your information. Final copy must be in pen or typed.

Cover Page: Your name, title of paper, class name, period, date

Paragraph 1: Introduction

Thesis statement

Paragraph 2: Day 1 information in narrative form

What is global warming?

What are the two general sources of global warming?

What is the greenhouse effect?

What are greenhouse gases and what role do they play in the warming of the earth?

Paragraph 3: Day 2 information in narrative form

What is biodiversity?

Why is biodiversity important?

Describe at least three possible effects of global warming on PA wildlife.

Describe a health and economic effect of global warming in PA.

Paragraph 4: Day 3 information in narrative form

What impact does your family contribute to global warming?

(i.e. pollution or energy use)

List and describe at least three ways we are able to decrease the amount of pollution we make or the energy that we use everyday.

Paragraph 5: Summarize information.

Draw conclusions or state observations

Restate thesis statement in a new way

Reference List: Cite and briefly describe each of the websites used in researching this topic.

Activity Decomposition by Daily Lesson

Each day the students were given a handout with focus questions and website references that they were allowed to visit during their time in the computer lab. This structure helped to keep students on task and at the recommended websites. Any additional web activity was to be done at home and cited in their paper. Each day of research corresponds to a paragraph of their paper. Students were encouraged to write beyond the scope of the outlined focus but were required to answer the basic research question of the impact of global warming on the biodiversity of Pennsylvania. The multi-paragraph paper was fashioned on a writing program used in the Pittsburgh Public Schools (PPS) and evaluated using a standard PPS informative writing rubric. The rubric appears at the end of the lesson after the sample cited works. The three days of lesson handouts are as follows:

Day 1 Lesson Handout

The Potential Impact of Global Warming on Biodiversity in Pennsylvania

Biology I Research Project

Objective: Students will be able learn fundamental concepts concerning global warming and its potential impact on the future of animal life in Pennsylvania.

Students will write a multi-paragraph paper which explains the nature of global warming, its potential impact on regional biodiversity, and what action we can take to deal with the issue.

Day 1

Focus: What is global warming?

What are the two general sources of global warming?

What is the greenhouse effect?

What are greenhouse gases and what role do they play in the warming of the earth?

Web Sources: www.ipcc.ch

Historical Overview of Climate change Science
Chapter 1 (pp.95-103, 115-116)

Assessment Report 4
Climate Change 2007: Synthesis Report (pp. 26-40)

Appendix I: Glossary (pp.869-883)

THIS IS THE ONLY SITE YOU ARE TO BE ON TODAY.

Day 2 Lesson Handout

Day 2

Focus: Biodiversity in Pennsylvania

1. What is biodiversity?
2. Why is biodiversity important?
3. Describe at least three possible effects of global warming on PA wildlife.
4. Describe a health and economic effect of global warming in PA.

Web Sources: 1. www.pabiodiversity.org
Go to What is Biodiversity? icon.

2. www.nwf.org/globalwarming
Go to global warming in your state fact sheets.
Click on Pennsylvania

THESE ARE THE ONLY WEBSITES YOU ARE TO BE ON TODAY

Day 3 Lesson Handout

Day 3

Focus: What Can We Do to Slow Global Warming?

1. What impact does your family contribute to global warming? (i.e. pollution or energy use)
2. List and describe at least three ways we are able to decrease the amount of pollution we make or the energy that we use everyday.

Web Sources: www.fightglobalwarming.com

Calculate your impact tab

Complete the questionnaire for everyone in your household.

Write down your final amount.

Go to what you can do tab

www.stopglobalwarming.org

THESE ARE THE ONLY WEBSITES YOU ARE TO BE ON TODAY

Lesson Cited Websites

Global Warming Research Paper

Student Annotated Reference List

www.ipcc.ch – Intergovernmental Panel on Climate Change

www.pabiodiversity.org- Pennsylvania wildlife info

www.nwf.org/globalwarming - Global Warming and Pennsylvania

www.fightglobalwarming.com - Human impact on global warming

www.stopglobalwarming.com – Articles on reducing global warming

Pittsburgh Public Schools Informative Writing Rubric

The location for this rubric is:

http://www.pps.k12.pa.us/14311061314171993/lib/14311061314171993/Portfolio%20Rubrics%206-12/informative_rubric.doc

End Notes

1. Scoones, Simon, Climate Change: Our Impact on the Planet, 2002, Raintree Steck-Vaughn pp 10-11
2. Green, Kenneth, Global Warming: Understanding the Debate, 2002, Enslow, pp.29-30.
3. Ibid. p.96
4. Emanuel, Kerry, What We Know About Climate Change, 2007, MIT Press, p. 5.
5. Ibid. p.6
6. Sneider, Stephen H. and Randi Londer, The Coevolution of Climate & Life, 1984, Sierra Club Books, p.28.
7. Ibid. p. 260
8. Ibid.
9. Ibid.
10. Maslin, Mark, Global Warming: A Short Introduction, 2004, Oxford Press, p. 23
11. Ibid, p. 24
12. Ibid, p. 25
13. Ibid, p. 26
14. Ibid, p. 28
15. Green, Kenneth, Global Warming: Understanding the Debate, 2002, Enslow, p.44.
16. Ibid. p.45
17. Fridell, Ron, Global Warming, 2002, Franklin Watts p.46
18. Green p. 61
19. Maslin. P. 53
20. Green p. 49
21. Ibid p.46
22. Maslin p.13
23. Ibid. p. 15
24. Emanuel, Kerry p. 60
25. Emanuel, Kerry pp. 60-61
26. Emanuel, Kerry pp. 62-63
27. Emanuel, Kerry pp. 39
LeTreut, H.R. and others, 2007: Historical Overview of Climate Change. In: Climate Change {Solomon and others}, Cambridge University Press, United Kingdom and New York, NY, USA., p.113.
28. Maslin. pp.83-101

Teacher Reading List

Books

Emanuel, Kerry, What We Know About Climate Change, The MIT Press, Cambridge, 2007.

Fridell, Ron, Global Warming, Franklin Watts, New York, 2002.

Green, Kenneth, Global Warming: Understanding the Debate, Enslow Publishers, Berkeley Heights, 2002

Maslin, Mark, Global Warming: A Very Short Introduction, Oxford University Press, Oxford 2004.

Schneider, Stephen H. and Randi Londer, The Coevolution of Climate & Life, Sierra Club Books, San Francisco, 1984.

Scoones, Simon, Climate Change: Our Impact on the Planet, Raintree Steck-Vaughn Publishers, Austin, 2002.

Student Reading List

Fridell, Ron, Global Warming, Franklin Watts, New York, 2002.

Green, Kenneth, Global Warming: Understanding the Debate, Enslow Publishers, Berkeley Heights, 2002

Websites

www.climatevision.gov Voluntary Innovative Sector Initiatives

www.doe.gov United States Department of Energy

www.eia.doe.gov Energy Information Administration

www.fightglobalwarming.com Calculator for Energy Impact

www.ipcc.ch Intergovernmental Panel on Climate Change (IPCC)

www.noaa.gov National Oceanic and Atmospheric Administration

www.pabiodiversity.org Loss of biodiversity in Pennsylvania

www.pgc.state.pa.us Habitat loss in Pennsylvania

www.nwf.org Global warming and Pennsylvania

www.stopglobalwarming.org Tips for Reducing Energy Usage

APPENDIX A

PA Assessment Anchors

Pennsylvania's public schools shall teach, challenge and support every student to realize his or her maximum potential and to acquire the knowledge and skills needed to...

S11.A.1.2.1 Apply and explain scientific concepts to societal issues using case studies (e.g., environmental health).

S11.A.1.3.3 Describe how changes in physical and biological indicators (e.g., soil, plants or animals) of water systems reflect changes in these systems (e.g., changes in bloodworm populations reflect changes in pollution levels in streams).

S11.A.3.2.3 Describe how relationships represented in models are used to explain scientific or technological (e.g., topographic maps).

S11.B.3.1.1 Explain the significance of diversity in ecosystems.

S11.B.3.1.3 Describe how living things affect the survival of one another.

S11.B.3.2.2 Explain biological diversity as an indicator of a healthy environment.