Unit Title: Global Climate Change: Pandora's Box **Date Developed/Last Revised:** July 9, 2013 **Unit Author(s):** Maggie Prevenas	**Grade Level:** 7-8 **Time Frame:** Three weeks or sixteen 45 min periods Please consider selecting individual lessons based on your instructional time frame. **Primary Content Area:** Science and Technology

UNIT DESCRIPTION:

Students observe and quantify global climate change by viewing photographs, comparing climate data from the past and present, and by analyzing trends in global temperature change. They explore the role of the carbon cycle in regulating global temperature in a role playing game and describe how the "biological pump" sequesters, or stores, carbon in the atmosphere and oceans. Students are introduced to ocean fertilization and how it is hypothesized to decrease rising global temperatures. Students use different resources to learn how businesses and scientists are experimenting with artificial regulation of the carbon cycle through a process known as ocean fertilization. They investigate the positive and negative effects of fertilization of the ocean by humans and create a list including both pros and cons. Finally they present their opinion in a three minute presentation before a 'mock county council budget hearing.' A reflection activity "A Modern Pandora's Box" has students choosing positive and negative outcomes from ocean fertilization, representing them as metaphors in the proverbial Pandora's Box and sharing their reflection with the class.

Big Ideas (Student Insights that Will Be Developed Over the Course of the Unit):

- Scientists use models to demonstrate ideas, explain observations, and make predictions.
- Scientific explanations are based on evidence gathered from observations and investigations.
- The Sun is the source of energy for most life on Earth.
- Technology is commonly used to locate, evaluate, and collect information from a variety of sources.
- Climate varies through space and time and is impacted by complex interactions among living and non-living components of the ecosystems on Earth, including both natural and man-made processes.
- Humans can reduce climate change and its impacts through informed decision-making and integrated approaches.

Essential Questions (Questions that Will Prompt Students to Connect to the Big Ideas):

How does the ocean act to sequester carbon?

What kinds of consequences does ocean fertilization have on the earth system and human lives?

	BENCHMARKS/STANDARDS/LEARNING GOALS
Science	**SC.7.1.1** Design and safely conduct a scientific investigation to answer a question or test a hypothesis **SC.7.2.1** Explain the use of reliable print and electronic sources to provide scientific information and evidence **SC.8.2.1** Describe significant relationships among society, science, and technology and how one impacts the other **SC.7.3.2** Explain the interaction and dependence of organisms on one another **SC.7.3.3** Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem **SC.8.8.4** Explain how the sun is the major source of energy influencing climate and weather on Earth
Technology	**CTE.7.1.1** Design, modify, and apply technology to effectively and efficiently solve problems **CTE.7.2.1** Apply appropriate and safe behaviors for the school, community, and workplace **SC.8.2.1** Describe significant relationships among society, science, and technology and how one impacts the other
Engineering	**CTE.7.1.1** Design, modify, and apply technology to effectively and efficiently solve problems **STEM Competency 6.4:** Demonstrates creative thinking, constructs knowledge, and develops innovative products and processes using technology
Mathematics	**CCSS.Math.Practice.MP1** Make sense of problems and persevere in solving them. **CCSS.Math.Practice.MP4** Model with mathematics.
English Language Arts and Literacy	**CCSS.ELA-Literacy.RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. **CCSS.ELA-Literacy.RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **CCSS.ELA-Literacy.RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). **CCSS.ELA-Literacy.WHST.6-8.1** Write arguments focused on *discipline-specific content.* **CCSS.ELA-Literacy.WHST.6-8. 8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. **CCSS.ELA-Literacy.WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research.
STEM Competencies	**STEM Competency 2.2:** Collaborates with, helps, and encourages others in group situations **STEM Competency 4.1:** Recognizes and understands what quality performances and products are **STEM Competency 6.4:** Demonstrates creative thinking, constructs knowledge, and develops innovative products and processes using technology

LESSON SEQUENCE

	Lesson Title/Description	Learning Goals (What Students Will Know and Be Able to Do)	Assessments	Time Frame
1	**Global Climate Change** Students observe changes in global temperature by viewing photographs, comparing climate data from the past and present, and analyzing trends in global temperature change.	• Make observations of global climate change from a variety of resources • Describe how human activities are impacting the climate system	**Formative:** Write an exit slip that summarizes the evidence for global climate change	1 class period (45 min)
2	**The Incredible Carbon Journey** Students become carbon molecules that move through different Earth systems in the interconnected and complicated carbon cycle.	• Compare the carbon cycle before the industrial revolution with the carbon cycle after humans began burning large quantities of fossil fuels • Create a graph from the data collected comparing pre-industrial and post-industrial cycles	**Formative:** Analyze data to compare the presence of greenhouse gases before and after the industrial cycle	1 block period (75+ min)
3	**The Biological Pump** A Web slideshow helps students learn the processes that are involved in the biological pump. Students think about how the pump reacts to various changes in the environment, and how availability of nutrients affects the amount of carbon dioxide that is eventually sequestered in the deep oceans.	• List or draw factors that increase and decrease phytoplankton growth • Use a graphic organizer to explain the concept of the ocean as a biological pump • Read scientific articles to augment PowerPoint information	**Formative:** Use a graphic organizer to explain their understanding of the role of the ocean in regulating CO_2 in the atmosphere	1 class period (45 min)
4	**Iron Fertilization of the Oceans** Students will identify **natural** sources of iron fertilization in the oceans and describe how it affects the biological pump by reading text and interpreting photos and diagrams. They investigate human intervention using iron fertilization in oceans and explore the beneficial or detrimental effects on the environmental conditions that affect individual organisms and the dynamics of population.	• Read scientific articles to identify natural sources of ocean fertilization • Use online resources to understand the benefits and problems from human intervention in fertilizing the ocean • Use a graphic organizer to organize scientific information from a variety of resources • Use a school endorsed citation methodology to cite information from online science and technical articles	**Formative:** Add to the graphic organizer to show understanding of what natural and human introduced iron does to the ocean ecosystem Cite specific textual evidence to support analysis of science and technical texts	1 block period (75 min)

5	**Ocean Fertilization Inquiry (Part 1 and 2)** Students participate in an inquiry investigation that is based on questions raised from acidification of different water samples. Their initial findings from Lab Acid, will fuel this inquiry investigation for Lab B.	• Predict, participate, collect data, and analyze an investigation • Follow directions safely • Collect and analyze data (graph data) • Predict next step in scientific process • Design and safely conduct a scientific investigation to answer a question or test a hypothesis	**Summative:** Lab Assessment: Design and safely conduct a scientific investigation to answer a question or test a hypothesis	2 block period (75 min each)
6	**Career Exploration-Change the World, No Really. Geochemical Engineer** Take a glimpse into an emerging environmental career. Geochemical engineering is a new discipline that looks to remedy complicated and interconnected Earth system problems using geological and/or chemical solutions.	• Discuss how scientific and mathematical modeling are important tools in solving complicated environmental problems • Realize that new careers utilizing math and science are a reality • Creative problem solving is required for engineering and scientific careers	**Formative:** Convey how scientific and mathematical modeling are important tools in solving complicated environmental problems and why creative problem solving is an essential skill	1 class period (45 min)
7	**Take It To The Streets-County Council Budget Hearing** After researching scientific articles, online multimedia, and other resources on the role of the carbon cycle and biological pump in regulating greenhouse gases in the atmosphere and ocean, students write testimony for use in a three minute presentation to a county council in which a position on artificial regulation of the carbon cycle through a process known as ocean fertilization is taken.	• Independently read scientific articles and draw evidence to support analysis, reflection, or research • Evaluate evidence and specific claims in informational text and select relevant information • Use a graphic organizer to guide thinking processes in outlining a written argument • Write testimony to argue for/against ocean fertilization • Support the testimony using evidence cited from the texts • Give feedback to another student by completing the testimony feedback/rubric	**Formative:** Student feedback evaluation (rubric) **Summative:** Student written and spoken 3 min testimony (rubric)	2 block periods (75 min each)
8	**Reflect: A Twentieth Century Pandora's Box** Students work in groups of two (pro and con) to brainstorm how Pandora's Box is a metaphor for the controversial issue of ocean fertilization. They create objects to represent the objects in their box and present it to peers in a whole class reflection.	• Create a modern-day version of Pandora's box as a metaphor for iron fertilization of the ocean. • Rate the efforts of peers	**Summative:** Reflection	1 block period (75 min)

This unit was inspired by: Maryland State Department Of Education, Programs, Ocean Education Resources, http://www.marylandpublicschools.org/MSDE/programs/environment/oceanscience.htm

Unit Title: Global Climate Change: Pandora's Box Lesson Title: Global Climate Change Date Developed/Last Revised: July 9, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 1 Grade Level: 7-8 Primary Content Area: Environmental Science/Technology Time Frame: 45 min

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.7.2.1** Explain the use of reliable print and electronic sources to provide scientific information and evidence
- **SC.8.8.4** Explain how the sun is the major source of energy influencing climate and weather on Earth
- **CCSS.ELA-Literacy.WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research.

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Independently read scientific information and draw evidence to support analysis, reflection, or research
- Evaluate evidence and specific claims in informational text and select relevant points
- Make observations of global climate change from a variety of resources
- Describe how human activities are impacting the climate system

2B. Assessment Tools/Evidence:

Formative:

- Activity guide to highlight evidence and summarize text from scientific articles
- Exit slip that summarizes the evidence for global warming

3. Learning Experiences (Lesson Plan)

Materials:

- Computer with projector or document projector

Handouts/Other Resources:

- Activity 1: Global Temperature Change
- Student Exit Ticket Lesson 1
- NOAA PowerPoint "How Do We Know The World Is Warming?" (from http://cpo.noaa.gov/warmingworld/ Click on "Download the Warming World Presentation for use in your classroom" in the bottom right corner of the page)
- Sea Level Rise Website, www.soest.hawaii.edu/coasts/sealevel, June 10, 2013

Procedure:

- Project the NOAA PowerPoint "How Do We Know The World Is Warming?"
- Lead students through the observation process:
  1. Present students with the PowerPoint**.**
  2. Students record their observations for each linked page, beginning with the statement "I see."
  3. Students discuss trends seen in the data.
  4. Students share observations, interpretations, and conclusions and hypothesize reasons for the trend.
  5. Each student summarizes in one sentence (in writing) her/his interpretation. This is an exit slip that will be collected by the teacher at the end of the hour.
  6. Students pose additional questions that could be answered with additional data on their student handout.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Name _____Date: _____

Activity 1: Global Temperature Change
NOAA Warming World Slide Interactive

Observations from data (photos, graphs, and diagrams):

Trends in Data:

Additional Questions or Data Needed:

Summarize your observations about global temperature change.

_____

_____

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Student Exit Ticket Lesson 1 Name:_____

How do we know the world is warming? Write a one sentence summary of what you learned from the PowerPoint.

Student Exit Ticket Lesson 1 Name:_____

How do we know the world is warming? Write a one sentence summary of what you learned from the PowerPoint.

Student Exit Ticket Lesson 1 Name:_____

How do we know the world is warming? Write a one sentence summary of what you learned from the PowerPoint.

Student Exit Ticket Lesson 1 Name:_____

How do we know the world is warming? Write a one sentence summary of what you learned from the PowerPoint.

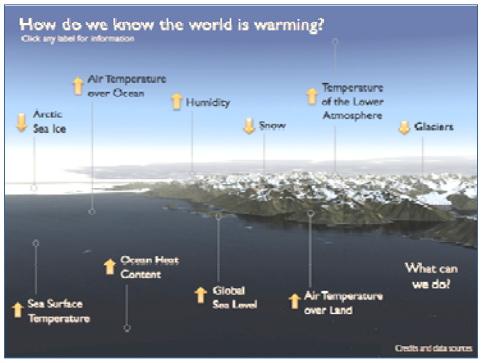
How do we know the world is warming?

An interactive presentation about climate change from NOAA

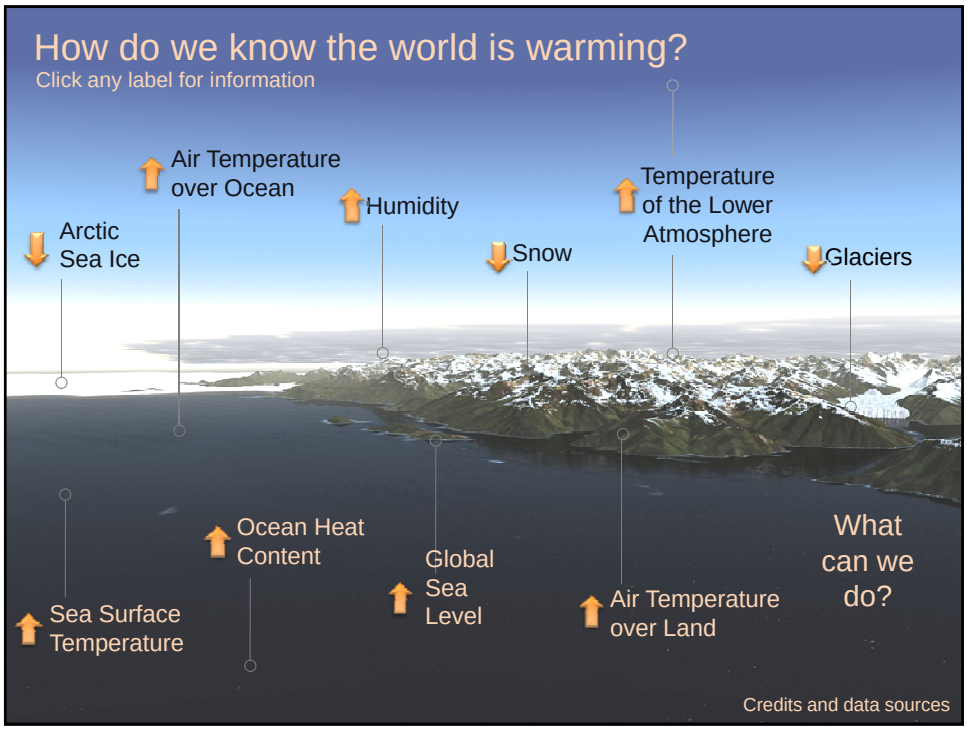
Instructions:

In Slide Show mode, go to slide #2 and click any label to jump to a slide of additional information

- Return to the main slide by clicking “Back”
- If you have Internet access available, click “Data” to launch a browser and display an interactive graph of scientific datasets that support the statement on the slide



Slide #2



Temperature of the Lower Atmosphere

Measurements from satellites and weather balloons show that the lowest layer of the atmosphere—where we live, airplanes fly, and weather occurs—is warming. Greenhouse gases are building up in this layer, trapping heat radiated from Earth's surface and raising the planet's temperature.

Data Back

Humidity

Measurements over land and water show more water vapor in the air. The air feels stickier when it's hot, and air conditioners have to work harder for us to feel comfortable.

Data Back

Air Temperature over Ocean

Thermometers on ships and floating buoys show that air near the ocean's surface is getting warmer, increasing its ability to evaporate water.

In turn, we see an increase in heavy precipitation events and flooding on land.

Data Back

Air Temperature over Land

Satellites and weather stations on land show that average air temperature at the surface is going up.

Consequently, we see an increase in the number of heat wave events and the area affected by drought.

Data Back

This sign in Paris gave a phone number people could call to find out if their loved ones were among the victims who died during a heat wave there in 2003.

Ocean Heat Content

Temperature sensors on buoys and in “floats” that move up and down through the ocean show an increase in the heat energy stored in the top half-mile of ocean water.

Warming causes water to expand, raising global sea level. Higher water temperatures can also affect marine ecosystems, disrupting fisheries and the people who depend upon them.

Data Back

Glaciers

Historical paintings, photographs, and other long-term records show that most mountain glaciers are melting away.

People who depend on water from melting glaciers for their living needs, crops, and livestock are facing potential shortages.

Data Back

Snow

Satellite images show that the area of land covered by snow during spring in the Northern Hemisphere is getting smaller.

Snow is melting earlier, changing when and how much water is available for nature and people.

Data

Back

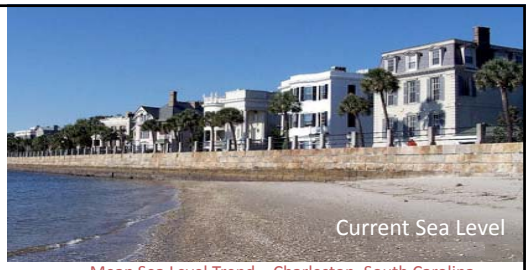
Global Sea Level

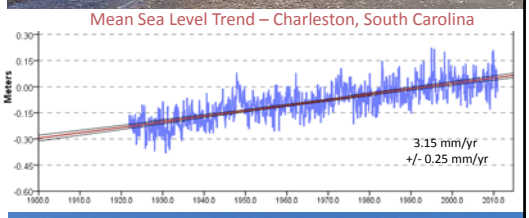
Tide gauges and satellites that measure the distance from their orbit to the ocean's surface both show that global sea level is getting higher.

Rising waters threaten ecosystems, freshwater supplies, and human developments along coasts.

Data

Back



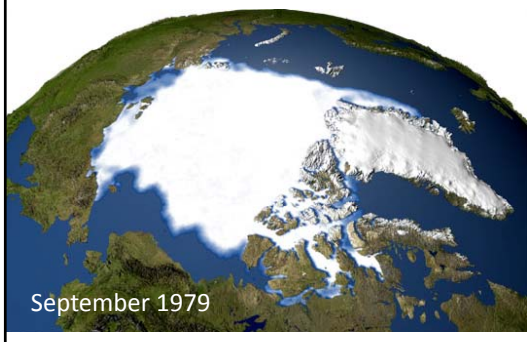


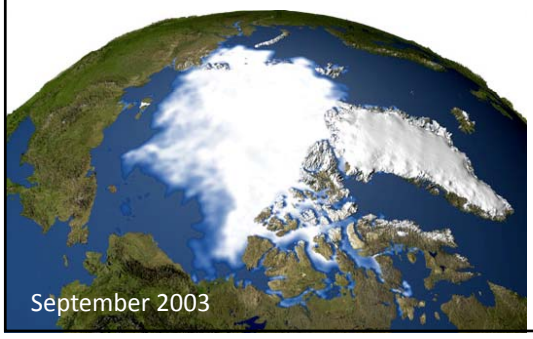
Sea Surface Temperature

Satellite sensors and thermometers on ships and buoys show that the temperature of water at the ocean's surface is rising.

Warm surface waters can damage coral reefs, reducing opportunities for fishing and tourism, and leave coasts vulnerable to storm surges and erosion.

Data Back





Arctic Sea Ice

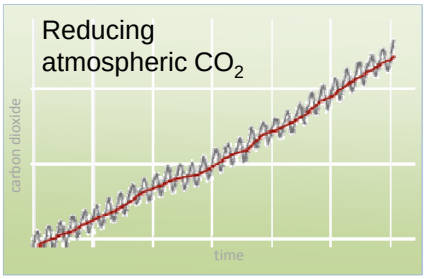
Satellite images show that the area covered by sea ice in the Arctic is getting smaller.

While a decrease in sea ice may open new shipping routes and provide easier access to natural resources, it may also introduce concerns related to national security and invasive species.

Data Back

Mitigation

Reducing greenhouse gas emissions or removing carbon dioxide from the atmosphere can lessen the severity of climate change impacts



Click graph for examples

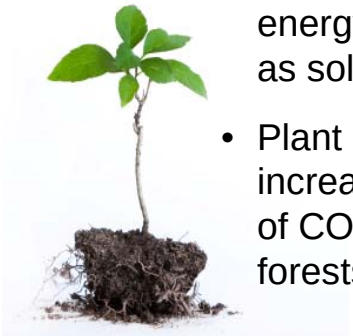
Adaptation

Taking action to minimize vulnerability to climate change impacts can smooth our transition to a warmer world

Click image for examples

Back

Mitigation – Reducing CO_2



- Develop new habits to eliminate wasted energy
- Switch to carbon-free energy sources such as solar and wind
- Plant new trees to increase the amount of CO_2 taken up by forests

Back One Slide

Assessing a region's ability to handle runoff from heavier precipitation

Adaptation –

Anticipating and adjusting to new conditions

- Protect habitat or structures threatened by sea level rise
- Develop plans to ensure adequate water supplies
- Plant different crops
- Develop new businesses

Back One Slide

Credits and Data Sources

References:

How do we know the world has warmed? by J. J. Kennedy, P. W. Thorne,
T. C. Peterson, R. A. Ruedy, P. A. Stott, D. E. Parker, S. A. Good, H. A. Titchner, and K. M. Willett, 2010: [in "State of the Climate in 2009"]. Bull. Amer. Meteor. Soc., 91 (7), S79-106.

Global Climate Change Impacts in the United States, U.S. Global Change Research Program. Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

Interactive PowerPoint Presentation prepared by NOAA Climate Program Office. Credits for images appear in the Notes section of each slide.
All comparative statements in the presentation refer to trends measured over a minimum of 30 years.

Press **Escape** key to end presentation

Back

Unit Title: Global Climate Change: Pandora's Box Lesson Title: The Incredible Carbon Journey Date Developed/Last Revised: July 9, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 2 Grade Level: 7-8 Primary Content Area: Environmental Science/Technology Time Frame: 1 block period (75 min +)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.8.2.1** Describe significant relationships among society, science, and technology and how one impacts the other
- **CCSS.ELA-Literacy.RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **CCSS.Math.Practice.MP4** Model with mathematics.

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Compare the carbon cycle before the industrial revolution with the carbon cycle after humans began burning large quantities of fossil fuels.
- Analyze data to compare the presence of greenhouse gases before and after the industrial cycle.

2B. Assessment Tools/Evidence:

Formative:

- Create a graph from the data collected comparing pre-industrial and post-industrial cycles.

3. Learning Experiences (Lesson Plan)

Materials:

- A large room or outdoor space
- Pony Beads (regular size 8/0) blue, green, clear, and black (at least 6 of each color for every student playing)
- Signs for each of the four stations (Lithosphere, Atmosphere, Hydrosphere, and Biosphere)
- 4 bowls or containers to hold the pony beads at each station
- White pipe cleaners (2 for each player)
- Five game cubes (made from the template found in the activity)
- Clear tape
- Scissors

Handouts:

- Student data page- "Incredible Carbon Journey Game Record" see booklet page 46, http://oceanservice.noaa.gov/education/discoverclimate/
- Graph paper (for formative assessment)

Other Resources:

This activity is taken directly from the NOAA booklet:

Discover Your Changing World With NOAA,
http://oceanservice.noaa.gov/education/discoverclimate/
April 15, 2013, Activity 10, The Incredible Carbon Journey, pages 38-46

Animated Carbon Cycle, http://epa.gov/climatechange/kids/basics/today/carbon-dioxide.html. April 15, 2013

Procedure:

- Print the pages of Activity 10 from the NOAA booklet.
- Read all instructions before playing the game.
- Make all the game cubes before playing the game.
- Distribute the Student Data Page (page 46) to each student.
- Follow instructions to play the game as it represents the Earth systems before the Industrial Revolution.
- Follow instructions to play the game as it represents the Earth systems after the Industrial Revolution.
- Have students create an individual graph, plotting the number of visits to each Earth system for round 1 (before the Industrial Revolution) and round 2 (after the Industrial Revolution)
- Students add their data to a class graph of round 1 and 2.
    - Discuss differences between individual and class graphs.
    - Post class graphs. Share and compare each period's results.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Unit Title: Global Climate Change: Pandora's Box Lesson Title: The Biological Pump Date Developed/Last Revised: July 9, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 3 Grade Level: 7-8 Primary Content Area: Environmental Science/Technology Time Frame: 1 class period (45 min)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.7.2.1** Explain the use of reliable print and electronic sources to provide scientific information and evidence
- **SC.7.3.3** Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem
- **SC.8.8.4** Explain how the sun is the major source of energy influencing climate and weather on Earth
- **CCSS.ELA-Literacy.WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research.

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- List or draw factors that increase and decrease phytoplankton, zooplankton, and higher level consumer growth.
- Use a graphic organizer to explain the concept of the ocean as a biological pump.
- Independently read scientific articles to augment PowerPoint information.

2B. Assessment Tools/Evidence:

Formative:

- Students use a graphic organizer to explain their understanding of the role of the ocean in regulating CO_2 in the atmosphere.
- Students are able to discuss their assigned discussion question and answer student questions associated with their responses.

3. Learning Experiences (Lesson Plan)

Materials:

- Computer with projector
- Document projector
- 12 Computers (1 for every two students) –not necessary to be online
- Student Graphic Organizer (key) for teacher

Handouts:

- Lesson 3 - Student Graphic Organizer (1 per student)
- 6 Paper copies of each reading (see other resources)

Other Resources:
-This lesson and power point are taken from EARTH Lesson Plan – The Biological Pump, http://www.mbari.org/earth/mar_chem/Iron/bio_pump_lesson.html, April 15, 2013. It's suggested to download the PowerPoint and make it available for use offline.

-Scientific articles: Students use reading selections at different reading levels to augment PowerPoint information. These are two suggested articles:

-"Could Fertilizing the Oceans Reduce Global Warming?" http://www.livescience.com/21684-geoengineering-iron-fertilization-climate.html," April 15, 2013

-"Iron Fertilization: Savior to Climate Change or Ocean Dumping" http://newswatch.nationalgeographic.com/2012/10/18/iron-fertilization-savior-to-climate-change-or-ocean-dumping/ April 15, 2013

Procedure:

- Distribute Lesson 3 - Student Graphic Organizer to students.
- Assign each group of two students one of the discussion questions listed on the back of the Student Graphic Organizer.
- Students work in groups of two. They use the Biological Pump PowerPoint to understand the role of the ocean in cycling carbon dioxide through Earth systems.
- Students individually read scientific articles to help them understand the ocean as a biological pump and the effects of altering different factors. They will need the additional information in one of the readings to fully understand their assigned question.
- After 20 minutes, have a discussion to involve all students in answering their assigned question and presenting their response to the class.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

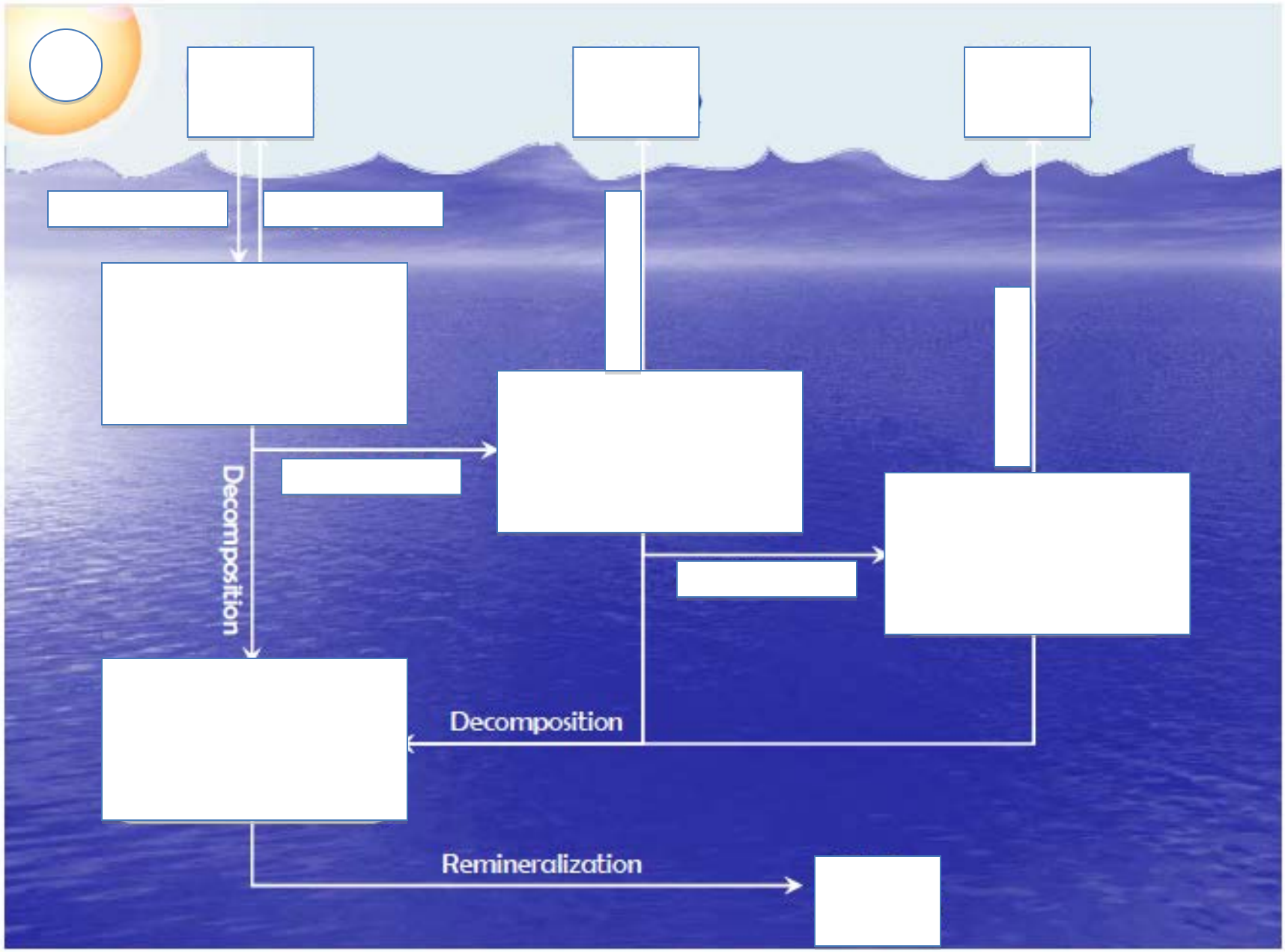
4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Lesson 3 - Student Graphic Organizer



Questions for discussion-

Your group is responsible for one of the questions below. Look for information in the PowerPoint and articles to help answer your assigned question.

1. What are important factors in phytoplankton growth?

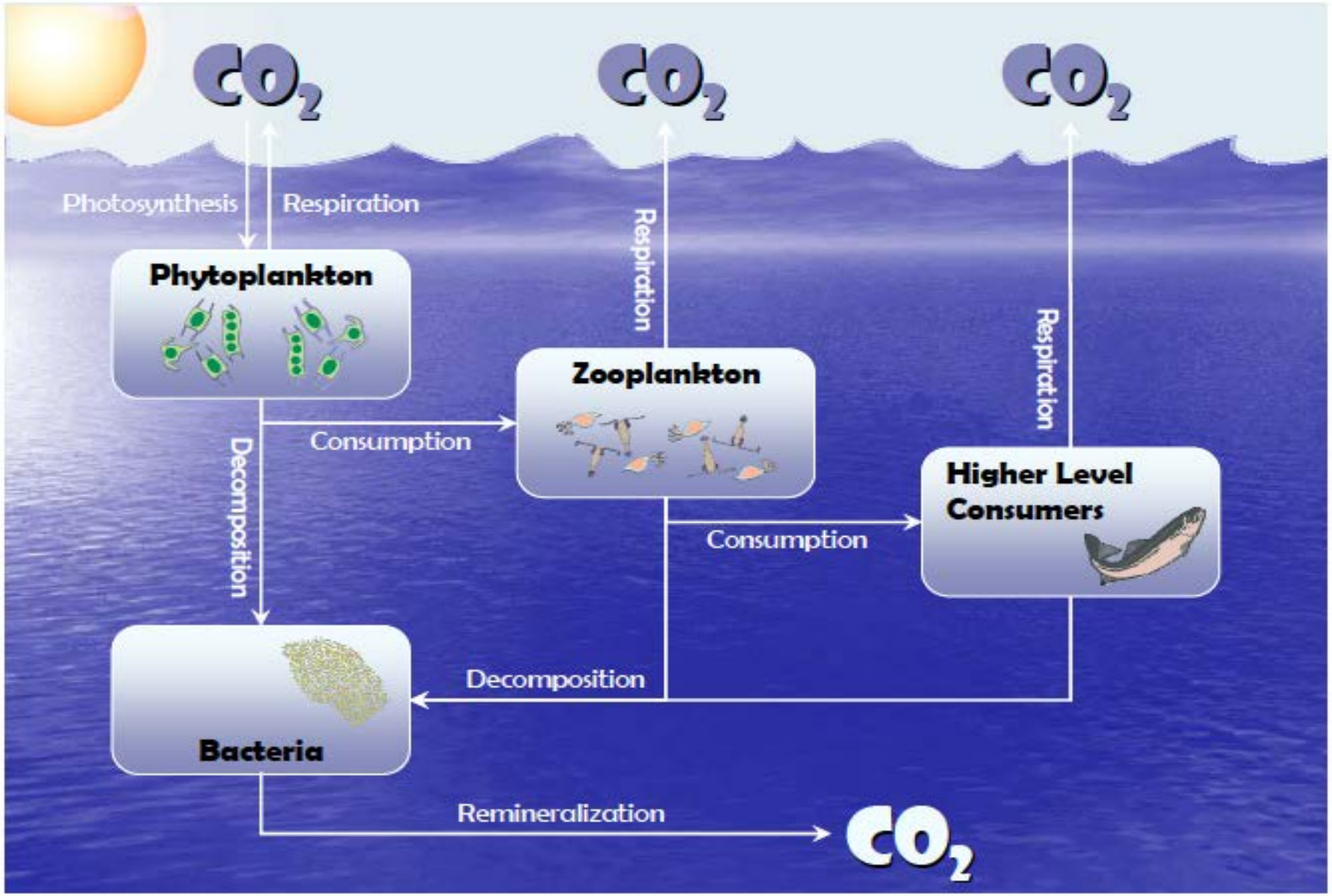
2. What would happen if the number of zooplankton grew, but the numbers of phytoplankton did not?

3. What would happen if the amount of carbon dioxide available for phytoplankton increased, but the number of zooplankton did not?

4. Why do you think this model is called the 'Biological Pump?'

5. Why do you think the Northwestern Hawaiian Islands are able to sustain so many more upper level carnivores than the main Hawaiian Islands?

Lesson 3 - Student Graphic Organizer Answer Key



Questions for discussion- (ANSWER KEY)

Your group is responsible for one of the questions below. Look for information in the PowerPoint and articles to help answer your assigned question.

1. What are important factors in phytoplankton growth?
   Carbon dioxide, sunlight, temperature of the water, number of zooplankton

2. What would happen if the number of zooplankton grew, but the numbers of phytoplankton did not?
   The phytoplankton might be consumed by an increase in zooplankton. Then the increased zooplankton would die, because there is very little food left.

3. What would happen if the amount of carbon dioxide available for phytoplankton increased, but the number of zooplankton did not?
   If the carbon dioxide increased, but zooplankton did not, there might be a bloom of the phytoplankton. This bloom would take much of the carbon dioxide out of the water, into the bodies of phytoplankton, then sink to the bottom of the ocean.

4. Why do you think this model is called the 'Biological Pump?'
   It is called a pump because carbon dioxide is being "pumped" throughout the system. It is a *biological* pump because living things are causing the carbon dioxide to flow through the system.

5. Why do you think the Northwestern Hawaiian Islands are able to sustain so many more upper level carnivores than the main Hawaiian Islands?
   Many different answers, listen to all plausible… very little human interference, excess fertilizers (from bird and fish guano) in water acting as fertilizer, coral have built in algae which feeds a huge population of secondary predators.

Unit Title: Global Climate Change: Pandora's Box Lesson Title: Iron Fertilization of the Oceans Date Developed/Last Revised: July 9, 2013 Unit Author(s): Maggie Prevenas	Lesson #: 4 Grade Level: 7-8 Primary Content Area: Environmental Science/Technology Time Frame: 1 block period (75 min +)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.7.2.1** Explain the use of reliable print and electronic sources to provide scientific information and evidence
- **SC.7.3.3** Explain how biotic and abiotic factors affect the carrying capacity and sustainability of an ecosystem
- **CCSS.ELA-Literacy.RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts.
- **CCSS.ELA-Literacy.WHST.6-8. 8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Read scientific articles to identify natural sources of ocean fertilization.
- Use online resources to understand the benefits and problems from human intervention in fertilizing the ocean.
- Use a graphic organizer to organize scientific information from a variety of resources.
- Use a school endorsed citation methodology to cite information from online science and technical articles.

2B. Assessment Tools/Evidence:

Formative:

- Students add to the graphic organizer to show their understanding of what natural and human introduced iron does to the ocean ecosystem
- Cite specific textual evidence to support analysis of science and technical texts

3. Learning Experiences (Lesson Plan)

Materials:

- 8 computers connected to the Internet
- Several printed copies of natural iron fertilization article
  - *The Baltimore Sun;* Health & Science; Blowing In the Wind; Friday, June 24, 2005. http://articles.baltimoresun.com/2005-06-24/news/0506240413_1_dust-deserts-ocean
- Several printed copies of human iron fertilization articles
  - http://legacy.utsandiego.com/news/science/20040214-9999-1n14fertile.html
  - http://www.livescience.com/21684-geoengineering-iron-fertilization-climate.html

Handouts:

- Lesson 4 Student Reading Guide
- Activity 4 Fertilization of the Oceans
- Lesson 4 Student Graphic Organizer

Procedure:

- Distribute Lesson 4 student handouts to students.
- Divide the class into three groups. Each group will rotate through a station every 15 minutes.
  -Stations are: 1. Natural Fertilization 2. Iron fertilization of the oceans by Humans (printed articles from pdf) and 3. Internet searching
- Have copies of the article on natural iron fertilization in ocean available for students. (Station 1)
  - *The Baltimore Sun;* Health & Science; Blowing In the Wind; Friday, June 24, 2005. http://articles.baltimoresun.com/2005-06-24/news/0506240413_1_dust-deserts-ocean
- Have copies of additional articles on ways humans would like to fertilize the ocean and the effects. (Station 2)
- Have 8 computers available for research and connected to the internet. (Station 3)
- Students read the articles and add to the graphic organizers to help them organize their information.
- Students use Lesson 4 Student Reading Guide to document the article or information and be able to cite the source correctly.
- Students may also search online for scientific information to help them understand ocean fertilization.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

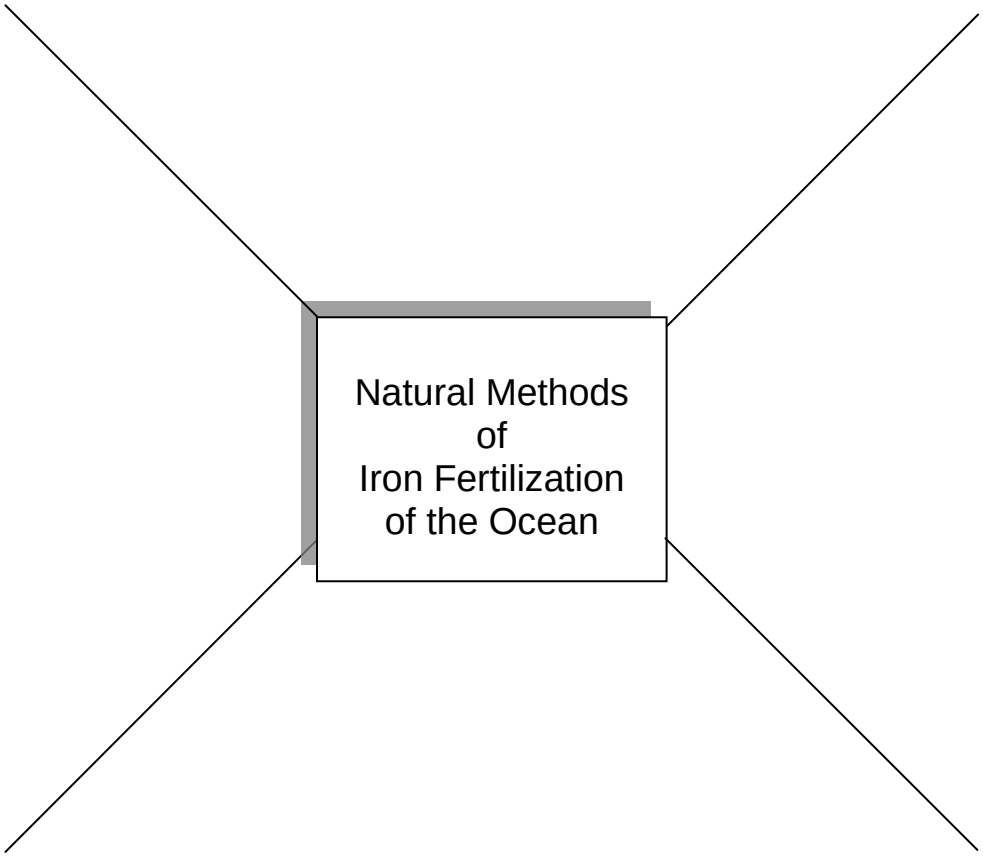
Lesson 4 Student Reading Guide
Argument Task
Intermediate Science
Ocean Fertilization

1. Name of Article: _____
2. Author: _____
3. Date of Publication: _____
4. URL: _____
5. Important information in my own words

6. Direct quotes from the article (resource)

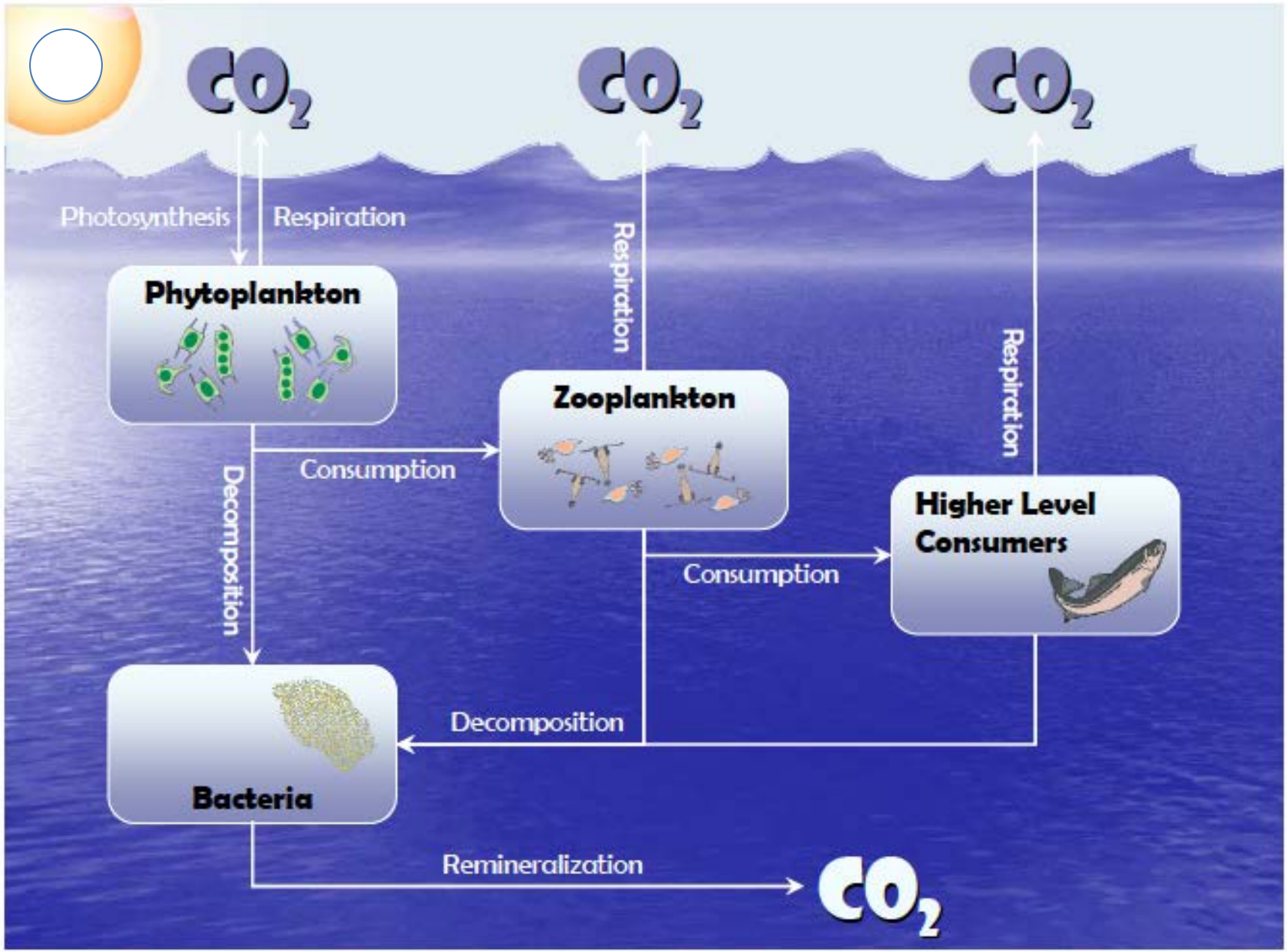
Name _____Date: _____

Activity 4: Fertilization of the Oceans



This lesson asks you to build on the graphic organizer you made in Lesson 3. It is printed on the back of this guide. Show what factor scientists add to the ocean and how the different organisms react to the addition.

Lesson 4 - Student Graphic Organizer



Unit Title: Global Climate Change: Pandora's Box Lesson Title: Ocean Fertilization Inquiry (Part 1 and 2) Date Developed/Last Revised: July 2013 Unit Author(s): Maggie Prevenas	Lesson #: 5 Grade Level: 7-8 Primary Content Area: Environmental Science/Technology Time Frame: 2 block period (75 min + 75 min)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.7.1.1** Design and safely conduct a scientific investigation to answer a question or test a hypothesis
- **CCSS.ELA-Literacy.RST 6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **CTE.7.1.1** Design, modify, and apply technology to effectively and efficiently solve problems
- **CCSS.Math.Practice.MP1** Make sense of problems and persevere in solving them.
- **CCSS.Math.Practice.MP4** Model with mathematics.

Supporting Standards:

- **CCSS.Math.Practice.MP5** Use appropriate tools strategically.
- **CCSS.Math.Practice.MP6** Attend to precision.

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Make predictions, participate safely and collect data from an investigation
- Analyze data (graph data)
- Determine next step in scientific process, and design and safely conduct a scientific investigation to answer a question or test a hypothesis
- Use technology to collect data (evidence) and as a tool in analysis

2B. Assessment Tools/Evidence:

Summative:

- Design and safely conduct a scientific investigation to answer a question or test a hypothesis (with Rubric)

3. Learning Experiences (Lesson Plan)

Materials:

Per lab group

- 3-Squeeze bottles
- 1-Medicine dropper
- 1-Graduated cylinder (50 ml or smaller)
- 3-Beakers (100 ml)
- Distilled water (fill and label squeeze bottle)
- Tap water (fill and label squeeze bottle)

- Sea water (fill and label squeeze bottle)
- 10% hydrochloric acid solution
- pH probe (with supporting hardware)

Handouts:

- Lesson 5- Part 1: Lab Acid
- Lesson 5-Part 2: Inquiry Investigation
- Inquiry Student Scoring Rubric

Procedure:

Part 1- Lab Acid

- Distribute Lesson 5- Part 1: Lab Acid to students.
- Have students answer the following questions on their handout (Lesson 5- Part 1: Lab Acid):
    - What are you investigating?
    - What is the independent variable?
    - What is the dependent variable?
    - Which sample is acting as a control?
    - What is your hypothesis?
- Go over safety procedures to ensure students are aware of potential problems.
- Have students work in pairs to complete the lab described below.
- After data is recorded, have students graph the data and discuss what happened.
- Students need to decide the next step they will take in investigating how the different waters are affected by acid. What question came about as a result of doing this lab?
- Students do not create a lab report for part 1, only part 2.

Acid Lab Suggested Procedure

- Ensure all glassware is clean.
- Measure 50 ml of distilled water into one beaker, 50 ml of tap water into a second beaker, and 50 ml of ocean water into a third beaker.
- Record the original pH of each of the water samples.
- Create a data table to record the information and observations similar to this:

Water sample	Start (0)	1	2	3	4	5	6	7	8	9	10	Final
Distilled(pH)												
Tap (pH)												
Ocean (pH)												

- After you add 1 drop of 10% HCl solution to each beaker, record the pH.
- Continue adding 10% HCl solution one drop at a time to each of the beakers until you have added 10 drops, recording the pH after each drop.
- Have students answer the following question on their handout (Lesson 5- Part 1: Lab Acid)
    - What is your conclusion?

Part 2- Inquiry Investigation

- Distribute Lesson 5-Part 2: Inquiry Investigation
- This is a Benchmark Assessment, but students may work in pairs to complete the tasks.
- Students choose a question that they have as a result of doing Part 1-Acid Lab. They need to investigate this question ensuring there is only one variable that changes.
- Students (working in groups of 2) describe materials needed, make a hypothesis or prediction, determine a procedure, collect data in a data table, and analyze it (in graph form). They also need to reflect on what they learned and what the next step in the investigation could be.
- Have students answer the following questions in their lab report:
    - What are you investigating?
    - What is the independent variable?
    - What is the dependent variable?
    - Which sample is acting as a control?
    - What is your hypothesis?
    - What is your conclusion?
    - If they had a chance to continue with this lab, what would they investigate next and why?
- Use a scientific investigation rubric, such as Inquiry Student Scoring Rubric to assess student performance.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7) **Completed by teacher after instruction has taken place**
4. Teaching and Collecting of Evidence of Student Learning: Teacher Notes:
5. Analysis of Student Products/Performances - Formative: Teacher Notes:
6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson): Teacher Notes:
7. Teacher Reflection: Replanning, Reteaching, Next Steps: Teacher Notes:

Unit: Global Climate Change: Pandora's Box
Lesson 5- Part 1: Lab Acid

Overview

Complex geochemical cycles manage the movement of greenhouse gases in the atmosphere between air, land, life, and water. The ocean contains lots of different dissolved chemicals that work as buffers to confound the issue of ocean fertilization. This lab provides a simple comparison between different waters with a glimpse into the complicated intricacies of ocean fertilization. Students add equal amounts of acid to different waters and interpret the results.

Science Standard 7.1.1 Design and safely conduct a scientific investigation to answer a question or test a hypothesis
CCSS.ELA-Literacy.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Students will:

- Make predictions, observations and explanations in an investigation
- Follow directions safely
- Collect and analyze data (graph data)
- Determine next step in scientific process

Materials needed for each lab group:

- 3-Squeeze bottles
- 1-Medicine dropper
- 1-Graduated cylinder (50 ml or smaller)
- 3-Beakers (100 ml)
- Distilled water (in a squeeze bottle)
- Tap water (in a squeeze bottle)
- Sea water (in a squeeze bottle)
- 10% hydrochloric acid solution
- pH probe (with supporting hardware)

Suggested procedure:

1. In the lab report, make sure you answer the following questions-
    - What are you investigating?
    - What is the independent variable?
    - What is the dependent variable?
    - Which sample is acting as a control?
    - What is your hypothesis?

2. Ensure all glassware is clean.
3. Measure 50 ml of distilled water into one beaker, 50 ml of tap water into a second beaker, and 50 ml of ocean water into a third beaker.
4. Record the original pH of each of the water samples.
5. Add 1 drop of 10% HCl solution to each beaker, and record the pH.
6. Continue adding 10% HCl solution one drop at a time to each of the beakers until you have added 10 drops. Record the pH after each addition.

   -Organize your data in a table similar to the one below:

Water sample	Start (0)	1	2	3	4	5	6	7	8	9	10	Final
Distilled(pH)												
Tap (pH)												
Ocean (pH)												

7. Graph the data.
8. Does the graph support your prediction or not? Explain.
9. In the lab report, make sure you answer the following question-
   - What is your conclusion?

Lesson 5 – Part 2: Inquiry Investigation

What question came about as a result of doing Part 1- Lab Acid? You need to decide the next step you will take in investigating how the different waters are affected by acid.

1. What question are you investigating?

---

2. State a hypothesis.

Based on what you learned from Part 1- Acid Lab, write a hypothesis that will be supported/not supported by the data you collect.

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3. Experimental design

(What is the independent and dependent variable? What is the one thing you are changing from Part 1 and what data will you collect? Don't forget to list your procedure as steps.)

4. Make a data table to record your evidence. Collect the data.

5. Analyze the data.

Draw a graph to help you visualize the patterns, trends, and relationships. Attach it to this Lab assessment. What data did you record? Does this data support or refute your hypothesis?

6. Draw a conclusion (Please write in complete sentences!)

INQUIRY STUDENT SCORING RUBRIC
MIDDLE SCHOOL
(GRADES 6-8)

Abilities necessary to do scientific inquiry:

	1. Beginning	2. Progressing	3. Proficient	4. Exemplary
A. Identifying Questions and Formulating Hypotheses that May be Examined through Scientific Investigations	Testing the question is not possible; hypothesis is missing or unclear	Formulates testable questions which lead to a scientific investigation; even though the hypotheses is present it does not directly answer the question	Formulates testable questions and hypotheses that lead to scientific investigation	Formulates testable questions and hypotheses that are specific, based on scientific concepts, and lead to scientific investigation
B. Designing and Conducting a Scientific Investigation	Little attempt is made to control and manipulate variables; design of investigation contains major flaws in sequence and logic; extensive teacher intervention is necessary	Flaws are evident in identifying variables; design of investigation contains minor flaws; some teacher intervention is necessary	Identifies what variables are controlled and what variables are manipulated; design of investigation is sequential and logical; experimental design requires minimal teacher intervention	Identifies what variables are controlled and what variables are manipulated; design of investigation is sequential and is aligned with the hypothesis; experimental design requires minimal teacher guidance
C. Using Appropriate Tools and Techniques to Collect and Record Data	Collects and records invalid data; uses inappropriate equipment and techniques; data collected contains inaccuracies in measurement which alter the results; required extensive teacher intervention or guidance	Collects and records objective data; incorrectly uses equipment and techniques; requires some teacher intervention	Collects and records complete and objective data; uses appropriate equipment and techniques; requires minimal teacher intervention	Collects and records data which is complete, accurate, and objective; uses appropriate equipment and techniques; requires minimal teacher guidance
D. Using Evidence to Develop Explanations and Describe Relationships between Evidence and Explanation	Students are unable to draw inferences (interpretation of an observation)	Students draw faulty inferences based on patterns or previously held ideas	Students draw inferences based on relationships, perceived patterns, or previously held ideas	Data is analyzed objectively; students draw logical inferences based on observed patterns and relationships; inferences lead to questions for future investigations
E. Communicating Procedures, Results, and Explanations of a Scientific Investigation	Scientific information is unclear; presentation lacks focus and organization; medium hinders communication	Scientific information has some clarity; presentation has some focus and organization; medium permits communication	Scientific information is communicated clearly; presentation is focused and organized; medium facilitates communication	Scientific information is communicated clearly and precisely but may also include inventive/expressive dimensions; presentation is effectively focused and organized (e.g., using tables, models, texts, figures); a variety of media enhance communication

Unit Title: Global Climate Change: Pandora's Box Lesson Title: Career Exploration- Change the World, No Really. Date Developed/Last Revised: July 2013 Unit Author(s): Maggie Prevenas	Lesson #: 6 Grade Level: 7-8 Primary Content Area: Environmental Science/Engineering Time Frame: 1 class period (45 min)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **STEM Competency 6.4:** Demonstrates creative thinking, constructs knowledge, and develops innovative products and processes using technology

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Become aware that new careers in engineering geochemical cycles are a reality
- Practice creative problem solving as a skill necessary to solve environmental problems

2B. Assessment Tools/Evidence:

Formative:

- **Journal prompt**: What was the best part of learning in today's lesson? What is another environmental problem that could be solved through geochemical engineering? How could biochemical engineers change the world? Do you have what it takes to be a geochemical engineer? Explain.

3. Learning Experiences (Lesson Plan)

Materials:

- Bag of Metaphors- Have objects that represent some of the causes and solutions to climate change in your grab bag (see Climate Change Metaphors pdf for suggested objects: click on "Get the Lesson Plan" at http://ocean.si.edu/for-educators/lessons/climate-change-metaphors).
- Video: Geochemical Engineering http://www.youtube.com/watch?v=c3XwOs6jz5o (Geochemical engineering video)
- Computer with Projector
- Speakers

Handouts:

- Lesson 6 Journal Prompt

Other Resources:

- http://wildbc.org/index.php/programs/climate-change-education/

Procedure:

- Show students the 10 minute DVD on Geochemical Engineering.
- Discuss. Is this a career that might be exciting or fun or a good match for them?
- Tell students that you would like them to practice being a geochemical engineer by having them brainstorm creative solutions for global climate change that geochemical engineers might actually use.
- Invite students to stand in a circle.
- Explain to them that you will invite certain people to take an item out of the bag. They may not look in the bag before they put their hand in.
- When they have taken their object out they are to look at it, hold it up and state what it is.
- When all the items are out of the bag, quickly review all of them.
- Ask the students holding the objects if they have any thoughts on how their particular object might be connected to geochemical engineering solutions to climate change or what a geochemical engineer does.
- Have students participate in a circular brainstorming wheel where each student contributes their ideas using the "What is it?" "What is it not?" response to how the object is related to geochemical engineering.
- When all the objects have at least two metaphors connecting them to geochemical engineering, put them in a central place for all the students to see and reflect on.
- Have students write in their science journal from the student journal prompt.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Lesson 6 Journal Prompt:

1. What was the best part of learning in today's lesson?
2. What is another environmental problem that could be solved through geochemical engineering?
3. How could biochemical engineers change the world?
4. Do you have what it takes to be a geochemical engineer? Explain.

Unit Title: Global Climate Change: Pandora's Box Lesson Title: Take It To The Streets-County Council Budget Hearing Date Developed/Last Revised: July 2013 Unit Author(s): Maggie Prevenas	Lesson #: 7 Grade Level: 7-8 Primary Content Area: Environmental Science/Communication Time Frame: 2 Block Periods (75 + 75 min)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **SC.8.2.1** Describe significant relationships among society, science, and technology and how one impacts the other
- **CCSS.ELA-Literacy.RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts.
- **CCSS.ELA-Literacy.RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **CCSS.ELA-Literacy.RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- **CCSS.ELA-Literacy.WHST.6-8.1** Write arguments focused on *discipline-specific content.*
- **CCSS.ELA-Literacy.WHST.6-8. 8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
- **CCSS.ELA-Literacy.WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research**.**

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Independently read scientific articles and draw evidence to support analysis, reflection, or research
- Evaluate evidence and specific claims in informational text and select relevant information
- Use a graphic organizer to guide thinking processes in outlining a written argument
- Write testimony to argue for/against ocean fertilization
- Support the testimony using evidence cited from the texts
- Give feedback to another student by completing the testimony feedback/rubric

2B. Assessment Tools/Evidence:

Formative:

- Peer Assessment of written testimony

Summative:

- Student written and spoken 3 minute testimony (rubric)

3. Learning Experiences (Lesson Plan)

Students use information from previous activities to write a three-minute testimony in which they will assume the role of a Hawaiian resident living on one of the main eight Hawaiian Islands. Students may assume one of the roles listed or name one of their own. Students present this opinion statement regarding fertilizing the nearshore ocean environment with island mined olivine in order to improve ocean productivity, in a three minute presentation before a 'mock county council budget hearing.'

Materials:

- Computer with Internet access and projection device
- Individual computers for student work
- Reading selections describing the biological pump/carbon cycle/ocean fertilization
- Presentation materials (as needed) by students

Handouts:

- Lesson 7 Task (Student checklist for writing and presenting)
- Student Graphic Organizer for Argument
- Teaching Task Rubric (Argumentation) (Rubric for County Council Testimony) , from http://www.literacydesigncollaborative.org (LDC Template Task Collection 1, p. 16)
- Classroom Assessment Rubric (Argumentation), from http://www.literacydesigncollaborative.org (LDC Template Task Collection 1, p.17)
- Testimony Feedback Chart (Argument)

Procedure:

- Distribute Lesson 7 Task and Teaching Task Rubric (Argumentation) to students.
- Students are told the County Council has proposed dedicating 10 million dollars to the University of Hawaii to oversee the fertilization of the ocean within 100 miles of the county shoreline to increase its productivity. The ocean fertilizer (olivine- an iron and silica rich rock) will be mined on island where olivine is readily available.
- Students assume the role of one of the players below (or one of their own) and research the pros and cons of their position.
    - Commercial Fisherman
    - Marine ecologist
    - Oceanographer
    - Meteorologist
    - Hawaiian Kumu
    - Member of the Hawaiian community
    - Recreational fisherman/woman
    - Owner of beachfront property
    - Owner of an exclusive beachfront hotel
    - Environmental pressure group such as Green Peace or Sierra Club
    - Officer for Environmental Protection Agency
    - Rock company executive responsible for providing iron olivine for fertilization

- Students write a three-minute testimonial and present it to a County Budget Council (a mock council). Students include the following in their written testimony:
  - A brief explanation of the ocean fertilization process.
  - A summary statement for supporting or not supporting the use of iron fertilization. The summary statement will provide the audience evidence from one of the following research categories-
    - How iron fertilization affects organisms and populations.
    - How iron fertilization might help to reduce greenhouse gases.
    - How iron fertilization might do harm.
  - A final conclusion statement.
- Students give and receive feedback on their written and spoken testimony using Student Feedback Form and Classroom Assessment Rubric (Argumentation).

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes:

Lesson 7 Task
Science
Take It to the Streets

After researching scientific articles, online multimedia, and other resources on the role of the carbon cycle and biological pump in regulating greenhouse gases in the atmosphere and ocean, students write testimony for use in a 3 minute presentation to a county council. Your position on artificial regulation of the carbon cycle through a process known as ocean fertilization is written and defended with evidence.

Be sure to acknowledge one competing view from your sources.

Activities to accomplish task (Check)

___ 1. Independently read scientific articles and draw evidence to support analysis, reflection, or research
___ 2. Evaluate evidence and specific claims in informational text and select relevant information
___ 3. Use a graphic organizer to guide thinking processes in outlining a written argument
___ 4. Write testimony to argue for/against ocean fertilization

___ 5. Support the testimony using evidence cited from the texts

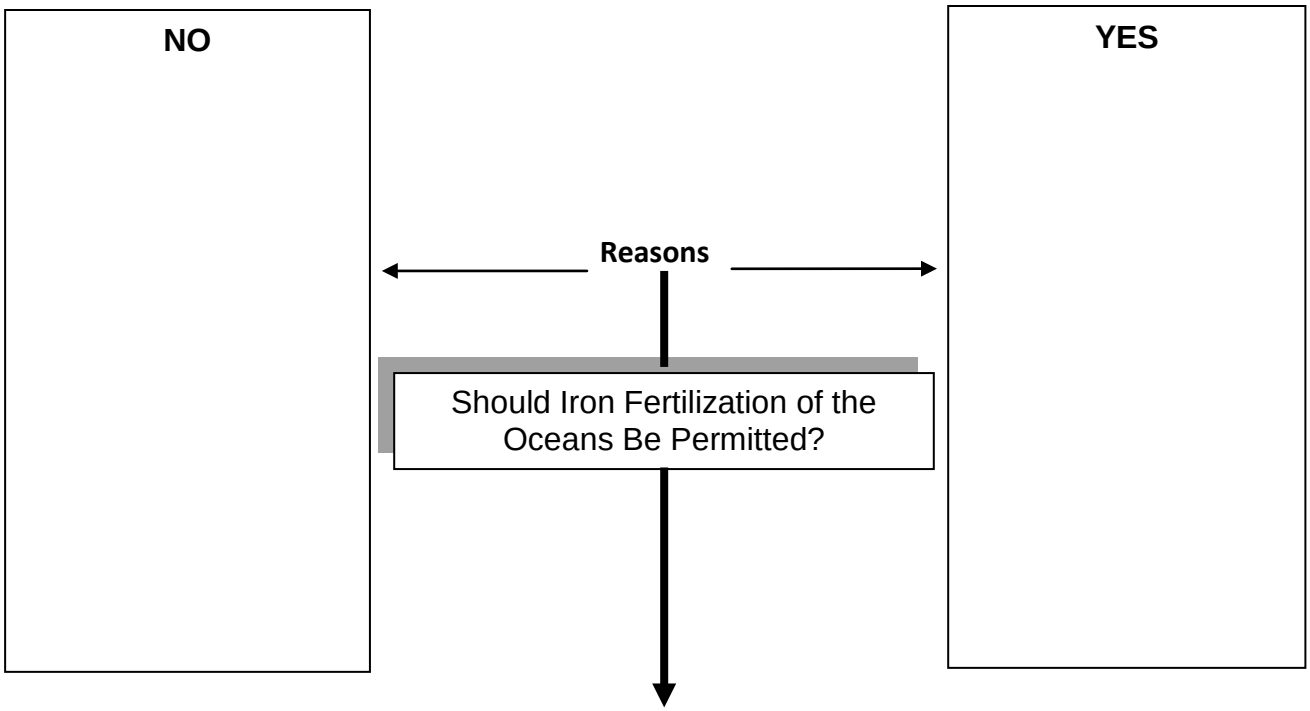
___ 6. Give feedback to another student by completing the testimony feedback/rubric
___ 7. Present the three minute testimony

___ 8. Submit final draft with feedback rubric attached

Name _____Date: _____

Activity 7: Human-made Iron Fertilization of the Oceans

Student Graphic Organizer for Argument



CONCLUSION

_____

_____

_____

_____

_____

_____

_____

Student Writer Name_____ Student Feedback Provider_____

Testimony Feedback Chart (Argument)

Use the chart below to provide feedback to the student writer.

Scoring Element	Comments
1. Focus	
2. Reading /Research	
3. Controlling Idea	
4. Development	
5. Organization	
6. Conventions	

Unit Title: Global Climate Change: Pandora's Box Lesson Title: Reflect: A Twentieth Century Pandora's Box Date Developed/Last Revised: July 2013 Unit Author(s): Maggie Prevenas	Lesson #: 8 Grade Level: 7-8 Primary Content Area: Project Reflection Time Frame: 2 class periods (45 min)

PLANNING (Steps 1, 2, & 3)

1. Standards/Benchmarks and Process Skills Assessed in this Lesson:

- **STEM Competency 2.2**: Collaborates with, helps, and encourages others in group situations
- **STEM Competency 4.1:** Recognizes and understands what quality performances and products are

2A. Criteria- What Students Should Know and Be Able to Do:

Students can-

- Create a modern-day version of Pandora's box by putting objects that represent positive and negative metaphors for iron fertilization of the ocean in a box.
- Write a reflection on the use of metaphors in learning this unit.

2B. Assessment Tools/Evidence:

Summative:

- Create a modern-day version of Pandora's box by putting objects that represent positive and negative metaphors for iron fertilization of the ocean in a box.
- Write a reflection on the use of metaphors in learning this unit.

3. Learning Experiences (Lesson Plan)

Materials:

- Cardboard shoe boxes (one for each group of 2 students)
- Markers, paints, cardstock weight paper, magazines
- Objects (students will provide)
- Pandora's Box Myth (Reading)- Use link (below) to create the reading handout (optional)

Other Resources:

- Education World, A Modern Pandora's Box, http://www.educationworld.com/a_tsl/archives/03-1/lesson011.shtml, 04/18/2013

Procedure:

Class Period 1 (introduction and brainstorming)

- Introduce the story of Pandora's Box. Online sources include A Brief Retelling of Pandora's Box
- Discuss the story.
- Group students into pairs.
- Students will create a modern Pandora's Box to show the positive and negative effects of ocean fertilization.
- Students brainstorm the contents of the box.

- They must each put two or more objects, cartoons, or pictures from magazines that represent negative effects of ocean fertilization, and one or two things that represent positive effects.
- Students will create the positive and negative metaphors (**as homework**) and bring them to school on the day of presentation.

Class Period 2 (coordination, presentation, and reflection)

- Allow students time to coordinate the contents and plan their presentation.
- Each group shares its box with the class.
  - Each student in the group should explain his or her additions to the box.
- Summarize the Reflection Project.
  - What metaphors were really powerful?
  - What metaphors were unique and creative?
  - What metaphor expressed your overall opinion of Ocean Fertilization the best?
- Reflection comments are to be written in Student Journal.

Homework Activity (Optional):

Students are encouraged to bring their ideas from the brainstorm session home and work on them so that they can put time and creativity into their metaphors.

TEACHING & ASSESSMENT (Steps 4, 5, 6, &7)
Completed by teacher after instruction has taken place

4. Teaching and Collecting of Evidence of Student Learning:
Teacher Notes:

5. Analysis of Student Products/Performances - Formative:
Teacher Notes:

6. Evaluation of Student Products/Performances – Summative (Not necessary for every lesson):
Teacher Notes:

7. Teacher Reflection: Replanning, Reteaching, Next Steps:
Teacher Notes: