Lesson: Follow the Footprints

Environmental Literacy Question: How have humans affected the Chesapeake Bay and its watershed?

Topic/Essential Question: How is the earth's climate changing?

Unit/Lesson Sequence: This is one of two lessons in the 'Concerning Climate' module based at Arlington Echo.

Content Standards:

Environmental Literacy Quarter 3

3.B.1.d. Explain and diagram how greenhouse gasses increase thermal energy in the atmosphere and its effect on earth's temperature and systems.

6.A.1. Identify and describe natural changes in the environment that may affect the health of human populations and individuals.

Science

3.4.F.1.a. Identify and describe the interactions of organisms present in a habitat.

6.4.B.1. Recognize and describe that people in Maryland depend on, change, and are affected by the environment.

Common Core Standards for English Language Arts Standards-

Speaking and Listening-4th Grade

Comprehension and Collaboration

- CCSS.ELA-Literacy.SL.4.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 4 topics and texts*, building on others' ideas and expressing their own clearly.

Length of lesson: 35 minutes

Student Outcomes:

- Students will be able to use background knowledge of climate change to participate in the carbon footprint scavenger hunt.
- Students will investigate and record how they can reduce their carbon footprint.

Knowledge of the Learner:

- Prerequisite knowledge, skills and processes: Students should view the EPA movie on climate change to gain an understanding of the causes of excess carbon in the carbon cycle and the effects of too much carbon in the atmosphere on climate change. Students should also have an understanding of the carbon cycle.
- Student needs, interests, previous learning: These will be identified in the pre-assessment.

- Conceptual difficulties: Understanding that the everyday things we do impact our carbon footprint and climate change.
- Differentiation: This lesson will appeal to different types of learners. The auditory learner will do well hearing the facts at each station of the scavenger hunt. The visual learner will do well seeing the carbon cycle and real-life examples of carbon footprint reduction strategies at each station. The reading and writing learners will do well using their journals. The kinesthetic learners will do well moving through the scavenger hunt.

Knowledge of Content:

- Content knowledge for instructor: Provided in the text of the lesson.
- **Vocabulary:**

Carbon Cycle	Sources	Sinks
Greenhouse Gas	Carbon Footprint	Fossil Fuels
Atmosphere	Photosynthesis	Renewable Energy
Watt	Kilowatt	Terawatt
LED Light	Deciduous Tree	Insulation

- **Resources:**

Cache jars	Pink flags	Riddle & answer cards	Chairs
Carbon Cycle Poster & pieces	Easel	Clipboards	

- **Supplements:**

  A: The Carbon Cycle

  B: Carbon Cycle discussion questions and information

  C: Follow the Footprint Map (Investigative Journal Page)

  D: Scavenger Hunt Questions and Answers

  E: Vocabulary

Instructional Delivery

Lesson setup:

Set cache jars with pink flags and riddle and answer cards in the appropriate spots **(see Supplement D for locations)**. Set up Carbon Cycle poster in the Bee Room—to start, the poster should only have "The Carbon Cycle" title on it, with the other pieces readily available nearby. Place chairs in the Bee Room in a semi-circle facing the poster with a clipboard under each chair.

Pre-Assessment:

During the introduction to the Concerning Climate module, Arlington Echo staff will invite students to share what they know about human impacts on the environment. Students will also play a greenhouse gas game with an Arlington Echo staff member as an introduction to the Concerning Climate lessons.

Activity: Footprint Tour

Motivation/Warm-Up:

1. Meet students in the Bee Room and instruct them to take a seat facing the poster.
2. Introduce yourself, and describe the concept of the carbon cycle to students. Using the felt board, explain the cycle **(refer to Supplement A)**. Ask volunteers or choose students to help to make a carbon cycle on the board; or add pieces as you present the cycle.
3. For the following questions and discussion, refer to **Supplement B**.
    a. Ask the students what happened in the natural cycle (lighter arrows on the right) and discuss their answers.
    b. Follow up by asking students what happened when humans began extracting and burning the fossil fuels for energy (darker arrows on the left)? Discuss their answers.
    c. Explain why the increase of carbon in the atmosphere is important and how it relates to humans and our changing climate.
    d. Ask students if they know any of the effects of climate change?
    e. Finally, ask students if they think there are any ways they can help?

Procedure:

1. Ask chaperone(s) to hand out an Investigative Journal and a pencil to each student; students may use the clipboards under their chairs. The students should turn to page **4** called "Follow the Footprints" **(see Supplement C)**.
2. Explain to the students that they will be going on a scavenger hunt to identify different strategies for reducing our carbon footprint.
3. At each stop on the scavenger hunt, they will find a pink flag and a cache jar (show the students a sample jar in the Bee Room before you begin your scavenger hunt). Inside the cache jar will be a riddle and an answer related to the specific carbon-reduction strategy at that stop. Students should write each strategy in the footprint that coincides with that specific stop on the scavenger hunt **(See Supplement D)**.
4. Lead the students outside with their journals. Use your surroundings to help students orient themselves to the map (ex: point out the Main Pavilion, Orienteering Pavilion, Cabins, etc. and ask them to find these landmarks on their maps).
5. Follow the map to the first location and find the pink flag and cache jar.
6. Before they open the jar, tell students to look around and observe what might be used to lower our carbon footprint.
7. Have students open the jar to read the riddle about the carbon-reduction strategy presented **(see Supplement D)**.
8. Have students guess the answer to the riddle **(see Supplement D for correct answer)**. The activity leader may add supplemental information from the chart as well. Students will write the carbon-

reduction strategy (answer to the riddle) in the appropriate footprint on their maps and then move to the next stop in the scavenger hunt.

9. The final stop on the scavenger hunt will lead students through Field Hall to the back door by the Bee Room; after writing down the final carbon-reduction strategy students should return to their seats in the Bee Room.

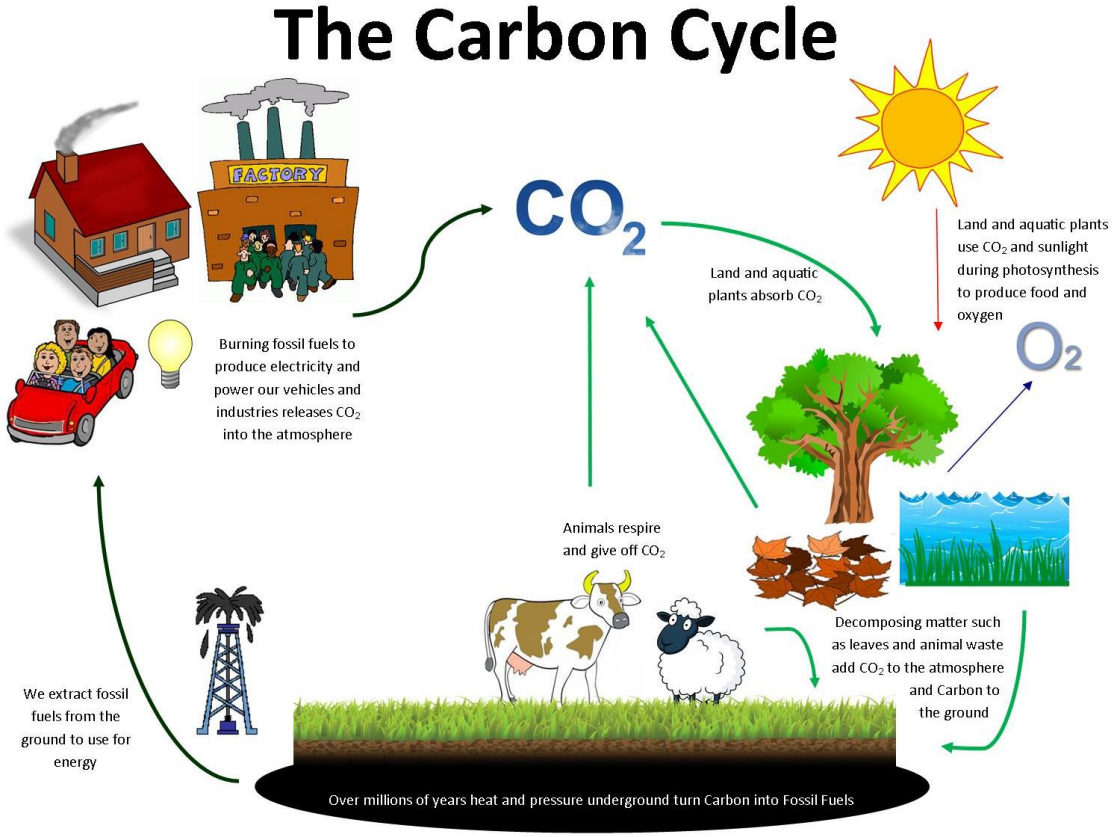
Assessment:
Finish the lesson by having students answer the last question on the map in their journals **(Supplement C)**: "What are some ways you can reduce your carbon footprint?" Students can write about things they already know and/or what they learned on their scavenger hunt. If time allows, students can share their ideas with the group.

After the lesson is finished, students will either move to their next lesson or back to the main pavilion for a debriefing session lead by an Arlington Echo staff member.

Notes for Clean up:
Please clean, organize and return the lesson materials to their proper locations at the end of each day of instruction. Remember to inform the Arlington Echo staff if you need assistance or if any materials are damaged or missing.

Notes for Inclement Weather:
Arlington Echo encourages keeping our outdoor activities outdoors—even in the rain—but in the case of severe weather (thunder/lightning extreme cold, etc.), the rain location for this activity will be inside the Bee Room. An alternate activity will be given to the instructor in case of inclement weather.

Supplement A



Carbon is one of the most common elements found on Earth and is the main ingredient of every plant and animal (even humans). Over time, carbon moves between many places and forms—this movement is known as the Carbon Cycle. The Carbon Cycle is made up of sources and sinks. **Sources** are things that add carbon to the atmosphere. **Sinks** are things that remove carbon from the atmosphere.

Explain the carbon cycle using the steps below; for each step ask a student to place the corresponding pieces and arrows on the board:

1. In the atmosphere, carbon reacts with oxygen to form a gas known as carbon dioxide (CO_2).
2. Land and aquatic plants absorb CO_2 and sunlight to photosynthesize and produce oxygen—this makes plants a carbon **sink**.
3. Animals and humans need oxygen to breathe. As animals and humans breathe, or respire, they give off CO_2—this makes human and animal respiration a carbon **source**.
4. As plants, animals, and other organic matter die, they decompose. During decomposition, carbon is released into the atmosphere (**source**) and carbon enters the ground beneath the land and oceans (**sink**).
5. After millions of years, heat and pressure turn the underground carbon into fossil fuels. Since the 1800s, humans have been extracting fossil fuels from deep underground on a large scale.
6. We burn these fossil fuels in order to power our buildings, vehicles, and factories; which releases the carbon that has been trapped underground for millions of years into the atmosphere. Through the burning of fossil fuels, humans have created a new **source** of carbon into the atmosphere.

Sources: U.S. Environmental Protection Agency (EPA), 2015; U.S. National Aeronautics and Space Administration (NASA), 2015

Supplement B

Carbon Cycle Discussion Questions and Information

a. What happened in the natural cycle (lighter arrows on the right)?

- The level of carbon dioxide in the atmosphere was stable because the sources (that add carbon to the atmosphere) and sinks (that remove carbon from the atmosphere) were in balance.

b. What happened when humans began extracting and burning the fossil fuels for energy (darker arrows on the left)?

- The level of carbon dioxide in the atmosphere increased because the sources and sinks became unbalanced—carbon was added to the atmosphere from burning fossil fuels (source) much faster than any natural sinks could remove it.

c. Why is this increase important and how does it relate to humans and climate change?

- Carbon Dioxide (the gaseous form carbon takes when it reacts with oxygen in the atmosphere) is one of the **Greenhouse Gasses**, meaning that it holds heat and traps it in the atmosphere, like a greenhouse. Greenhouse gasses exist naturally in the atmosphere and are important for keeping Earth warm enough for organisms to live.
- When humans burn fossil fuels (source) and remove natural sinks such as forests and wetlands, carbon dioxide is added to the atmosphere faster than it can be removed.
- This results in an overload of carbon dioxide in the atmosphere, and because carbon dioxide is a heat-trapping greenhouse gas, this increase causes the atmosphere to warm up.
- The atmosphere's temperature cycles between warm and cool naturally over time, which is what creates periods like Ice Ages. The recent increase in carbon and other greenhouse gasses, however, has caused the atmosphere to warm and change much more quickly and significantly than has ever been observed in history.

d. Do you know any effects of climate change?

- Higher temperatures overall
- Increased droughts in dry areas and floods in wet areas
- More extreme, changing, and unpredictable weather patterns
- Ice, snowpack, and glacier melt in the arctic regions
- Warmer ocean temperatures
- Sea level rise
- Ocean acidification

e. Is there anything <u>you</u> can do to help?

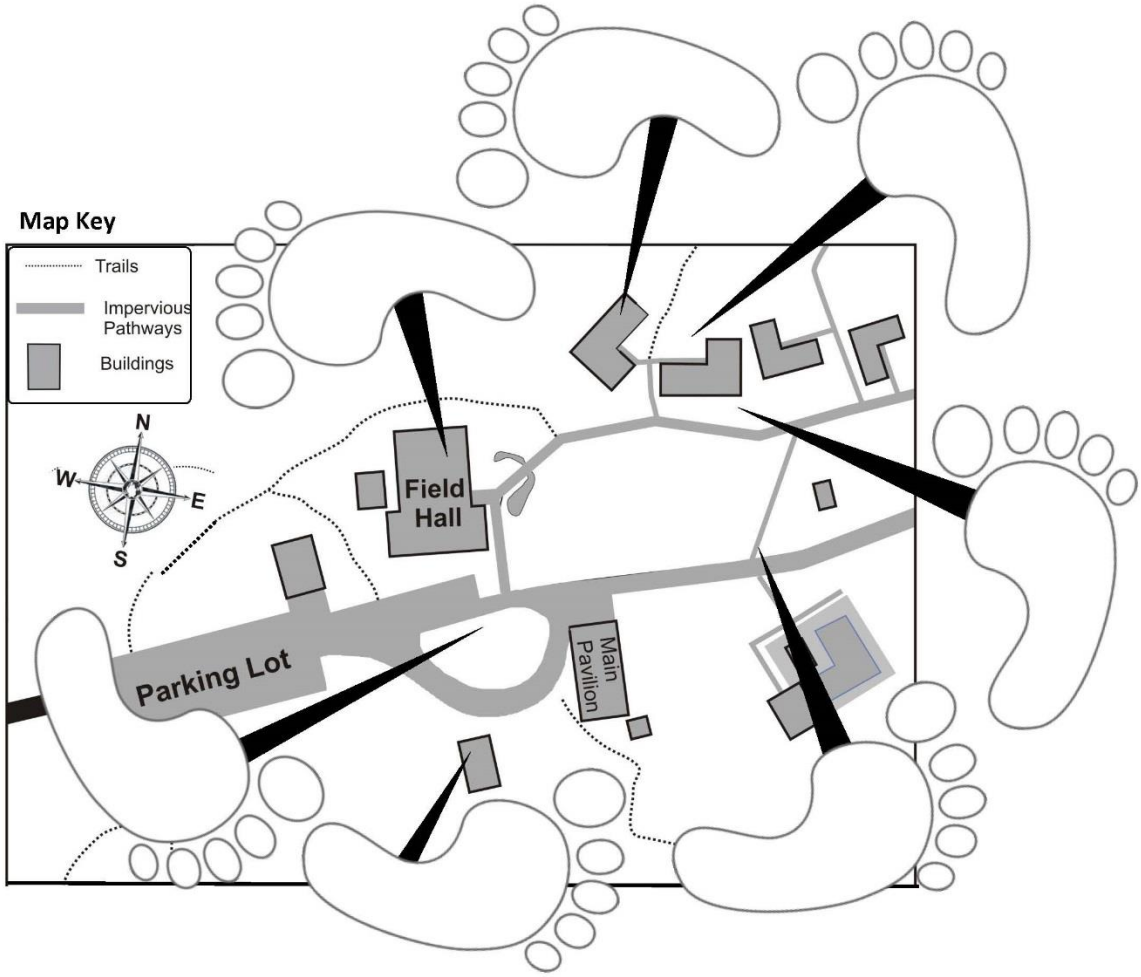
- Reduce your **Carbon Footprint** (the amount of carbon released into the atmosphere as a result of an individual's activities)

Sources: U.S. Environmental Protection Agency (EPA), 2015; U.S. National Aeronautics and Space administration (NASA), 2015

Supplement C

Follow The Footprints

You will be journeying through a number of sites across Arlington Echo.
As part of this scavenger hunt you will need to gather answers to the riddles from each of these sites.
Add the answers from each location to the footprints below.
Each answer is a strategy you can use to reduce your carbon footprint.



What are some ways you can reduce your carbon footprint?

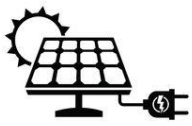
_____

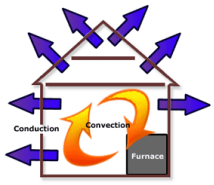
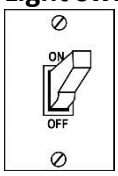
_____

_____

Supplement D

Scavenger Hunt Riddles and Answers

Strategy	Riddle	Answer
Solar Panel  *Location:* *Bus circle*	When we produce electricity by burning fossil fuel, we add a lot of carbon to the atmospheric pool. If you want to create power without so much pollution, try installing _____ _____ as a cleaner substitution.	**Solar Panels-** Solar panels convert sunlight into electricity. Using solar panels is a clean and renewable way to get electricity and a great substitution for non-renewable fossil fuels that release carbon into the atmosphere when burned.
Energy-Efficient Light  *Location:* *Orienteering Pavilion*	If you want a bulb that saves energy but glows just as bright, instead of incandescent buy an _____ _____ _____.	**Energy-Efficient Light-** LED lights are 75% more efficient than traditional bulbs and they last 25 times longer. According to the US Department of Energy, wide-spread use of LED lights in the United States could save 348 terawatt hours of energy. To put this into perspective, 348 terawatt hours is more than the entire yearly energy consumption of the United Kingdom.
Bicycle  *Location: Across from the pool*	Not only do cars add carbon to the air but they put many other pollutants up there. One way to save gas is to go for a hike, or if you want to get there faster you could always take your _____.	**Bike-** There are over one billion bicycles found throughout the world, and in many countries biking is one of the most popular forms of transportation. In the Netherlands, 25% of the people use bicycles to get to work, compared to just 0.6% of people in the United States. Motor vehicles produce roughly 30% of carbon dioxide emissions in the U.S. If everyone in the U.S. who lives within 5 miles of their workplace chose to bike to work just one day a week, it would be like taking a million cars off the road and removing all of the emissions produced by those cars. *Sources-BBC news, National Geographic, US Census Bureau*
Deciduous Tree  *Location:* *In front of Magothy cabin*	In the summertime when the weather is hot, you want to make sure your house is not. To stay nice and cool without too much A.C., keep your house in the shade, plant a _____ _____.	**Deciduous Tree-** Unlike evergreens, deciduous trees lose their leaves in the winter. Planting deciduous trees outside windows (especially on the South side) blocks the sun from heating your house in the summer but lets the sun shine through in the winter. This keeps your house naturally cooler in the summer and warmer in the winter, lessening the need for heating and air conditioning. Using the sun's power for heating and cooling without using solar panels is

		called passive solar power. In addition, planting trees is beneficial because trees are sinks that remove carbon from the atmosphere during photosynthesis.
Clothesline  *Location:* *Behind Magothy cabin*	One way to keep your energy bills from going higher and higher is to reduce your use of the clothing dryer. Instead you can find a rope or some twine and hang up your garments on a simple _____.	**Clothesline-** Which appliance accounts for 4% of all electricity generated in the United States? The clothes dryer uses more energy than any other appliance in most houses. Drying your clothes on a line can save you money and help the environment at the same time—plus, clotheslines help your clothing last longer and keep your garments from shrinking! *Source-U.S. Energy Information Administration*
Insulation  *Location:* *Patapsco cabin*	Comfortable temperatures in your home can feel great. To keep the heat from escaping, you should try to _____.	**Insulate** – Heat is continuously conducted from the warm side of a wall to the cold side. Insulation slows down the heat loss. Most people rely on fossil fuels to heat homes and buildings. Insulating the walls and attic can dramatically decrease the amount of fuel needed to heat a home or building. Burning less fuel means less carbon enters the atmosphere. Insulation currently in place in U.S. buildings and homes reduces the amount of carbon dioxide by 780 million tons each year, the equivalent of over 150 coal-fired power plants. *Source-North American Insulation Manufacturers Association*
Light switch  *Location:* *At the end of the hallway in Field Hall by the back door to the Bee Room*	When you leave the room it only takes a little finger twitch to save a lot of energy by turning off the _____.	**Switch** Most electricity that is used to power our lights comes from burning fossil fuels, specifically coal and oil. It is estimated that up about 14.1 million tons of carbon dioxide is added to the atmosphere each year through producing electricity for lights that do not need to be on. To offset all that carbon dioxide, we'd have to plant 875 million trees annually. *Source-The International Dark-Sky Association*

Supplement E

Vocabulary

Carbon Cycle—the process and movement of carbon as it is recycled and reused throughout the biosphere (the total of all ecosystems)

Source—something that adds carbon to the atmosphere

Sink—something that removes carbon from the atmosphere

Greenhouse Gas—a gas that traps heat in the atmosphere; major greenhouse gases include water vapor, ozone, carbon dioxide, methane, and nitrous oxide

Carbon Footprint—the amount of carbon released into the atmosphere as the result of an individual's activities

Fossil Fuels—natural fuels, such as coal, oil, and natural gas, that emit carbon dioxide into the atmosphere when burned—these fuels are considered non-renewable because they take millions of years to form through heat and pressure underground

Atmosphere—the mass of air blanketing the earth; it is held in place by gravity and protects Earth's organisms from severe weather and radiation from the sun, and keeps us warm

Photosynthesis—the process of plants using energy from sunlight, carbon dioxide, and water to produce food and oxygen

Renewable Energy—any natural source of energy that is not depleted when used (ex: solar, wind, water)

Watt—a unit of power that expresses the rate at which energy is being used

Kilowatt—1,000 watts of electrical power (an amount of electricity is typically expressed in kWh, kilowatt hours)

Terawatt—One trillion watts of electrical power

LED Light—Light-emitting diode—a substitute for traditional, incandescent bulbs; LED lights give off less heat and require less energy per lumen (unit of brightness)

Deciduous Plant—a tree or shrub that loses its leaves seasonally

Insulation—a covering and/or lining material prevents or reduces the passage, transfer, or leakage of heat, electricity, and/or sound