4.3 - Ecosystems Unit Project, Packet 3

Score
□ Above & Beyond
□ Meets Expectations
□ Near Expectations
□ Incomplete – *fix the following pages*:

First & Last Name: _____ Period/Hour: _____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: What impact do my choices have on ecosystems?

Anchoring Phenomenon: We'll conclude our unit on ecosystems by analyzing how our own choices and lifestyles can cause disturbances. In particular, we will focus on how our day-to-day lives contribute to rising levels of carbon dioxide, reduce availability of freshwater, and reduce the availability of other natural resources. We will also investigate how small changes can reduce our *ecological footprint*.

Deeper Questions

1. What is my carbon footprint and my water footprint?
2. If everyone lived like me, how many planets would we need?
3. How can I reduce my ecological footprints and reduce disturbances?

Schedule

Part 1: Introduction
- Review of Core Ideas

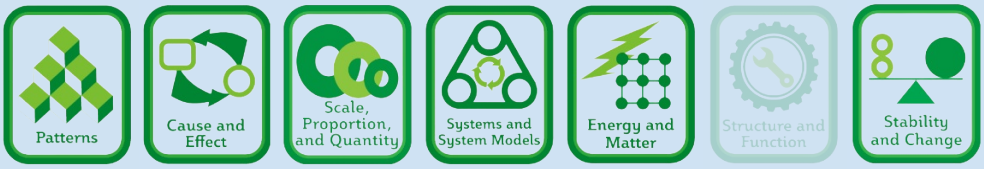
Part 2: Planning the Investigation
- RQ, Hypothesis, & Rationale

Part 3: Investigation
- What Impact Do My Choices Have?

Part 4: Solutions
- What can we do to reduce our ecological footprints?

Part 5: Scientific Posters & Work Time
- Preparing Your Presentation

NGSS Standards (*PEs* & *CCCs are summarized below. SEPs are noted throughout the packet*).
S-ESS2-2 Earth's Systems. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-4 Earth's Systems. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. HS-ESS2-6 Earth's Systems. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. HS-ESS3-6 Earth and Human Activity. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.



Semester Schedule

1. Matter & Energy
1.1: What happens when something burns?
1.2: How does burning change matter & energy?
1.3: Unit Assessment

2. Animals
2.1: How do animal cells use food?
2.2: What happens to food when it is consumed?
2.3: How do cells acquire atoms from food?
2.4: Unit Assessment

3. Plants
3.1: How do plant cells differ from animal cells?
3.2: How do plant cells obtain matter and energy?
3.3: How can we investigate plant growth and function?
3.4: Unit Assessment

4. Ecosystems
4.1: Why do different places have different amounts of species?
4.2: How does human activity affect species?
4.3: Unit Assessment

Resource Links: Class Website; Carbon Footprint Calculator; Water Footprint Calculator; Ecological Footprint Calculator; Research Poster Template;

Part 1: Review of Core Ideas (4.3.1)

Overview: Review unit concepts in preparation for your investigation. Work in small teams to answer listed questions. Take notes for class discussion; your instructor may assign specific questions if time is limited.

4.1 Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. What is an ecosystem? How do living species depend on each other & their environments?
2. What is biomass? How does biomass relate to glucose molecules and soil minerals?
3. What is the difference between producers and consumers?
4. How is a primary consumer different from a secondary consumer? How do these terms relate to trophic levels?
5. If a growing animal consumes 10 kg of plant biomass over the course of a week, how much mass would be added to the animal's body? Explain using the term 10% Rule.
6. True or false: the amount of plant, moose, and wolf biomass should be relatively equal in a stable ecosystem. Explain.
7. What is the carrying capacity of an ecosystem? How does carrying capacity relate to biomass production and to the 10% Rule?
8. What is biodiversity? How does biodiversity relate to carrying capacity & biomass?
9. Why does more biodiversity exist in rainforest ecosystems compared to most other regions?
10. What is ecosystem resilience? What is an ecosystem disturbance? How are these terms related?
11. How do changes to carrying capacity and biodiversity affect ecosystem resilience?
12. Tundra and alpine ecosystems are often quite fragile. Why might it take years or even decades for these ecosystems to recover after disturbances? Why aren't they more resilient?

4.2 Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. How did an asteroid strike 65 million years ago disrupt all ecosystems and cause the extinction of the dinosaurs? Address factors from the atomic to ecosystem levels.
2. What is necessary for ecosystems to function in regards to changes to matter and energy?
3. How do rates of CO_2 emissions compare to rates of absorption? Why is this occurring?
4. Wh does the moon have greater temperature fluctuations than Earth if both are the same distance from the sun?
5. True or false: CO_2 is only a small percentage of the earth's atmosphere; therefore, changes to CO_2 concentrations are unlikely to have a major impact on temperature. Explain.
6. What is a greenhouse gas? What determines if a molecule can act as a greenhouse gas?
7. What is the greenhouse effect?
8. What is infrared radiation (IRR)? How do IRR & light relate to the greenhouse effect?
9. Could recent changes in global temperatures be part of a natural cycle? Use the term *Milankovitch Cycles* in your response.
10. What is climate change? How does it relate to changes in CO_2 concentrations?
11. How do changing CO_2 levels affect ecological factors such as vegetation, oxygen, precipitation, and ocean acidification?
12. True or false: while rising CO_2 levels are affecting ecosystems, human activity is largely unaffected by climate change. Explain.

Part 2: Planning & Carrying Out an Investigation (4.3.2)

Overview: You will plan an investigation to calculate the ecological impact of your daily choices & lifestyle.

Research Question - *What are we wondering? What do we want to figure out?*
SEP: Asking questions (for science) and defining problems (for engineering).,

1. You will collect data on your *carbon footprint* (CO_2 emissions from your choices), *water footprint* (daily freshwater usage), and overall *ecological footprint* (how many planets are needed if everyone lived like you) and how these compare to global averages. Phrase this as a **research question** below.

   *I wonder*_____

   _____

Hypothesis, Rationale, Variables, etc. - *Make a testable prediction based on evidence.*
SEP: Planning and carrying out investigations; Developing & using models.

2. Turn your **research question** into a **hypothesis**. A hypothesis is like a guess or a prediction – it is how you would answer your research question based on your existing knowledge. Fill in the blanks below:

   *I predict that*_____

   _____

3. Now provide a **rationale** for your hypothesis. A rationale states why you think your hypothesis might be right; it provides some evidence and/or logic that supports the validity of your hypothesis.

   I think this because: _____

   _____

4. The **independent variable** is the key difference or change between the treated group and control group. Here, we are comparing impacts of your lifestyle to a typical lifestyle based on global averages.

   What is your independent variable? _____

   A **dependent variable** is what you measure to answer your research question and determine if your hypothesis is correct. You can have multiple dependent variables as long as they are relevant.

   What are your dependent variables?_____

   _____

5. A **control** is the untreated group for comparison. *In this experiment, what is your control?*

   _____

Part 3: Investigation (4.3.3)

Overview: You will use online calculators to determine your carbon footprint, water footprint, and overall ecological footprint to collect data needed to address the research question and hypothesis you provided earlier.

Calculator 1 - Carbon Footprints. *SEP: Planning and Conducting an Investigation*

1. ☐ First, predict how your carbon footprint (CO_2 emissions from your lifestyle) compares to the US average and the global average.

   I predict the following: _____

   _____

   _____

2. ☐ Visit the Carbon Footprint Calculator (click the link or type the following address into a browser: https://www.nature.org/en-us/get-involved/how-to-help/carbon-footprint-calculator/).
3. ☐ Follow the instructions. You should be calculating a carbon footprint only for yourself (not for your whole household). If you are unsure about a question, provide your best guess.
4. ☐ Record your data in Results.

Results - Calculator 1. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

1. **What were your estimated greenhouse gas emissions?** _____ tons of CO_2 eq/year.
2. **Compare to the national average, my emissions are:** higher / lower / roughly the same (circle one)
3. **Compare to the global average, my emissions are:** higher / lower / roughly the same (circle one)
4. **What would happen to the pace of climate change if everyone had your carbon footprint?**

   The pace of climate change would be: faster / slower / the same (circle one)

5. **A lifestyle is sustainable if it can occur over a long period of time without any serious negative consequences. What does this data indicate about the sustainability of your lifestyle?**

   _____

   _____

6. **These calculators require broad assumptions and may reflect some biases of the people who created them. Describe an aspect of this calculator that might seem biased or overly generalized.**

   _____

   _____

Calculator 2 - Water Footprints. *SEP: Planning and Conducting an Investigation*

5. ☐ Next, predict how your water footprint (daily freshwater use) compares to the US average and the global average.

   I predict the following: _____

   _____

   _____

6. ☐ Visit the Water Footprint Calculator (click the link or type the following address into a browser: https://www.watercalculator.org/wfc2/q/household/).
7. ☐ Follow the instructions. You should be calculating a water footprint only for yourself (not for your whole household). If you are unsure about a question, provide your best guess.
8. ☐ Record your data in Results.

Results - Calculator 2. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

1. **What was your estimated water footprint? _____** gallons/day
2. **Compare to the national average, my water use is:** higher / lower / roughly the same (circle one)
3. **The global average is 1002 gallons per day. My water use is:** higher / lower / roughly the same
4. **45% of the US freshwater supply is showing an unsustainable decline due to overuse. What would happen to the pace of freshwater depletion if everyone had your carbon footprint?**

   The pace of freshwater depletion would be: faster / slower / the same (circle one)

5. **A lifestyle is sustainable if it can occur over a long period of time without any serious negative consequences. What does this data indicate about the sustainability of your lifestyle?**

   _____

   _____

6. **These calculators require broad assumptions and may reflect some biases of the people who created them. Describe an aspect of this calculator that might seem biased or overly generalized.**

   _____

   _____

Calculator 3 - Ecological Footprints. *SEP: Planning and Conducting an Investigation*

9. ☐ Next, predict how your overall ecological footprint (number of planets' resources needed if everyone had your lifestyle) compares to the US average and the global average.

   I predict the following: _____

   _____

   _____

10. ☐ Visit the Ecological Footprint Calculator (click the link or type the following address into a browser: https://www.footprintcalculator.org/home/en).
11. ☐ Follow the instructions. You should be calculating a water footprint only for yourself (not for your whole household). If you are unsure about a question, provide your best guess.
12. ☐ Record your data in Results.

Results - Calculator 3. *SEP: Engaging in an Argument from Evidence. Analyzing & Interpreting Data*

7. **How many planets' resources would be needed if everyone had your lifestyle?** _____

8. **We would need 5.1 Earths if everyone lived like Americans. In comparison, my ecological footprint is:** higher / lower / roughly the same (circle one)

9. **The <u>global average</u> is 1.75 planets' resources. My footprint is:** higher / lower / roughly the same

10. **The overuse of natural resources is a leading cause of ecosystem disturbances. If everyone had your carbon footprint, what would happen to the pace of ecosystem disturbances?**

    The pace of ecosystem disturbances would be: faster / slower / the same (circle one)

11. **A lifestyle is <u>sustainable</u> if it can occur over a long period of time without any serious negative consequences. What does this data indicate about the sustainability of your lifestyle?**

    _____

    _____

12. **These calculators require broad assumptions and may reflect some biases of the people who created them. Describe an aspect of this calculator that might seem biased or overly generalized.**

    _____

    _____

Part 4: Solutions (4.3.4)

Overview: The average American has a larger carbon footprints (14,515 kg, or 16 tons) than the global average largely because of our societal structures. For example, we usually need to drive for basic necessities like groceries, which makes reducing our carbon footprint more difficult. This is also the case for water and ecological footprints - our culture frequently encourages consumption. Even those who are actively committed to cutting their resource consumption face major obstacles. Yet, small daily changes can significantly reduce ecological footprints.

Directions: From both lists, circle or highlight 5^{+} actions you could feasibly start utilizing this year.

Choices that reduce carbon emissions.	Choices that reduce water consumption.
• Bike/walk to school (319 kg CO_2/yr) • Use cold water and low-flow showerhead for a year • Cut out beef for a year (490 kg CO_2/yr) • Eliminate red meat for a year (747 kg CO_2/yr) • Practice "Meatless Monday" (111 kg CO_2/yr) • Vegetarian diet, with eggs & dairy (319 kg CO_2/yr) • Use USDA portion sizes for meat (370 kg CO_2/yr) • Avoid air travel for a year (90 kg per hour of flying) • Skip a transatlantic flight for a year (760 kg CO_2/yr) • Use a fan, not AC (511 kg CO_2/yr) • Use a clothesline instead of a dryer (111 kg CO_2/yr) • Drive at posted speed limits (328 kg CO_2/yr) • 10% renewable energy utility (226 kg CO_2/yr) • Fully solar-powered home (2266 kg CO_2/yr) • Trim daily showers by 5 mins (372 kg CO_2/yr) • Replaced 10 lightbulbs w/ CFLs (3692 kg CO_2/yr) • Use LED Christmas lights (83 kg CO_2/yr) • No-rush shipping on Amazon (384 kg CO_2/yr) • Adjust your thermostat by 2 degrees warmer in summer, cooler in winter. (349 kg CO_2/yr) • Insulate water heater & keep max temp < 120 deg. (323 kg CO_2/yr) *Note: all these values are based on average consumption and are on a per person basis. A more complete version of this table with sources of information can be found here.* *Lastly, climate change can seem like an unsolvable problem, but significant progress has been made in recent years, as described in this MIT article.*	• Fix leaks (indoors and outdoors). • Replace old equipment like toilets, dishwashers, and laundry machines. • Clean vegetables in a bowl of water, not under running water. • Run the dishwasher only when full. • Choose a dishwasher with a "light-wash" option. • Limit garbage disposal use; compost if you can. • Install faucet aerators. • Take short showers; turn off water when brushing teeth and shaving. • Check and repair leaky toilets using the food coloring method. • Install toilet dam, faucet aerators, and low-flow showerheads. • Run full laundry loads; opt for water-saving washing machines. • Optimize natural vegetation; plant more trees and shrubs, less grass. • Set mower blades higher for soil moisture retention and healthier grass. • Water lawn only when necessary; opt for morning or late evening watering. • Use soaker hoses for gardens; avoid watering walkways and buildings. • Apply mulch to reduce evaporation and control weeds. • Add compost to improve soil and water retention. • Collect rainwater in a screened container for irrigation. • Wash cars efficiently using a bucket and hose for final rinse. • Clean outdoor areas with a broom instead of water.

Part 5: Scientific Posters & Work Time (4.3.5)

Overview: In science, good communication is crucial. Scientists need to share their discoveries so others can learn from them and make new findings. Scientists often use posters to communicate their work. These posters are like visual summaries of research projects. They have a short written part, along with data and pictures, to share important information. Research posters include the same parts as a research paper or presentation; these are summarized below.

For this experiment, you can use a research poster template. Use the information in this packet to complete the poster. Be sure to share this file with your instructor so that they can assess it and provide feedback.

Parts of a Research Poster

Title: this section needs to include…
- The study subject (the topic/question you studied).
- The independent variable and the dependent variable(s).
- Your names, class, hour, and school.

Introduction: this section needs to include…
- The research question (*We wondered if*…).
- The hypothesis (*We predicted that*…).
- The rationale, or reason for your hypothesis (*We thought this would be the case because*…).

Background Information: this section needs to include…
- Concepts, facts, and terminology from other sources so the average reader can understand your work.
- All facts must be followed with parenthetical citation for the source of the information (Author, Year).
- All sources used in the background information need to also be cited in the references.

Methods & Materials: this section needs to include…
- A materials list of all items used in the investigation.
- A cook-book recipe-style description of how you conducted this experiment.

Results: this section needs to include…
- A written summary of your results, data, and observations.
- A graph/chart/table with labeled components and a written description.

Discussion: this section needs to include…
- The original research question and hypothesis.
- An explanation of whether the data support or reject your hypothesis (or if more data is needed).
- A summary of why you think the data supports/refutes/does not address the validity of your hypothesis.
- A discussion of the validity of your findings. What might limit the validity of your work?
- The implications of your work - what did you learn from this investigation? How might this change decisions you make in the future? How could this work be used to solve problems?

Reference List: this section needs to include…
- All sources used must be listed alphabetically. Each should include: 1) Author's name (last name, first name); 2) Year of publication; 3) *Title of document*; and 4) Publication source or website.
- *E.g.,* US Environmental Protection Agency. (2023). *Fix a Leak Week*. www.epa.gov

