Name__________________

DATA Nugget

Sink or source? How grazing geese impact the carbon cycle

Featured scientists: Trisha Atwood, Karen Beard, and Jaron Adkins from Utah State University and Bonnie Waring from Imperial College. Written by Andrea Pokrzywinski.

Trisha installing CO_2 plots in the field.

"If it wasn't for the geese, you and I would not be here today because our ancestors would not have made it. When long, hard winters emptied people's food caches early, starvation loomed. Return of geese in April saved us." - Chuck Hunt, born and raised on the Yukon-Kuskokwim Delta

Research Background:

Spring geese are an essential food source for subsistence communities like Chevak, Alaska. Elders in western Alaska Native communities have observed a decrease in geese returning to their villages over time. These changes affect the local communities and could also affect the local ecosystem.

One way geese change their environment is by eating grass. In the Yukon-Kuskokwim Delta in western Alaska, birds from every continent on Earth migrate to this sub-Arctic habitat to lay their eggs and raise their young. Once they arrive, geese eat a ton of grass. They graze only in specific areas, called **grazing lawns**, leaving the rest of the vegetation alone.

When geese graze on wetland plants, they remove plant matter, potentially decreasing the amount of carbon dioxide, or CO_2, that is released during photosynthesis. As plants photosynthesize, they absorb CO_2 from the atmosphere and turn it into glucose (a sugar) and oxygen. **Gross primary production** is the total amount of energy that plants capture from sunlight to grow and live before they use up some of that energy for themselves. Plants can slow climate change by removing CO_2 from the atmosphere and turning it into plant matter, like leaves and roots.

Trisha is a scientist who became interested in ways that animals can affect the carbon cycle through their interactions with the environment. She wondered whether fewer geese returning to western Alaska could have global consequences that extend beyond remote communities. She thought that if geese ate enough grass, they may limit

Name___________________

photosynthesis. This is important because it could change whether this ecosystem is a carbon sink or a carbon source. An ecosystem is called a **carbon sink** if it absorbs more CO_2 through photosynthesis than it releases through respiration. Alternatively, an ecosystem can be a **carbon source** if more CO_2 is released than absorbed. We want ecosystems to be carbon sinks because then they keep CO_2 out of the atmosphere, where it contributes to global warming.

A scientist posing as a goose while they clip grass to mimic grazing.

To test her idea, Trisha teamed up with fellow scientists Bonnie, Karen, and Jaron to take a closer look at how grazing grass influences whether the Y-K Delta ecosystem is releasing or absorbing CO_2. To do their experiment they had to get creative. They considered getting a lot of geese, bringing them to an ungrazed area, and letting them chow down. However, it's hard to capture geese and get them to graze exactly where you want. So instead, the research team simulated the effects of geese by cutting the grass to mimic nibbling and then gently vacuuming the pieces of grass to remove them.

The team set up six different experimental areas. Inside each area were two plots: one that was left ungrazed, and the other which was artificially grazed. The research team then used a piece of equipment called a LI-COR to measure the quantity of CO_2 in the air above each plot. They recorded the CO_2 levels during the day and night. The comparison from day to night is one way to look at gross primary production and respiration in a system. At night, when there is no light, plants can't photosynthesize, so the detected CO_2 will be from respiration. The levels during the day represent a combination of CO_2 absorption by plants and release from respiration.

To assess whether the ecosystem is a carbon sink or source, we need to determine the difference between respiration and gross primary production, or **net ecosystem exchange** (**NEE**). A negative NEE means the ecosystem absorbs more CO_2 than it emits. A positive NEE means the ecosystem is releasing more CO_2 than it is absorbing. In this way, scientists classify an ecosystem as either a carbon sink that is storing carbon or a carbon source that is releasing carbon into the atmosphere.

Net Ecosystem Exchange (NEE) Calculation NEE = Respiration – Gross Primary Production	
Positive NEE	Carbon Source
Negative NEE	Carbon Sink

Name___________________

Scientific Questions: How does geese grazing affect the carbon cycle in western Alaska? Does geese grazing alter whether the ecosystem is a carbon source or sink?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientists collecting data from LI-CORs in the plots

Scientific Data:

Use the data below to answer the scientific questions:

Note: all values are in units of micromoles (µmol).

GPP = CO_2 absorbed by photosynthesis **R** = CO_2 released through respiration
NEE = net production of CO_2

Plot ID	Plot Type	Gross Primary Production (GPP)	Respiration (R)	Net Ecosystem Exchange (NEE)
1	control	2.0	2.4	
1	grazed	0.7	2.3	
2	control	3.2	2.1	
2	grazed	1.0	1.4	
3	control	1.5	1.1	
3	grazed	0.0	1.4	
4	control	2.9	2.5	
4	grazed	0.8	1.0	
5	control	2.6	1.9	
5	grazed	0.3	1.1	
6	control	2.8	2.2	
6	grazed	0.6	1.0	

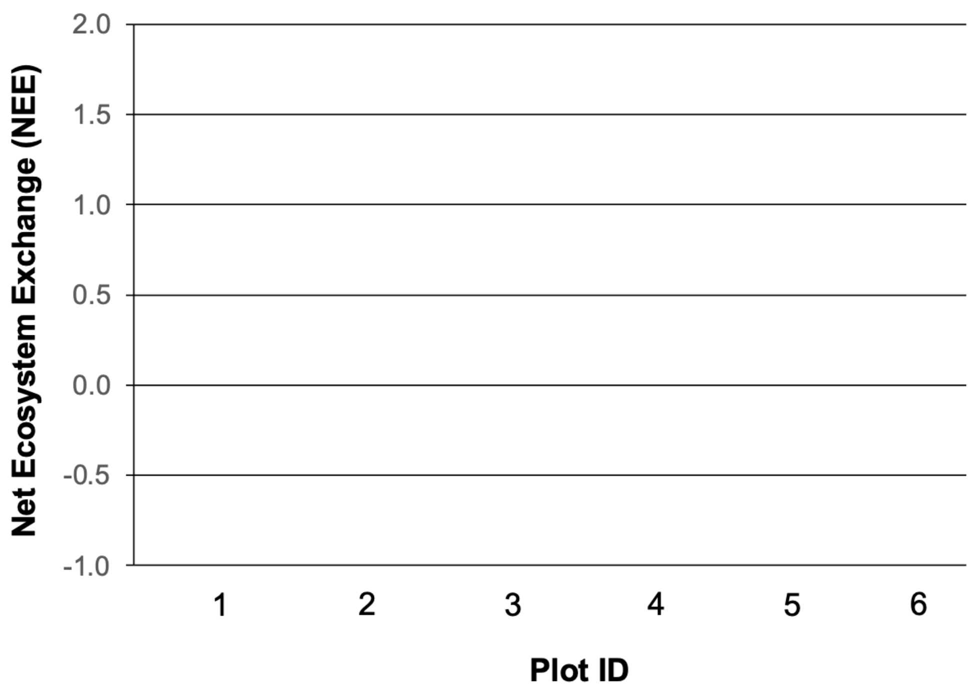
What data will you graph to answer the questions?

Independent variable: ____

Dependent variable: ____

Name___________________

Draw your graph below: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see and write one sentence describing what you see next to each arrow.



Interpret the data:

Make a claim that answers the scientific questions – How does geese grazing affect the carbon cycle in western Alaska? Does geese grazing alter whether the ecosystem is a carbon source or sink?

What evidence was used to write your claim? Reference specific parts of the table or graph.

Name__________________

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how geese grazing could impact the carbon cycle.

Did the data support the team's hypothesis? Use evidence to explain why or why not. If you feel the data are inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on the team's research? How do your questions build on the research that has already been done?