Name____________________

DATA Nugget

Breathing in, Part I

Featured scientists: Kristina J. Anderson-Teixeira, Smithsonian Conservation Biology Institute & Susan C. Cook-Patton, The Nature Conservancy. Written by Ryan Helcoski.

Research Background:

Photosynthesis is the process by which trees and other plants trap the sun's energy within the molecular bonds of glucose ($C_6H_{12}O_6$), a type of sugar. During photosynthesis, oxygen (O_2) is released as a byproduct. For this reason, trees are often portrayed as the lungs of the planet "breathing out" oxygen. Photosynthesis is represented by the following equation:

$$6CO_2 + 6H_2O + Energy \rightarrow C_6H_{12}O_6 + 6O_2$$

Oxygen is then used by living things for **cellular respiration.** Your cells use oxygen to free the energy stored within glucose. That is why you, and most living things, need oxygen to survive. Cellular respiration follows this equation:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2 + Energy$$

But there's another aspect of photosynthesis that's just as important as the release of oxygen. Look at a tree or other plant out your window – how did it get so big? The answer is in the equation for photosynthesis. Carbon dioxide (CO_2) and water (H_2O) provide the carbon, hydrogen, and oxygen needed to build glucose. Trees use glucose as both an energy source and construction material. As they grow, they arrange glucose in long, winding structures. Some of this carbon becomes part of the plant for as long as they live. This means that the carbon that builds plants comes from the air! This process of pulling carbon out of the atmosphere and holding on to it for long periods of time is known as **carbon sequestration** or **carbon accumulation**. It's what the trees do when they use photosynthesis to "breathe in."

Kristina placed this band around a tree in Panama. It is used to measure growth.

These processes caught Kristina's interest. She wanted to know more about how carbon accumulation differed across

Name____________________

Susan stands in a reforestation experiment near the Chesapeake Bay.

the globe. So, in 2006, she and a small team of scientists created a database using information from 91 studies on carbon in trees.

In the meantime, Susan was working at the Nature Conservancy and getting tons of questions from people who wanted to plant new forests to help fight climate change. People wanted to know what kinds of forests to plant, and how much carbon they might be able to accumulate. Susan, like Kristina, knew that carbon accumulation differed across the globe and wanted to give people the right numbers for the right places. She started gathering carbon data by sifting through thousands of scientific papers. In the process, she found Kristina's work. One day, Susan called Kristina to chat.

Kristina and Susan decided they needed to work together to learn more about how carbon accumulation rates differ across various types of forests found around the world. So, they set out to build on previous research and get more accurate measurements. Instead of doing their own new study, they needed to gather data from thousands of existing studies in locations from all over the earth. So that's exactly what they did. Kristina and Susan, along with an international team of researchers, began their work creating **ForC**, the **Global Forest Carbon Database**.

ForC is an open-access database containing over 40,000 records from more than 10,000 plots in over 1,500 geographic areas. All of the data come from published research by scientists and include studies from every forested climate zone. It is a living database that is always being updated as scientists publish their work, making it the most complete source of forest carbon data in the world! It was exactly what Kristina and Susan needed.

Kristina and Susan used ForC to investigate global carbon capture by young regrowing forests. Based on their previous research, they thought that, since tropical forests regrow fastest due to a year-round warm and wet climate, they would have the highest rate of carbon accumulation. In order to study carbon accumulation, they selected 13,112 measurements from young, regrowing (<30 years old) forests around the world. They grouped measurements by forest type, averaged them, and compared their data. With these values they could inform policy decisions and prioritize forest regrowth in parts of the world that would have the highest impact. Review the table below for information on the six main forest types that Kristina and Susan studied.

Name____________________

Scientific Question: Which young forest types accumulate the most carbon?

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.

Scientific Data:

Use the data below to answer the scientific question:
Table 1: information on the six main young forest types that Kristina and Susan studied.

Forest Type	Description	Climate
Boreal	Taiga, dominated by pines, spruce, larch and birch, short growing season	Long cold winters, short summers, low rainfall
Temperate Broadleaf	Mixed forest, dominated by flowering trees that drop leaves in the cool season	Warm summer, cool winter, moderate rainfall
Temperate Coniferous	Dominated by cone bearing plants, like pines	Moderate summer, cool winter, rainfall varies
Tropical and Subtropical Dry Broadleaf	High biodiversity, trees drop leaves during dry season	Warm, rainfall varies by season
Tropical and Subtropical Savanna Woodland	Large open areas with tree crowns forming sparse canopies	Warm, low seasonal rainfall
Tropical and Subtropical Moist Broadleaf	Highest biodiversity, massive trees, diverse canopy, dense jungles	Warm and wet year-round, high rainfall

Name____________________

Table 2: Data on average carbon accumulation from the ForC database. To measure carbon accumulation, they chose the unit MgC/ha/yr which is a measure of the megagrams of carbon accumulated by a hectare of forest per year.

Young Forest Type	Average Annual Carbon Accumulation MgC/ha/yr	95% Confidence
Boreal	1.01	0.48
Temperate Broadleaf	1.92	0.51
Temperate Coniferous	1.58	0.59
Tropical and Subtropical Dry Broadleaf	1.49	0.51
Tropical and Subtropical Savanna Woodland	1.76	1.05
Tropical and Subtropical Moist Broadleaf	2.31	0.50

What data will you graph to answer the question?

Independent variable: ________________________________

Dependent variable: _________________________________

Name____________________

<u>Draw your graph below</u>: 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.

<u>Interpret the data:</u>

Make a claim that answers the scientific question.

Name____________________

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

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how trees use carbon for growth and how that leads to carbon accumulation.

Did the data support Kristina and Susan's hypothesis? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

Name____________________

Your next steps as a scientist: Science is an ongoing process. What new question do you think should be investigated? What future data should be collected to answer your question? What do you think should come next?