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DATA Nugget

The carbon stored in mangrove soils

Featured scientist: Sean Charles from Florida International University

Research Background:

In the tropics and subtropics, **mangroves** dominate the coast. There are many different species of mangroves, but they are all share a unique characteristic compared to other trees – they can tolerate having their roots submerged in salt water.

Mangroves are globally important for many reasons. They form dense forested wetlands that protect the coast from erosion and provide critical habitat for many animals. Mangrove forests also help in the fight against climate change. Carbon dioxide is a greenhouse gas that is a main driver of climate change. During photosynthesis, carbon dioxide is absorbed from the atmosphere by the plants in a mangrove forest. When plants die in mangrove forests, decomposition is very slow. The soils are saturated with saltwater and have very little oxygen, which decomposers need to break down plants. Because of this, carbon is stored in the soils for a long time, keeping it out of the atmosphere.

Sean Charles taking soil samples amongst inland short mangroves.

Sean is a scientist studying coastal mangroves in the Florida Everglades. Doing research in the Everglades was a dream opportunity for Sean. He had long been fascinated by the unique plant and animal life in the largest subtropical wetland ecosystem in North America. Mangroves are especially exciting to Sean because they combine marine biology and trees, two of his favorite things! Sean had previously studied freshwater forested wetlands in Virginia, but had always wanted to spend time studying the salty mangrove forests that exist in the Everglades.

Sean arrived in the Everglades with the goal to learn more about the factors important for mangrove forests' ability to hold carbon in their soils. Upon his arrival, he noticed a very interesting pattern – the trees were much taller along the coast compared to inland. This is

Tall mangroves growing close to the coast.

because mangroves that grow close to the coast have access to important nutrients found in ocean waters, like phosphorus. These nutrients allow the trees to grow large and fast. However, living closer to the coast also puts trees at a higher risk of damage from storms, and can lead to soils and dead plants being swept out to sea.

Sean thought that the combination of these two conditions would influence how much carbon is stored in mangrove soils along the coast and inland. Larger trees are generally more productive than smaller ones, meaning they might contribute more plant material to soils. This led Sean to two possible predictions. The first was that there might be more carbon in soils along the coast because taller mangroves would add more carbon to the soil compared to shorter inland mangroves. However, Sean thought he might also find the opposite pattern because the mangroves along the coast have more disturbance from storms that could release carbon from the soils.

To test these competing hypothesis, Sean and a team of scientists set out into the Everglades in the Biscayne National Park in Homestead, Florida. Their mission was to collect surface soils and measure mangrove tree height. To collect soils, they used soil cores, which are modified cylinders that can be hammered into the soil and then removed with the soil stuck in the tube. Tree height was measured using a clinometer, which is a tool that uses geometry to estimate tree height. They took these measurements along three transects. The first transect was along the coast where trees had an average height of 20 meters. The second transect between the coast and inland wetlands where trees were 10 meters tall, on average. The final transect was inland, with average tree height of only 1 meter tall. With this experimental design Sean could compare transects at three distances from the coast to look for trends.

Once Sean was back in the lab, he quantified how much carbon was in the soil samples from each transect by heating the soil in a furnace at 500 degrees Celsius. Heating soils to this temperature causes all organic matter, which has carbon, to combust. Sean measured the weight of the samples before and after the combustion. The difference in weight can be used to calculate how much organic material combusted during the process, which can be used as an estimate of the carbon that was stored in the soil.

Name________________________

Scientific Question: How does the amount of soil carbon change with decreasing mangrove height from the coast to inland wetlands?

What is the hypothesis? Find the two hypotheses in the Research Background and underline them. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies. Having two alternative hypotheses means that more than one mechanism may explain a given observation. Experimentation can determine if one, both, or neither hypotheses are supported.

Scientific Data:

Use the data below to answer the scientific question:

Habitat type	Distance from coast	Mangrove tree height	Sample along transect	Proportion soil organic carbon
coastal fringe	closest	tallest	1	0.258
coastal fringe	closest	tallest	2	0.354
coastal fringe	closest	tallest	3	0.333
coastal fringe	closest	tallest	4	0.298
coastal fringe	closest	tallest	5	0.337
intermediate	intermediate	intermediate	1	0.274
intermediate	intermediate	intermediate	2	0.369
intermediate	intermediate	intermediate	3	0.384
intermediate	intermediate	intermediate	4	0.379
intermediate	intermediate	intermediate	5	0.370
inland	furthest	shortest	1	0.158
inland	furthest	shortest	2	0.185
inland	furthest	shortest	3	0.179
inland	furthest	shortest	4	0.212
inland	furthest	shortest	5	0.084

**Distance from the coast was measured in meters (m), and then broken up into 3 categories. These categories are closest (10-20 m from coast), intermediate (100-120 m from coast), and furthest (275-300 m from coast).*
***Mangrove tree height was measured in meters (m), and then broken up into 3 categories. These categories are shortest (<1.5 m), intermediate (2-6 m), and tallest (10-20 m).*
****Proportion soil organic carbon is calculated after measuring the difference in soil sample weights before and after combustion.*

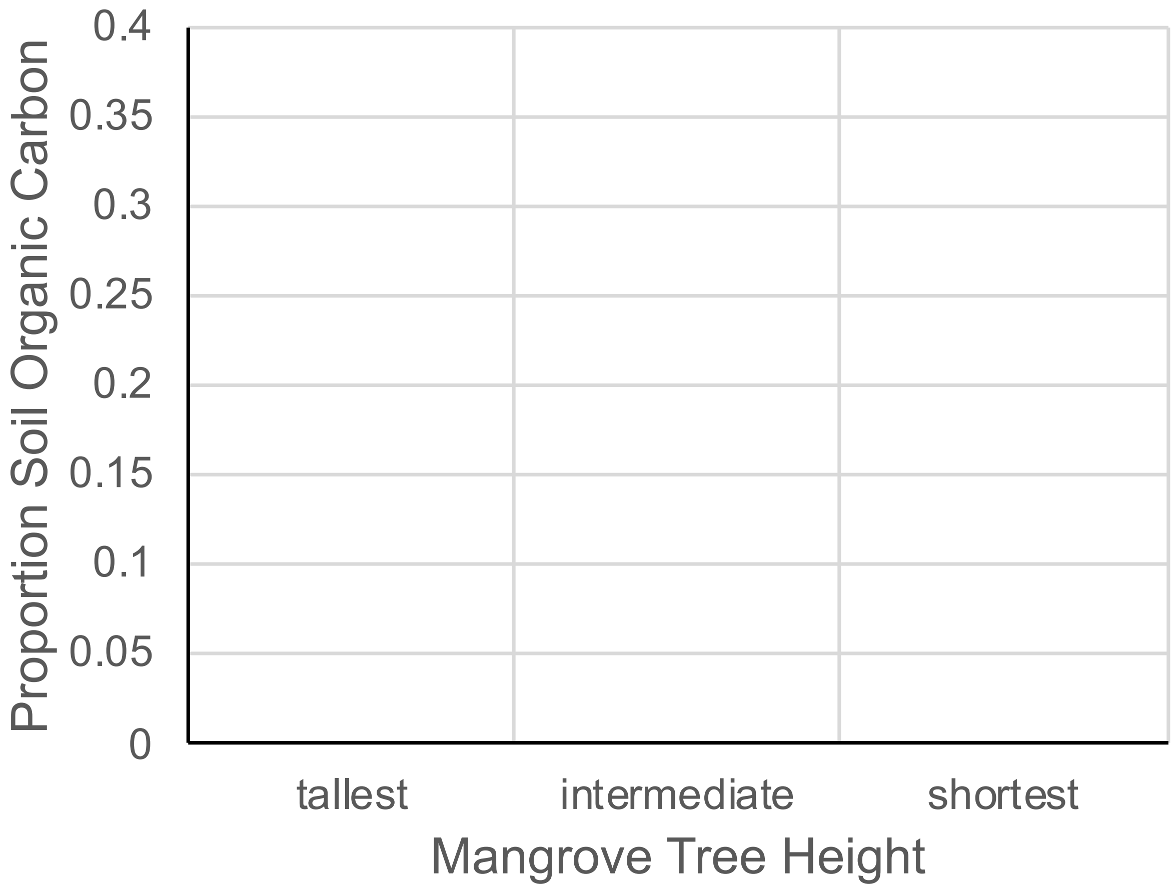
What data will you graph to answer the question?

Independent variables: ______________________________

Dependent variable: ______________________________

Name________________________

Draw your graph(s) below: Identify any changes, trends, or differences you see in your graph(s). 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 question.

Name_______________________

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

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how carbon gets into the soil, and why taller trees contribute more carbon to soils.

Did the data support one, both, or neither of Sean's two hypotheses? Use evidence to explain why or why not. If you feel the data were inconclusive, explain why.

Name________________________

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Sean's research? What future data should be collected to answer your question(s)?