Name_____

# DATA Nugget

**Turning up the heat**

Featured scientists: Mark Hammond (he/him), Moriah Young (she/hers), Kara Dobson (she/hers), and Emily Parker (she/hers) from the Kellogg Biological Station Long Term Ecological Research Program

*Research Background:*

As you step into a warm greenhouse, you can feel how the glass has captured the sun's heat inside. Now imagine that same warmth spreading across the entire planet due to increased greenhouse gas emissions. Climate scientists predict that by the year 2100, Earth's average temperature could increase by as much as 3°C because of climate change. That might sound small, but even a few degrees matter a lot!

Open-topped chambers and control, ambient condition plots spread across a field at the Kellogg Biological Station.

At the Kellogg Biological Station in southwest Michigan, a group of researchers wanted to know how climate warming will affect plant communities. To find out, they created what they call "mini time machines" using **open-top chambers**. These chambers are clear, hexagonal-shaped structures that trap heat and make the air inside warmer - just like a greenhouse. The chambers still allow for natural levels of precipitation, air flow, and insects to enter through their open tops. By comparing plant communities grown in these **warmed conditions** with chambers, to **ambient conditions** without the chambers, scientists can see how rising temperatures might impact the plants in the future. Understanding these changes can help us prepare for a future where the climate is different from what we know today.

The scientists working in the open-top chambers were at multiple stages in their careers. Moriah is a graduate student who became fascinated with plants when she first learned how to identify different species. Instead of looking at plants as all one patch of green, she could then notice all the diversity and the different roles they play in an ecosystem. Mark is a lab technician working with Moriah. He is interested in how plants will respond to warmer climates because it gives a glimpse of the world his grandchildren will see.

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Tall goldenrod plants flowering in one of the ambient condition plots.

When Moriah and Mark started, they were joined by a few other scientists: Kara, another graduate student, and Emily, an undergraduate student. The open-top chambers had already been out in the field for five years. The field was growing with a diverse mix of plants common in the area. Together, they observed that plants growing in the warmed conditions inside the chambers seemed to be taller than those growing in the ambient conditions outside the chambers.

To collect some data to back up their observation, the team began with one species, **tall goldenrod**. This is a wildflower species with a bright yellow flower, and it is one of the most common species at this location. They wanted to see how goldenrod growth differed in warmed and ambient conditions. When temperatures rise, some plants grow faster and taller to compete for sunlight, but this takes a lot of energy. That means plants have less energy for survival, making seeds, or defending against herbivores, like insects. The researchers predicted that goldenrod inside the chambers would be taller, but would also have fewer stems and plants because they were putting their energy into growing tall instead of making more plants.

To test their ideas, the team measured goldenrod **height** with meter sticks and counted the number of goldenrod stems in each plot, called **abundance**. Their experiment had 30 plots. Half of the plots had open-top chambers, and half did not. That gave them 15 replicates of each treatment. Each plot is 1 meter x 1 meter.

*Scientific Question*: How does climate warming affect tall goldenrod height and abundance?

*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.

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*Scientific Data:*

**Use the data below to answer the scientific question:**

| **Warmed Conditions** (inside open-topped chambers) | | |
|---|---|---|
| Plot | Average height of goldenrod (cm) | Average abundance (stem count) |
| 1 | 127.4 | 4 |
| 2 | 122.0 | 5 |
| 3 | 123.9 | 7 |
| 4 | 136.5 | 7 |
| 5 | 124.8 | 7 |
| 6 | 125.6 | 8 |
| 7 | 125.4 | 9 |
| 8 | 123.2 | 9 |
| 9 | 117.0 | 8 |
| 10 | 115.1 | 8 |
| 11 | 122.2 | 9 |
| 12 | 113.8 | 8 |
| 13 | 139.8 | 8 |
| 14 | 121.4 | 11 |
| 15 | 117.3 | 11 |

| **Ambient Conditions** (no open-topped chambers) | | |
|---|---|---|
| Plot | Average height of goldenrod (cm) | Average abundance (stem count) |
| 16 | 80.7 | 13 |
| 17 | 79.9 | 15 |
| 18 | 91.4 | 14 |
| 19 | 91.5 | 14 |
| 20 | 79.3 | 11 |
| 21 | 82.6 | 14 |
| 22 | 85.2 | 17 |
| 23 | 85.4 | 10 |
| 24 | 86.3 | 14 |
| 25 | 75.9 | 14 |
| 26 | 90.4 | 13 |
| 27 | 80.1 | 14 |
| 28 | 81.5 | 10 |
| 29 | 90.4 | 13 |
| 30 | 79.7 | 18 |

Average **height** of tall goldenrod in **warmed** conditions: _____

Average **abundance** of tall goldenrod in **ambient** conditions: _____

Average **height** of tall goldenrod in **warmed** conditions: _____

Average **abundance** of tall goldenrod in **ambient** conditions: _____

What data will you graph to answer the question?

Independent variable: _____

_____

Dependent variables: _____

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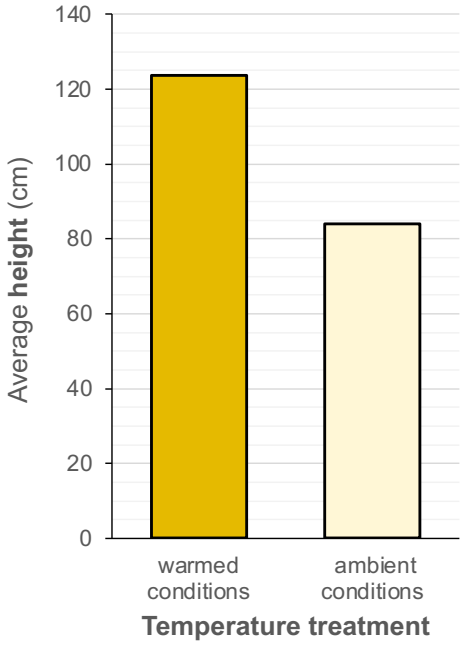
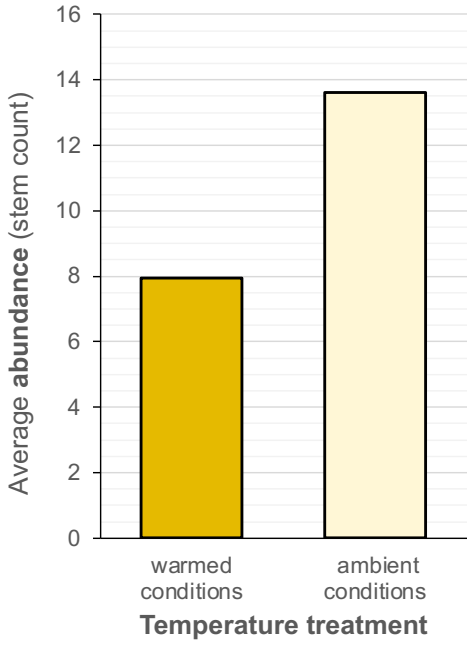
Name_____

*Below are graphs of the data*: Identify any changes, trends, or differences you see in your graphs. 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 - How does climate warming affect tall goldenrod height and abundance?

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

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Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about how the chambers used in the experiment approximate future climate warming.

Did the data support Mark, Moriah, Kara, and Emily'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 Mark, Moriah, Kara, and Emily's research? How do your questions build on the research that has already been done?