**Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Today’s Question:** Why do some pollinators nest earlier than others?

**Part 1: Initial Hypotheses**

A ***hypothesis*** is an educated answer to a scientific question. Come up with some hypotheses now for why pollinators might nest at different times.

1. Pollinator nest timing is determined by…
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part 2: Graphing and Summarizing Nest Dates**

To answer today’s question, first we need to know when native pollinators build their nests. To do this, follow the instructions on your *Graphing and Summary Statistics Instructions* sheet.

***TABLE 1: Analyzing your data.***

|  |  |  |
| --- | --- | --- |
| **Average** | **Minimum** | **Maximum** |
|  |  |  |

**Part 3: What do bees\* need? \*and other wood-nesting pollinators!**

Now that you have looked at when pollinators nest, we need to figure out ***why*** each of these pollinators nest when they do. Since all these species are wood nesters, we’re going to focus on what each species uses in the nesting process. All these species need 1) something to feed (provision) their offspring and 2) something to plug their nests to protect their eggs and larvae from the elements. So we are going to test two alternative hypotheses:

H1) Pollinators’ nest timing is determined by the availability of the food they provide their

offspring.

H2) Pollinators’ nest timing is determined by the availability of the material they use to plug their

nests.

We will test these two hypotheses by graphing nest food and plug data on top of your graph of nest timing. How will we know which hypothesis is supported? Discuss this with your group.

To test these two hypotheses, first you need to figure out what your species uses to provision and plug its nests. To find out, go to <science-live.org/bees/about/pollinatordiversity.html>. Click on your species and enter what you find here:

**Provisions with:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Plugs with:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Now return to your Google Spreadsheet and select the tab labeled “Predictor Variables.” Which of these data sets best fit your species’ provision and plug needs?

**Provision Data Variable Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Plug Data Variable Name:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Using the instructions under **Part 3: What do bees need?** on your *Graphing and Summary Statistics Instructions* sheet, add your two predictor variables to your pollinator nesting graph. Once you have graphed them, find the **date** for the peak value (highest value) for your species’ nests, provision resource, and plug resource and complete the table below.

***TABLE 2: Peak nesting and resources. Date Range***

|  |  |
| --- | --- |
| **Peak nesting: When does your species make the most nests?** |  |
| **Peak provisions: When is your provision resource most abundant?** |  |
| **Peak plugs: When is your plug resource most abundant?** |  |

Based on your answers in TABLE 2, which hypothesis, H1 or H2, does your species support? \_\_\_\_\_\_\_\_\_\_

Why?

**Part 4: Extensions**

When factors like food or nest plug materials are limited, they can limit the nest success of individuals that try to nest in times of fewer resources: if there isn’t enough food to provision the nest or aren’t enough materials to properly seal the nest, eggs are less likely to hatch and become adults next year. On the other hand, nests made when resources are most abundant will probably produce the most offspring, leading to more members of the population next year that will reproduce at the same time as their parents (see graphs below). If the timing of food/nesting resources remains fairly consistent from year to year, then, over many generations, more and more of the population will nest in the same, optimal nesting time, causing peaks like those you graphed today. **Limited resources** like seasonal food or nesting materials that control the survival and reproduction of individuals in a population are called **selection pressures**.

**Generation 1:**

Early nesters don’t have enough food for their offspring…

…so fewer offspring survive, and fewer bees make early nests next year.

**Generation 2:**

**Generation 3:**

If this continues over time, more and more of the population will nest in peak season.

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1. There is a fifth pollinator species in the Google Spreadsheet that none of the class groups analyzed: Hylaeus. You will see a graph of Hylaeus nesting patterns on the “SpeciesData-Hylaeus” tab. Calculate average, minimum, and maximum values for Hylaeus and compare them to the other species we looked at today. Also, look at the peak nesting date for Hylaeus.
   1. How does this species’ nesting behavior graph look different from yours? From the other species on the board?
   2. Look up Hylaeus on the ScienceLIVE website to find out what it uses for provisioning and plugging its nests. Why might this species show different nesting behavior than the other species we looked at today?
2. The data you looked at today show that there is an ideal time to build nests for each pollinator species, indicated by the peak nesting dates that we focused on. Now let’s look at the non-peak nesters: those individuals that built nests earliest on your graph.
   1. Do you think the nests these early individuals made are as high quality as those made in the peak nesting period? (Hint: Do they have everything they need to build a successful nest?)
   2. Given your answer to (a), during which dates will the most successful nests be made? Consequently, which pollinator parents will produce the most offspring?
   3. Let’s assume nesting time is inherited – parent pollinators pass nesting date on to their offspring. If all the offspring produced in 2013 nest in the same time period as their parents did, when will peak nesting be in the next year (2014)?
3. As climate changes, many species of plants are changing their phenology: they are producing leaves, pollen, and flowers up to one month earlier than they did 100 years ago.
   1. If nesting resources peak two weeks earlier in 2023 than in 2013, will your answer to (1-b) be the same? If not, which individuals of your species will have the most success in 2023?
   2. Will the population be as big in 2023 as in 2013? Why/why not?

* 1. If all members of your species nested ONLY during the two-week peak period you recorded for 2013 (in other words, if there were no early or late nesters in 2013, only peak season nesters), how would your species be affected by climate change?