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

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

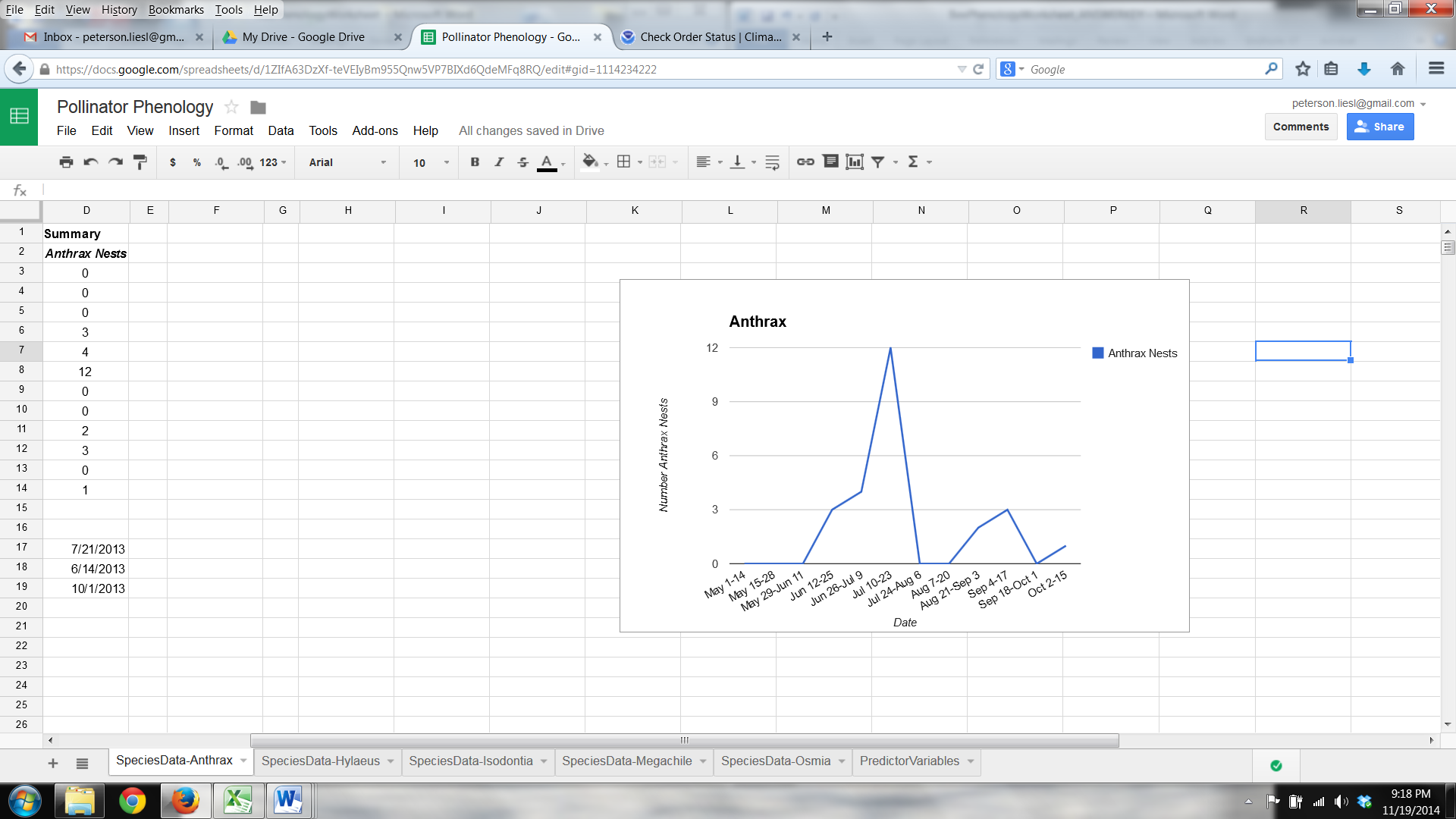
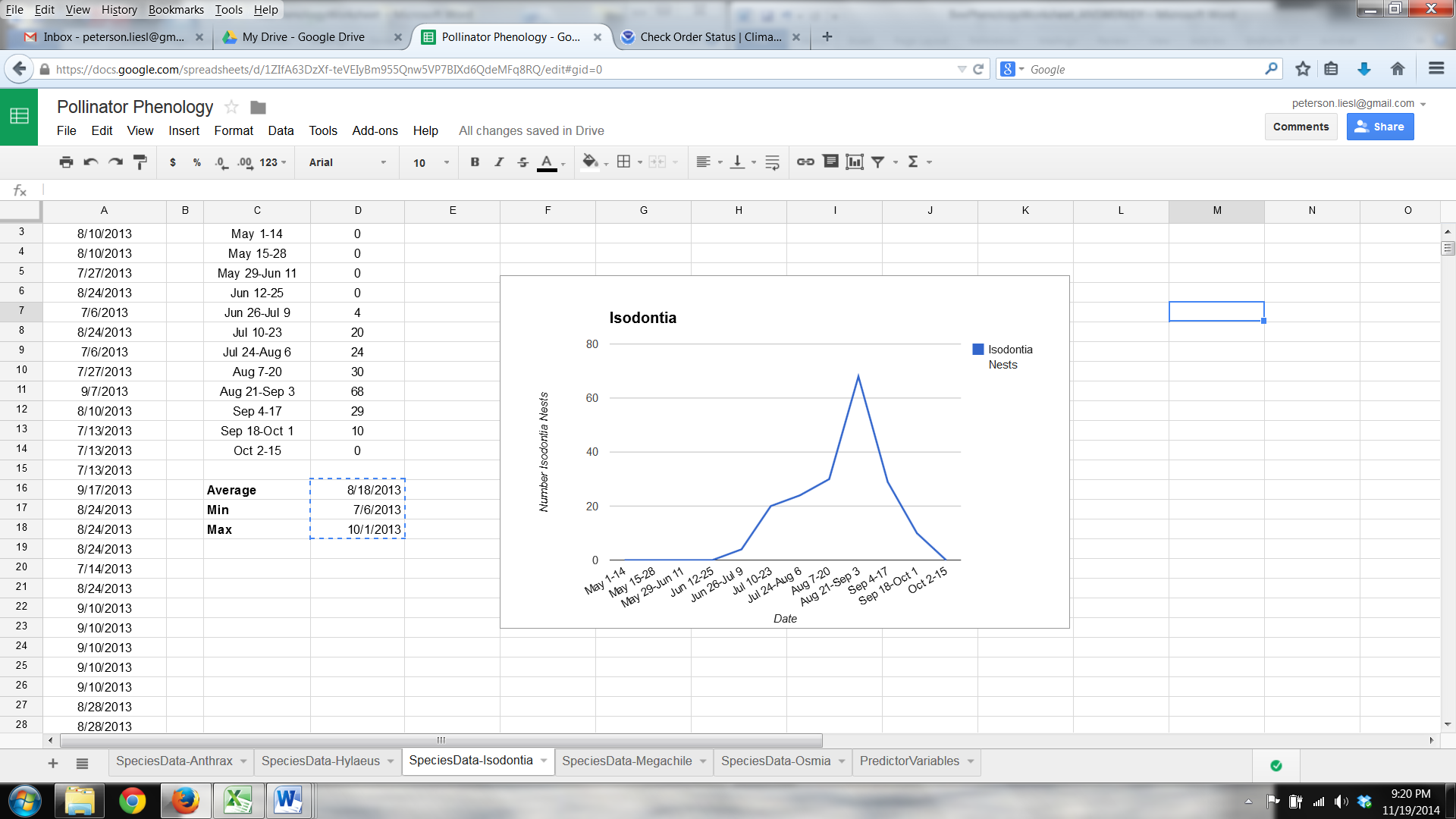
**Part 1: Initial Hypotheses**

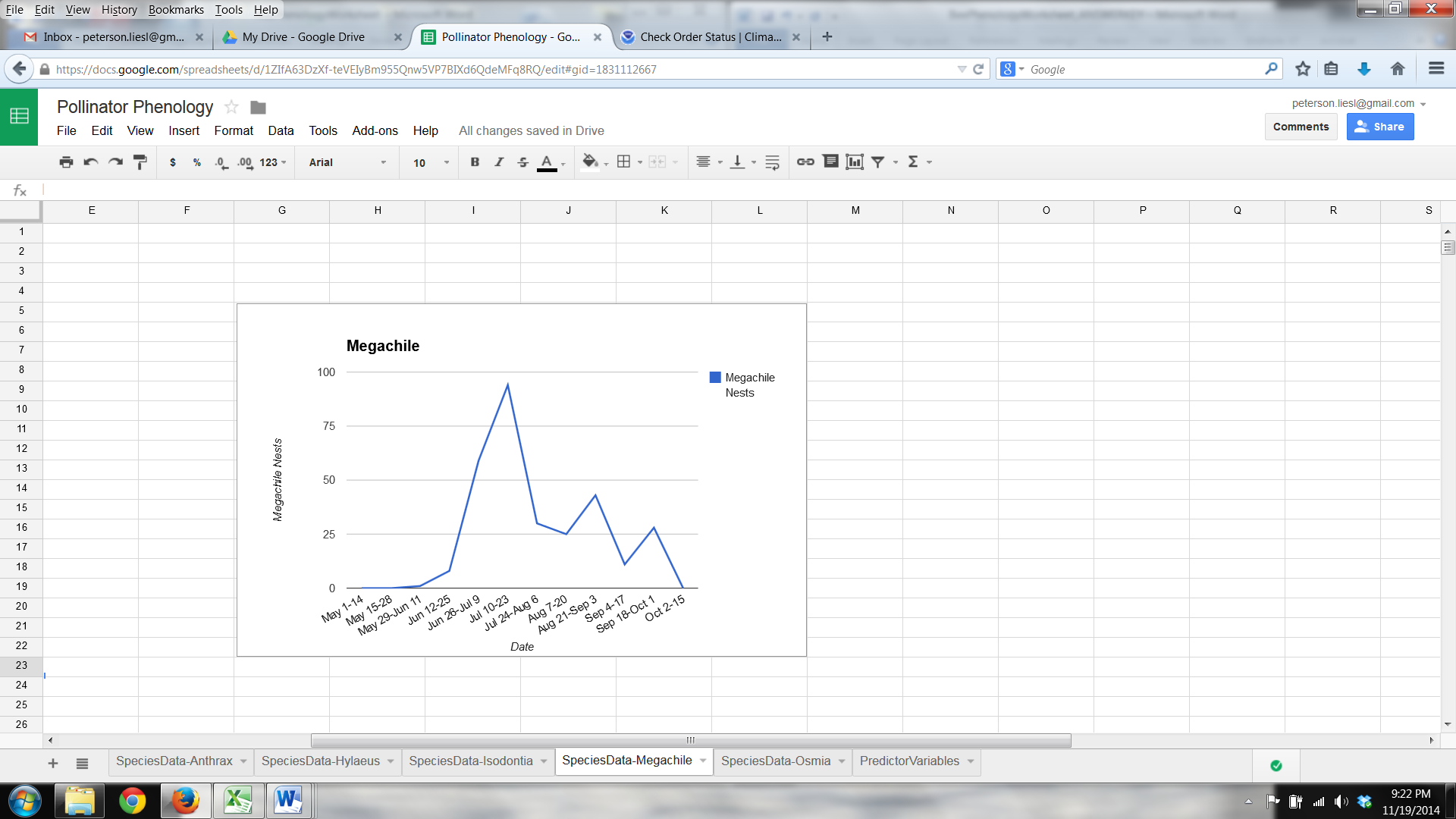
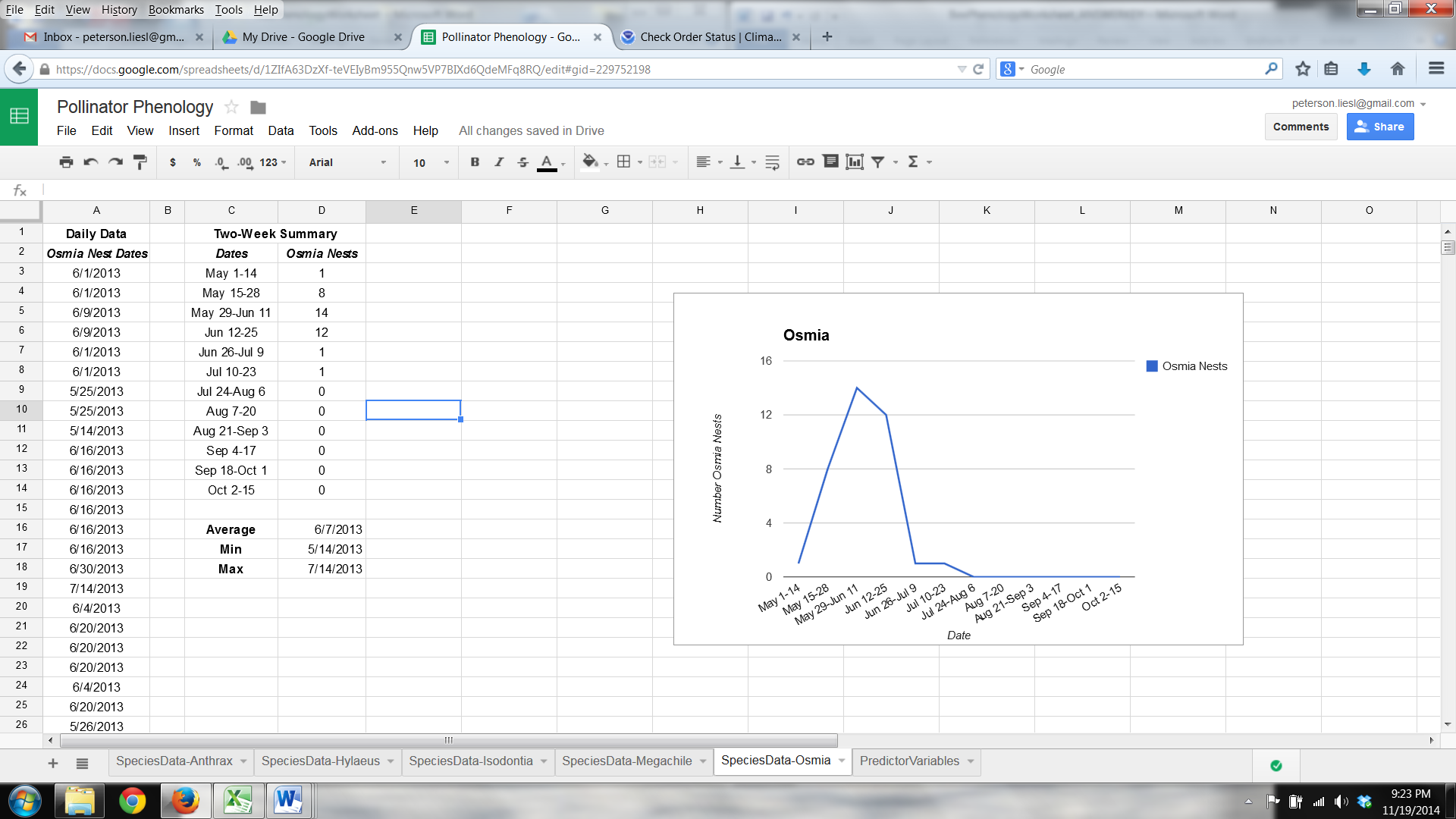
A ***hypothesis*** is an educated answer to a scientific question. Come up with some hypotheses now for why pollinators might nest at different times.

1. Pollinator nest timing is determined by… any potential ideas are welcome at this stage

**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.***

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Average** | **Minimum** | **Maximum** |
| Anthrax | 7/21/13 | 6/14/13 | 10/1/13 |
| Isodontia | 8/18/13 | 7/6/13 | 10/1/13 |
| Megachile | 7/30/13 | 6/1/13 | 10/1/13 |
| Osmia | 6/7/13 | 5/14/13 | 7/14/13 |

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

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

The predictor (plug or provision) that peaks closest to the nesting peak must be the key determinant of nest timing. The pollinator must wait for both factors to be present in the environment before it can successfully nest, so the resource that peaks later will be the main limiting factor for nesting.

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](file:///C:\Users\Liesl\Dropbox\Research\ScienceLIVE\CSC2014\science-live.org\bees\about\pollinatordiversity.html). Click on your species and enter what you find here:

|  |  |  |
| --- | --- | --- |
| **Species** | **Provisions** | **Plugs** |
| Anthrax | other pollinator larvae | Mud and leaves (uses the plugs built by other pollinators) |
| Isodontia | tree crickets and katydid nymphs | grass |
| Megachile | pollen | leaves |
| Osmia | pollen | mud |

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?

|  |  |  |
| --- | --- | --- |
| **Species** | **Provision Variable** | **Plug Variable** |
| Anthrax | Total Bee/Wasp Nests | Mud Index |
| Isodontia | Cricket+Katydid | % Grass Cover |
| Megachile | Pollen | % Leaf Buds Open |
| Osmia | Pollen | Mud Index |

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

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Peak Nesting Date Range** | **Peak Provision Date Range** | **Peak Plug Date Range** |
| Anthrax | Jul 10-23 | Jul 10-23 | May 1-14 |
| Isodontia | Aug 21 – Sep 3 | Jul 24 – Aug 6 | Jun 12-25 |
| Megachile | Jul 10-23 | May 1-14 | Jul 10-23\* |
| Osmia | May 29 – Jun 11 | May 15-28 | May 1-14 |

\*Some students may be confused because leaves don’t actually “peak” they plateau (reach 100% and stay there for the rest of the season). They should pick the date at which leaves first reach 100%, Jul 10-23.

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

|  |  |
| --- | --- |
| **Species** | **Hypothesis Supported** |
| Anthrax | H1-Provisions |
| Isodontia | H1-Provisions |
| Megachile | H2-Plugs |
| Osmia | H1-Provisions |

Why?

Though some groups will support H1 and others H2, all should have the same reasoning: the variable that is controlling nesting peaks closer to the nesting peak than the other variable (e.g. Anthrax’s food source peaks later than its plug material).

**Part 4: Extensions**

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 your species? From the other species on the board?

Hylaeus has a similar average, minimum, and maximum to Megachile, but it doesn’t have one peak – it peaks 3 times and has high nesting rates for most of the season.

* 1. 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? Are the selection pressures for Hylaeus different than those for the other species we looked at today?

Hylaeus plugs its nests with silk it makes itself, and provisions its nests with pollen, which is common throughout the season. Neither of these factors are limiting, so there aren’t strong selection pressures on nesting phenology. Because of this, it isn’t as dependent on its environment as other species and doesn’t have a peak nesting date – it nests throughout the season.

1. 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?)

The early and late nesting individuals probably don’t make as high quality nests, because their nesting materials and food aren’t at their peaks during these times.

* 1. Given your answer to (a), during which dates will the most successful nests be made? Consequently, which pollinator parents will produce the most offspring?

The most successful nests will come from the individuals that nest at peak season, when their food and plug resources are available. As a consequence, the peak season nesters will produce the most offspring.

* 1. 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)?

Peak nesting will be in the same time period in 2014 as in 2013.

1. 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?

If nesting resources peak two weeks earlier, the individuals nesting in 2013’s peak season won’t have as much success – instead, individuals nesting two weeks earlier, when there are more nesting resources, will produce more offspring.

* 1. Will the population be as big in 2023 as in 2013? Why/why not?

The population will probably be smaller in 2023, because there are fewer parents making nests that early. As they have more nest success, the population will probably grow again.

* 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?

If all members of a species only nested in peak season, the species couldn’t respond to climate change. The species would decline and probably go extinct.