North American Bee Decline Data Play

This Half-Earth Project Data Play is about bees. Bees are one of the most diverse groups of insects in the world and famous for being important pollinators. One goal of this Data Play is to reset your "bee meter" (see Martin Dohrn video in blog post!), from the familiar honey bee to diverse and important wild bees. The honey bee is a domesticated species that live in large colonies, and were introduced worldwide from Europe.

Look at the 8 bee photos above labeled A-H.

1. Do you think these photos are of 8 different bee species or a single species? (circle your answer)

2. Guess what kind of bees are in these photos? Explain your answer.

_____

If you said "bumble bee" that's correct. Each photo is of a different bumble bee species, but they are closely related species in the same genus, *Bombus*. Bumble bees, like many native bees, are nearly solitary and live in the ground, tree cavities, or in leafy piles.

Here's the scientific names of the bumble bees in the photos above. B. stands for *Bombus*
A - *B. occidentalis*, **B** - *B. bifarius*. **C** - *B. vosnesenskii*, **D** - *B. pensylvanicus*,
E - *B. bimaculatus*, **F** - *B. impatiens*, **G** - *B. affinis*, **H** - *B. terricola*

Now have a look at the map on the next page. The map and the bumble bee photos are from this study, **"Patterns of widespread decline in North American bumble bees**" published in the journal *Proceedings of the National Academy of Sciences in the United States of America* (full article). The purpose of the study was to analyze the factors leading to bumble bee decline in the United States.

To begin your analysis, look at the shapes and think about what you're seeing. Is it a map? Do you recognize the country? What is the gray showing, what are the circles showing? Answer the questions on the page following the map.

Teacher note: this activity makes use of the I2 strategy (BSCS)

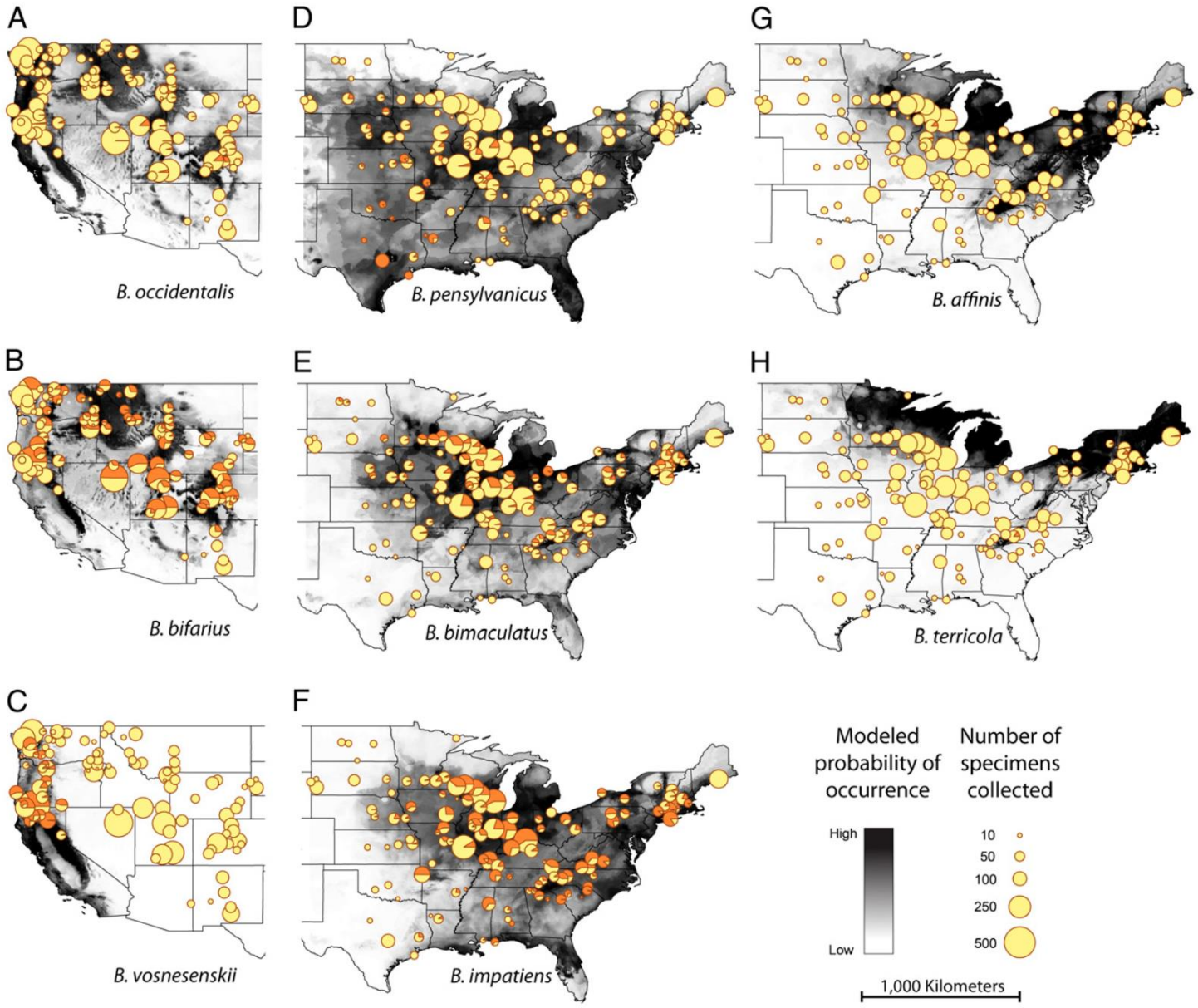

Fig. 1. Summary of Bombus individuals surveyed from 382 collection locations for eight target species, including historical range maps (grayscale shading) with current sightings (pie charts) and associated photographs of hypothesized declining western B. occidentalis (A) and eastern B. pensylvanicus (D), B. affinis (G), and B. terricola (H); stable species are represented by the western B. bifarius (B) and B. vosnesenskii (C), and the eastern B. bimaculatus (E), and B. impatiens (F). Sizes of the pie charts indicate total number of individuals surveyed at each location; size of the orange segment indicates the fraction of the respective target species collected at that site (some locations are pooled across sites for visual clarity; for detailed data, refer to Table S1). Underlying grayscale shading represents the modeled distribution of each target species from unique presence localities obtained from natural history collections (SI Methods, Statistical Niche Models).

Looking at the Figure

Identify

1. What do you see in Fig. 1 above? Mark and describe at least three things?

Interpret

2. What do you think Fig. 1 is showing? Identify some patterns that you see. When you look at panels A-H and compare them to each other, what do you notice?

3. Name a panel (A-H) that is showing a pattern for a bee species in the Western US _____.

4. Name a panel (A-H) that is showing a pattern for a bee species in the Eastern US _____.

   Look at the key in the lower right

5. State in your own words what you think the gray to black patterns mean.

6. State in your own words what you think the yellow circles are showing.

Now read the caption under Fig. 1 above and think about your answers above, make changes if you like.

The researchers who produced Fig. 1 used population genetics data and pathogen infection data to first confirm that US Bumble Bee populations are declining and then try and understand what the causes of decline might be. In their publication they highlight 8 species that reveal some important patterns including 4 species with a dramatic decline in relative abundance of 96%. These same bees have shrinking geographic ranges with a loss of 23– 87% over the last 20 years. They used data from 73,000 museum records and field surveys of more than 16,000 specimens from 382 sites in the US. They conclude that Bumble bee populations with lower genetic diversity and high levels of pathogen infection had the greatest declines. Research continues, to understand the underlying cause such as habitat loss or degradation. Now let's deepen our analysis and try to draw some conclusions that might help to save these important, beautiful, and threatened bees.

Deepening Your Analysis and Forming Conclusions

7. What do the orange slices on the pie charts represent? Why do you think this piece of information is included in the figure?

8. What type of data do you think was used to create the gray patterns on the maps?

9. Based on your observations of the figure, which bumble bee specie(s) are declining? Describe how you utilized the images to make your conclusion.
   Hint: compare the gray patterns to the circle patterns on the maps.

10. Could you use these images to make hypotheses about other bee species?

11. What other types of data do you think is needed to understand why these bee populations are declining?

12. Research papers provide information to consider for taking conservation actions. Most research is directed at collecting basic information and understanding cause and effect, not necessarily recommending a course of action. Based on this research what action would you recommend? What other information would you like to have?

Extension:
Consider a deeper dive into the parasitic fungus *Nosema bombi,* which can kill individual bees and reduce brood size therefore lowering overall bee population. The group of *Nosema* fungi infect many bee species including honeybees, and *Nosema bombi* may have been introduced to Bumble bees through honeybee colonies. Have a look at Figure 3 in the study, **"Patterns of widespread decline in North American bumble bees**" published in the journal *Proceedings of the National Academy of Sciences in the United States of America* (full article).