Phenology and Climate Change: Lesson 3a Temperature Effects and Phenological Mismatch

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Essential Question

Summary

Snapshot

Engage

Students examine models of temperature change over time to draw conclusions about climate.

Explore

Students compare the effect of temperature on insect and bird migration timing.

Explain

Students take notes over climate change and make predictions about the consequences of changes in migration timing.

Extend

Students explore a model of phenological mismatch.

Evaluate

Materials

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Engage

Direct students to the "Temperature" page of the Shiny app. Give them time to explore the temperature change over time in various parts of the country. Suggest they select "Click map to choose" and pick their own state on the map. They might also consider

Next, have them toggle on the temperature anomaly graph. Explain the difference between temperature and temperature anomaly. They need to understand the concept of anomaly in order to interpret the focal model for this activity.

Explore

After the discussion, return to the Shiny app. This time the students will investigate the temperature variable for both the leaf hopper and the aerial insectivore data sets. Before turning them loose to complete their exploration of the models, present students with the following question: *In what ways, if any, are leafhoppers and migratory birds responding to temperature?* Give students a few minutes to discuss the question with their neighbor(s), having each pair or small group generate and write down one hypothesis for leafhoppers and one for migratory birds. Have groups share their hypotheses with the class.

Using the <u>How I Know It</u> strategy, have students collect evidence which supports or refutes their hypotheses as they play with the models. "What I know" comprises the inferences and conclusions students are drawing from the data, and "how I know it" accounts for the specific evidence from the models that support those conclusions.

Class discussion of results.

Teacher's Note: Guiding questions

- Is the rate of advance more rapid for birds or insects? Why? (Consider how their life history might affect the data, with leafhoppers migrating over multiple generations in one season versus a single generation of birds.)
- What problems might be caused by the difference in arrival time between birds and insects?
- Did the models support or refute your hypothesis?
- What evidence would you need to feel confident your hypothesis was correct?

Explain

Discuss patterns identified in and conclusions drawn from Shiny app models. Specifically ask students to assess how well they predicted the effects of temperature on the relationship between insects and migratory birds?

[Content - Why do we care about temperature effects in the first place?]

- Climate change overview
- Additional life history? (e.g., day length versus temperature effects)

Teacher's Note: Guiding questions

- If a species can't respond quickly/match their timing to temperature change, how might that affect the species in the long-term? (Species that can't keep pace with temperature change/phenological shifts will be less successful at reproduction and may go extinct over time.)
- How would a population be affected by individual animals' abilities to respond to changes in temperature? (Animals who can keep pace with changes in seasonal timing will be more successful at reproducing, and those animals and their offspring with the ability will increase in the population over time.)

Extend

Once students have a working understanding of this variable, they should move to the "Phenology Mismatch" page of the Shiny app. Orient them to how to interpret the graphs the model generates.

Provide students with the **Lesson 3 Explore handout**, and task students with answering the following questions using a <u>CER</u> format:

- How does the rate of climate change affect the results of the model?
- How is bird carrying capacity affected by climate change and life history (i.e., caterpillar and bird sensitivity to day length and temperature)?

Evaluate

[maybe] To conclude the lesson, ask students to create a visual representation of how insect arrival/activity and bird arrival are related to one another, including how they are changing over time. This could take a variety of forms, including but not limited to: graphs or tables, flow charts, concept maps, illustrations, etc. Additionally, have them include a 1-3 sentence explanation of their representation. These visual summaries will be used to kick off the next lesson.

Resources

- Birds, Bugs, and Phenology <u>https://aeroecology.shinyapps.io/Birds_Bugs_and_Phenology/</u>
- Claim, Evidence, Reasoning (CER) strategy <u>https://learn.k20center.ou.edu/strategy/156</u>
- Gallery Walk strategy <u>https://learn.k20center.ou.edu/strategy/118</u>
- Research Poster strategy <u>https://learn.k20center.ou.edu/strategy/49</u>