Phenology and Climate: Lesson 1

Insect Activity and Migration Timing

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Published by *K20 Center*

Grade Level	10th – 12th Grade	**Time Frame**	250 minutes
Subject	Science	**Duration**	4-5 Periods
Course	Environmental Science		

Essential Question

1. How do insect activity and migration change seasonally? 2. Why is the timing of seasonal insect activity and migration important?

Summary

This is the first lesson in a three-lesson series examining the relationships among insect migration, bird migration, and temperature change over time. In this lesson, students will learn about phenology (the timing of biological events) by exploring a variety of insect data sets. Through scaffolded analysis of graphical data, the use of an interactive digital model, and life history descriptions, students will develop an understanding of (1) how insect activity varies over a season and (2) how this migration activity has changed over time. From these activities, they will draw conclusions and make predictions about the biological significance of the data sets.

Snapshot

Engage

Students listen to a news story about the “insect highway” and generate questions.

Explore

Students create and interpret graphs of seasonal insect activity data and begin generating “big science ideas.”

Explain

Students revisit their initial questions and learn about phenology and the source of the Explore data.

Extend

Students explore a model of insect migration data and identify patterns in insect arrival over time.

Evaluate

Students determine what information they still need in order to answer their remaining questions and create a Six-Word Memoir summarizing their learning.

Standards

ACT College and Career Readiness Standards - Science (6-12)

IOD202: Identify basic features of a table, graph, or diagram (e.g., units of measurement)
IOD502: Compare or combine data from a complex data presentation

Next Generation Science Standards (Grades 9, 10, 11, 12)

HS-LS2-2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Oklahoma Academic Standards (Biology)

B.LS2.2 : Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Oklahoma Academic Standards (Biology)

EN.LS2.2: Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

Attachments

- Day of Year Tables—Phenology and Climate 1.docx
- Day of Year Tables—Phenology and Climate 1.pdf
- Insect Arrival Data—Phenology and Climate 1.docx
- Insect Arrival Data—Phenology and Climate 1.pdf
- Leafhopper Map Comparison—Phenology and Climate 1.docx
- Leafhopper Map Comparison—Phenology and Climate 1.pdf
- Leafhopper Migration Guide—Phenology and Climate 1.docx
- Leafhopper Migration Guide—Phenology and Climate 1.pdf
- Lesson 1 Slides—Phenology and Climate 1.pptx
- WIS-WIM—Phenology and Climate 1.docx
- WIS-WIM—Phenology and Climate 1.pdf

Materials

- Lesson slides
- Poster paper
- Meter stick or ruler
- Sticky notes
- 8 Colored markers (1 color per group)
- Day of Year Tables handout (attached; cut into strips; 1 per group)
- Insect Arrival Data handout (attached; cut into tables; 1 per group)
- WIS-WIM handout (attached; 1 per student)
- Leafhopper Map Comparison handout (attached; 1 per student)

45 minutes

Engage

Introduce the lesson title, the lesson objective, and the essential questions on **slides 2-4**. Go to **slide 5** and introduce students to the *Look Up! The Billion-Bug Highway You Can't See* story. Play the "5-Minute Listen" version of the story. After listening once, play the story a second time. During this second play, provide students with sticky notes and ask them to come up with questions about the story as they listen. If you use a Driving Question Board (see paragraph below Teacher's Note: Format), have them write each question on its own sticky note.

Teacher's Note: Format

You might also consider having students read the associated article, which provides the same information in a different format or provide students with a link to the transcript.

Go to **slide 6**. Using the Stand-Up, Sit-Down strategy, have students share out their questions one at a time and create a class list from the responses. Use these questions to begin a class Driving Question Board. Record questions in a public space that can be referred back to at a later time (e.g. poster paper, Google Doc, whiteboard, etc.).

Teacher's Note: Question Themes

While it is an optional step, it can be helpful to have students group their questions into themes/big ideas as they share out. A simple way to do this is for a student to determine whether their question is similar to questions that have already been posed or whether it should be in a category of its own.

For example, a student might decide their question about food sources would fit with one about territory availability because they are both about resources, while another student might decide that their question about responding to weather belongs in its own group.

45 minutes

Explore

Teacher's Note: Question Prompts

If students are struggling with their WIS-WIM, prompt them with the following questions:

- Do you see any trends common among all the years?
- Are there any outliers?
- What are the most noticeable discrepancies?

Break students into eight groups. Provide each group one table from the **Insect Arrival Data** handout (2014–2021) and a colored marker. While working on the following WIS-WIM activity, have a volunteer from each group, one at a time, add their % arrival data (10, 25, 50, 75, 90% values) on the large graph you created prior to the start of class. They will look at this graph of insect arrival data as a whole group later.

Hand out a copy of the **WIS-WIM** handout to each of the groups. Go to **slide 7**. Using the WIS-WIM strategy, ask students to identify features of the graph(s). After they've had a few minutes, continue to **slide 8** and ask them to determine the meaning of those specific observations. Finally, go to **slide 9** and have them interpret the entire figure and write a brief caption summarizing what the figure communicates. When all groups have finished, display the figure on **slide 10** and ask a few volunteers to share their conclusions with the class.

Next, return to the whole-class graph of insect arrival data. Use the WIS-WIM strategy here too, but ask the class to develop the ideas together as a group. Whether you choose to record students' WIS-WIM information on the figure is up to you. Guide students to explain the meaning of the graph in one to two sentences and record their final conclusion(s) on the Big Ideas Anchor Chart. Finally, show students **slide 11** to help them understand the relationship between the two graphs. If they are struggling to interpret the graph adequately, you could show this slide before **slide 10** to scaffold their understanding.

Teacher's Note: Big Ideas

Students may draw other conclusions, but the most important conclusion they should draw is that insect abundance has increased earlier in the season since 2013. They may also note that this is most dramatic earliest in the season and that insect activity maxes out earlier in the season as well (e.g., 90% of the insects appear in the data earlier since 2013).

50 minutes

Explain

Teacher's Note: Taking Notes

Have students take notes during this portion of the lesson at your discretion, but keep in mind that migration, phenology, and degree days are all concepts that will be relevant for the rest of the lesson series. To help avoid students' tendency to write down everything on the slides, you might pause between sections and ask the class to summarize in their own words what information is important to write down for reference later.

Go to **slides 12-16** and review with students the information about insect migration and reasons why organisms would migrate. Follow by a brief overview of phenology. The notes section of the slides provides additional optional details you can share with students. Go to **slide 17** and explain the concept of degree days to students.

Slides 18-21 cover how radar is used to detect organisms and include example radar images. More detailed information about the content is provided in the notes section of these slides. As you lead students through the content, ask them to consider: "*How could 'degree days' explain the patterns we saw in the insect arrival data?*"

Go to **slide 22**. At this point, the class should return their attention to the questions they generated in the Engage. Ask the class to determine whether they can answer any of their questions at this point, and if so, determine whether the answers belong on the Big Ideas list.

After that, solicit any new questions students have after their Explore activities. If the questions were grouped by theme, this is also a good point to re-evaluate the themes to determine whether there are better ways to group the questions. Go to **slide 23** and ask students to add any other big ideas they feel they learned from the information provided to the anchor chart in the Explain.

Go to slides 24-25 to provide students some life history information about potato leafhoppers, which are the focal organism in the Extend activity.

Teacher's Note: Multi-generational Migration

An important detail to note for later when students are comparing birds to insects, is that seasonal leafhopper migration occurs over multiple generations. Rather than a single individual moving the entire distance of the range over the course of a season, offspring of each subsequent generation move a little further north than their parents did (**slide 25**).

45 minutes

Extend

Teacher's Note: Site Access

Be sure to check with your school and/or district to make sure that the Shiny App website is unblocked and accessible to student devices. This page will be used for the rest of this lesson series.

Now that students have examined the seasonal activity of resident insects (i.e., from Oklahoma), next they will explore insect migration timing using potato leafhopper data. Go to **slide 26**. Direct students to the "Leafhopper Migration" page of the Shiny app and show them how to change the model's variables. See the **Leafhopper Migration Guide** for details on how to help students navigate the model. Provide students with a copy of the **Leafhopper Map Comparison** handout.

Teacher's Note: Presence/Absence Consistency

Due to the nature of the data set used in the leafhopper model, the quantity of data will vary from year to year. Some years have no data (1968-1979) and others will have data from most sites. Filled circles on the maps indicate that someone physically went to the location and collected data during a given year. Empty circles mean no one went to the location to collect any data that year.

Direct students to select years with more bold circles to increase the amount of data available to analyze. A table of states with the most complete data sets and the years with the most states sampled is provided in the Leafhopper Migration Guide.

Once students have accessed the Shiny app, go to **slide 27** and walk them through the instructions. Leave these displayed throughout the work time for reference.

Have students focus on Map 1 to begin. They should pick a year early in the time series and move the days of the year slider to look for patterns in insect arrival. Next, they should select a different year for Map 2 and repeat the process, looking for patterns in insect arrival for that year specifically.

Finally, have them compare the side-by-side maps to identify trends between the years. Direct their attention to the horizontal latitude line as part of their analysis. This shows an approximate average of the range over which the insects have migrated (e.g., as insects are detected in more northern states, the line will shift north).

Bring students together as a class to discuss their results. Go to **slide 28** and ask volunteers to share their findings. Continue the conversation by going to **slides 29-30** and having students discuss the questions.

Teacher's Note: Possible Discussion Questions

Results

- What patterns or trends did you observe in leafhopper appearance within a single year? (Example: insects arrive later in the season the farther north you go on the maps)
- What patterns or trends did you observe between the two years/two states you compared? (Example: insects arrived earlier in the season in more recent years than in the past)

Significance

- Are leafhoppers altering their migration phenology? How do you know?
- Do they always migrate strictly from north to south?
- Why might one location not have leafhoppers observed until later in the year, when a further north location already has them? *(Note: students may give answers about study design or that a farmer didn't notice the insects, but there are more relevant biological reasons. For example, local weather was cooler that year/field, the winds that brought in migrants happened to bypass that location, or maybe they planted a different, less attractive crop that year).*
- How might insect life history drive these patterns?
- Why might scientists be interested in/care about insect seasonal activity and migration data?

30 minutes

Evaluate

Go to **slide 31**. Return one more time to the driving question board to determine whether any can be answered and whether any should be removed (e.g., can't be answered, are no longer interesting, etc.). Give students a few minutes to think about what other information they might need to answer their existing questions. From these ideas, encourage them to generate questions that would help them collect the missing information they need (i.e., what question could we ask to generate/find the information we need?). Add these to the question list. Next, go to **slide 32** and ask students whether there are any new Big Ideas to add to their list and record them.

Go to **slide 33**. To wrap up the lesson, ask students to create a Six-Word Memoir to summarize the most *scientifically meaningful* thing they learned about insect phenology (e.g., a cool fact about leafhoppers wouldn't be meaningful in this case).

Funding Source

This material is based on work supported by the National Science Foundation under Grant No. 1840230. Any opinions, findings, and conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Resources

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