LESSON DESCRIPTION

Students will learn about The Field Museum’s scientific collection of specimens and discuss how the collection serves as a tool to study the biodiversity found on Earth. Students will explore the idea of sample size and determine why it’s important for scientists to conduct research with a large collection in order to answer a question or reach a conclusion with sufficient data. Using the idea of sample size in building an accurate representation of biodiversity over time, students will visit the Specimens: Unlocking the Secrets of Life exhibit. In the exhibit, students will collect information about how The Field Museum scientists actively utilize the scientific collection and determine reasons why the collection should continue to increase in size.

COMPELLING QUESTIONS

• Why does The Field Museum have a scientific collection containing millions of specimens?
• Why does the collection continue to grow every year?

OBJECTIVES

Students will

• Obtain information about what is considered a significant sample size for a collection of specimens when determining information about the biodiversity of a particular habitat.
• Gather information that addresses how The Field Museum’s scientific collection is used in researching specific questions.
• Communicate how The Field Museum’s expanding scientific collection increases our current understanding of biodiversity.

KEY WORDS

BIODIVERSITY – the variety of life in the world or in a particular habitat or ecosystem
EXTINCTION – the state or process of a species coming to an end or dying out
SCIENTIFIC COLLECTION – a group of specimens used for the study of nature
SPECIMEN – an individual animal, plant, or piece of mineral used for scientific study
SPECIATION – the formation of a new species
CONNECTIONS TO STANDARDS

Next Generation Science Standards

DISCIPLINARY CORE IDEA
• LS4.D: Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction).

SCIENCE AND ENGINEERING PRACTICE
• Obtaining, Evaluating, and Communicating Information: Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.

CROSSCUTTING CONCEPT
• Scale, Proportion, and Quantity: The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.

Common Core State Standards: Math
CCSS.Math.Content.HSS.IC.B4
• Use data from a sample survey to estimate a population mean or proportion; develop a margin of error though the use of simulation models for random sampling.

APPROXIMATE TIME

Three 45-minute class periods

PREPARATION NOTES

This is a three-part lesson (a pre-field trip lesson, during the field trip, and a post-field trip lesson). Plan out the timing of the lesson to best fit your teaching schedule and your students’ learning styles, being mindful of how this may fit into an existing unit of study.

You will need to cut out the Student Resource A: Insects cards prior to the “Engage” section of the lesson.

MATERIALS

• Teacher Resource A and B
• Student Resource A and B (per group)
• Student Resource C (per student)
• Clear Jar or Container
• Calculators (optional)
• Clipboards (optional)
• Butcher Paper
• Sticky Notes

RESOURCES

Website - Specimens: Unlocking the Secrets of Life

EXHIBIT AREA OF FOCUS

All
PROCEDURES

ENGAGE (IN THE CLASSROOM)

1. Ask students: **What plants and animals exist on Earth today?** Student responses may include: oak trees, pine trees, palm trees, flowering plants, ivy, squirrels, raccoons, deer, rabbits, dogs, cats, birds, etc.

2. Then tell students to imagine the Earth in the Jurassic Age, around 200 million years ago. Ask: **Could we see the same plants and animals?** Or did different plants and animals exist? Show **Teacher Resource A: Jurassic Age** and elicit student responses. Listen for students to recognize that different plants and animals, such as giant ferns and dinosaurs, existed in the Jurassic Age.

3. Ask students: **Have you ever heard the word “biodiversity”? What does it mean?** Guide students to the idea that biodiversity is the variety and types of life in the world or in a particular habitat or ecosystem. Explain that scientists measure biodiversity by studying increases in new species, called speciation, or decreases in species, called extinction.

4. Ask: **Does the biodiversity on Earth change?** Refer back to the example of biodiversity today and biodiversity during the Jurassic Age. Listen for students to recognize that biodiversity does indeed change because the types of organisms living on Earth have changed over time.

5. Explain to students that while the plants and animals on Earth are always changing, an increase in speciation can be an indication of a healthy biodiversity, meaning the environment or ecosystem has diverse plant and animal life and is more likely to withstand ecological changes.

6. Tell students that scientists believe that understanding biodiversity over time is critical to understanding our Earth today in order to promote healthy biodiversity in environments around the world.

7. Ask students to consider: **How do scientists study present and past biodiversity? Where do collections of present and extinct life on Earth exist?**

8. Guide students to the idea of museums as places where objects are collected and used to study the past and present.

9. Explain to students that one such museum is The Field Museum’s. Tell students that there are hundreds of scientists who work at The Field Museum, and they use the collection of plant, animal, and mineral specimens in their research in order to understand the Earth’s biodiversity over time.

10. Tell students that as of 2017, The Field Museum has close to 30 million objects ranging from dinosaur bones, to microscopic stardust, to fossilized plants, to lots and lots of insects. Explain that The Field Museum has a collection of 17 million insects, which is more than the number of people who live in Illinois!

11. Ask: **What do you think scientists can learn from 17 million insects?** Elicit student responses. Explain that each insect is a snapshot of a moment in time and specific place. By collecting millions of insects, scientists are able to put together as close to a complete picture as possible of Earth’s insect biodiversity over time.

*Teaching Tip: If possible, visit the Specimens website for additional information about The Field Museum’s scientific collection.*

12. Explain that every year the size of the insect collection at The Field Museum continues to grow because its scientists continue to add to it. Ask students to consider: **Does the size of a collection, or sample size, matter? Can scientists get the same information about biodiversity of a place with fewer samples?**

13. Tell students they will do an activity to get a better idea of how sample size can make a difference when analyzing biodiversity in a particular environment.

14. Use **Teacher Resource B: Sample Size Activity Facilitation Guide** to lead students through the activity and discussion. This activity will take approximately 30 minutes.
PROCEDURES (continued)

15. After students have finished the activity, ask: What difference did sample size make in the conclusions we could draw about biodiversity in the environment? Listen for students to recognize that a larger sample size leads to a clearer picture or more accurate prediction of insect biodiversity in the pond habitat.

16. Remind students that earlier they discussed the fact that The Field Museum increases the size of its insect collection each year. In fact, The Field Museum’s entire collection continues to grow, not just the insect collection. Ask: Do you think scientists use the collection? Or do the specimens in the collection sit on shelves gathering dust? Guide students to the idea that the collection at The Field Museum is actively used, not only on display for visitors but by scientists behind the scenes.

17. Ask: What are some of the ways that Field Museum scientists and researchers from around the world use the growing collection to study the biodiversity of life? What do you think are the questions or predictions Field Museum scientists have and how do they use the collections to find out the answers?

18. Tell students they will visit The Field Museum and the Specimens: Unlocking the Secrets of Life exhibit to learn more about how scientists actively use the collections to understand biodiversity over time. Prepare for any field trip procedures.

EXPLORE (AT THE FIELD MUSEUM)

1. Upon arrival, guide students to the Specimens: Unlocking the Secrets of Life exhibit.

2. Before entering the exhibit, provide each student with Student Resource C: Specimen Story and a writing utensil.

3. Tell students they will identify a “Specimen Story” from the exhibit that highlights how a scientist has used The Field Museum’s collection in contributing to our understanding of the biodiversity on Earth over time.

4. Tell students they will look for specific information regarding the size of the collection, how the collection is used in research, the location of research, and the impact that the research has had or could have.

5. Provide students with a meeting time to rejoin the group. Encourage students to find a “Specimen Story” that resonates with them and suggest that they walk through the exhibit first before choosing which story to capture on their student resource.

6. After the exhibit, collect all student resources and save for the next class.

EXPLAIN & EVALUATE (IN THE CLASSROOM)

1. Ask students to share one or two things they recall about the field trip to The Field Museum. While students are sharing, distribute the completed Student Resource C to each student.

2. Remind students they began by discussing the idea that having an adequate sample size is crucial for scientists in understanding the biodiversity of life on Earth over time.

3. Remind students that as of 2017 The Field Museum has 30 million objects. Explain that the scientific collection at The Field Museum provides scientists with the sample size needed to answer questions about our world.

4. Tell students they will now use their “Specimen Story” from their visit to The Field Museum to get a big picture of exactly how scientists use the collection in their research spanning the globe.

5. Instruct students to write down on a sticky note:
   a. The name of the specimen from their “Specimen Story”
   b. The approximate location where scientists collected the specimen to study biodiversity

6. Place students into small groups and encourage students to each take one to two minutes to share their “Specimen Story.” While students are sharing, draw a large circle on the board or butcher paper. Draw a rough outline of a world map inside the circle, indicating the major continents.
**PROCEDURES (continued)**

7. After students have shared their stories, instruct them to place their sticky note on the map to indicate where scientists are using the collection to study global biodiversity.

8. Ask students: Based on what we learned about sample size and how scientists use the samples from the collection, is it important that The Field Museum’s collection continues to grow? Why or why not? Elicit student responses.

9. Tell students that many people aren’t aware of the important work that’s happening inside the walls of The Field Museum. People don’t realize there is a collection of millions of specimens that scientists use to understand the Earth’s history of biodiversity, which helps us think about how best to care for our planet in the future.

10. Inform students that in their small groups, they are charged to create an argument for how The Field Museum’s scientific collection increases our understanding of biodiversity (examples from the “Specimen Stories”) and why the size of the collection should continue to grow.

11. Give students some time to create their argument. If students need additional support, encourage them to use the following structure when building out their argument: We believe The Field Museum’s scientists actively contribute to our understanding of the world’s biodiversity because (examples from “Specimen Stories”) and we believe the scientific collection should continue to grow because (examples of impact or potential impact from research).

12. Encourage groups to share their arguments.

13. Discuss action steps with the class. Ask: How should we communicate our arguments so others are aware and support places like The Field Museum? (Example ideas could include: Make a presentation to another class, set up a table at Parent/Teacher Conferences, create a display on a public bulletin board, write a statement in the school newsletter, etc.)

**ENRICHING THE LESSON**

- To give students additional opportunity to explore local biodiversity and the process of collecting specimens, consider renting the “Great Lakes Plant Diversity” Experience Box from the *N. W. Harris Learning Collection* (harris.fieldmuseum.org)
Photo Credit: @ Gerhard Boeggemann  (commons.wikimedia.org)
Teaching Tip: Prior to this activity, cut out the insect species cards. Shuffle them up and place them inside a (preferably) clear jar or container.

1. Place students into five groups. The group sizes can vary, but it’s important there are five groups for this activity. Distribute **Student Resource B: Sample Size Comparison Guide** to each group.

2. Explain to students that in this example, scientists are studying insect biodiversity in a pond habitat. Show students the jar with the insect cards inside and explain that this is a representation for the pond habitat.

3. Tell students they will help the scientists answer: **What is an appropriate sample size to get a complete picture as possible of the insect biodiversity in this pond habitat?**

4. Explain that students will first collect a small sample size from the pond habitat. Have one representative from each group pick one insect card from the jar. Each table should have only one insect.

5. Create a line graph on the board or piece of butcher paper. Label the X-axis “Insect Species” and the Y-axis “Number Collected.”

6. One at a time, encourage the groups to share the name of insect they collected. Write down the name of the insect along the X-axis and draw an “X” along the Y-axis to indicate it was collected in the sample. See the chart below for an example:

<table>
<thead>
<tr>
<th># COLLECTED</th>
<th>Fly</th>
<th>Mosquito</th>
<th>Wasp</th>
<th>Ladybug</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Direct students to **Student Resource B: Part 1**. Have groups select a recorder to write down the name and number of insects the class collected in the Sample 1 chart.

8. Ask students:
   a) *What is our sample size, or how many insects did we collect in this sample?* (Five)
   b) *Which species are present in this sample?*
   c) *Which species did we collect the most of? Least?*

9. Then ask: **Based on the species we collected, how can we predict the biodiversity, or how many of each insect lives, in the pond habitat?**

10. Listen for students to recognize they need to determine the percentage of population for each insect species. Refer students to the formula and example on **Student Resource B: Part 1**, and encourage students to calculate the predicted population percentage for each insect the class collected in Sample 1. Walk around providing assistance as needed.
11. Have groups share the predicted percentages for each insect species. Write the percentages on butcher paper or on the board. Label as “Sample 1.”

12. Ask: *Do you think this is an accurate representation of the insect biodiversity in this pond? (No.) What can we do to increase the accuracy? (Collect a larger sample size.)*

13. Have students turn the insect card from Sample 1 face down. Next, ask for a representative from each group to select three more insects from the jar. Each table should now have four insects total.

14. Have each group share-out the new insect species they collected. Add to the line graph accordingly. Instruct the recorder to write down the name and number of insects the class collected in the Sample 2 chart on **Student Resource B: Part 2**.

15. Ask students:
   a) *What is the sample size, or total number of insects, we collected? (20)*
   b) *Which species have we collected the most of? Least?*

16. Then ask students: *Based on our new sample size, what is the predicted biodiversity of the pond?* Tell students to repeat the percentage process from Sample 1, and have groups share the revised predicted percentages.

17. Write the percentages next to Sample 1 results. Label as “Sample 2.” Encourage students to reflect upon the difference between Sample 1 and Sample 2. Listen for students to recognize that by increasing the sample size, they were able to get a more accurate picture of the pond’s insect biodiversity.

18. Ask students: *What new information did we learn about the pond’s biodiversity? How does this information change our initial ideas about insect biodiversity from the first sampling?* Refer students to the example on the bottom of Part 2. Tell students to compare the predicted percentage from Sample 1 to Sample 2 for each insect species, and then calculate and record the rate of change. Students should record the rate of change in the column labeled “S1 to S2 Change” on the Sample 2 chart.

19. Ask students to consider if they believe Sample 2 gives us the best possible representation of biodiversity. Ask: *Should we increase our sample size again?*

20. Have students turn over the insects from Sample 2. Next, ask a representative from each group to select six more insects from the jar. Each table should now have ten insects total.

21. Have each group share-out the new insect species they collected. Add to the line graph accordingly. Instruct the recorder to write down the name and number of insects the class collected in the Sample 3 chart on **Student Resource B: Part 3**.

22. Ask students:
   a) *What is the sample size, or total number of insects, we collected? (50)*
   b) *Which species have we collected the most of? Least?*

23. Then ask: *Based on our new sample size, what is the predicted biodiversity of the pond?* Have students repeat the percentage process and share the revised percentages.

24. Write the percentages next to the other results. Label as “Sample 3.” Encourage students to reflect upon the difference between the samples. Listen for students to recognize that again by increasing the sample size, they were able to get an even better picture of the pond’s insect biodiversity.
25. Ask students: *What new information did we learn about the pond’s biodiversity? How does this information change our ideas about insect biodiversity in the pond?* Tell students to compare the predicted percentage from Sample 2 to Sample 3 for each insect species, and then calculate and record the rate of change in “S2 to S3 Change” column.

26. Remind students they collected a sample of 50 insects. *Ask: Is this every insect in the pond habitat?* Show the jar that should still contain four insect cards.

27. Explain that scientists are unable to collect everything, and so they rely on a sample of specimens to provide as complete a picture as possible of the biodiversity in that environment. Then ask: *Which sample size gives us the best picture of the pond’s actual biodiversity? Why?* Elicit student responses.

28. Have students clean up desk spaces and prepare to wrap up the discussion.
STUDENT RESOURCE A: INSECT SPECIES

Fly  Fly  Fly  Fly
Fly  Fly  Fly  Fly
Fly  Fly  Fly  Fly
Grasshopper  Grasshopper  Grasshopper  Dragonfly
Dragonfly  Dragonfly  Dragonfly  Dragonfly
Dragonfly  Dragonfly  Dragonfly  Dragonfly
Dragonfly  Dragonfly  Dragonfly  Dragonfly
STUDENT RESOURCE A: INSECT SPECIES (continued)

- Dragonfly
- Dragonfly
- Dragonfly
- Wasp
- Wasp
- Wasp
- Wasp
- Wasp
- Wasp
- Spider
- Spider
- Spider
- Spider
- Spider
- Ladybug
- Ladybug
- Ladybug
- Ladybug
Ladybug
Ladybug
Ladybug
Ladybug

Ladybug
Mosquito
Mosquito
Mosquito

Mosquito
Mosquito
Mosquito
Mosquito

Mosquito
Mosquito

PART 1
Fill in the name of the insect species and number collected from the pond habitat. To determine the predicted percentage of insect biodiversity, use the following formula:

$$\frac{\text{Individual Insect Species Collected}}{\text{Total Sample Size}} = \%$$

For example: $$\frac{7 \text{ Butterflies}}{10 \text{ Total Sample Size}} = 0.7 \text{ or } 70\%$$

This means we can predict that butterflies make up 70% of the pond’s biodiversity.

<table>
<thead>
<tr>
<th>Insect Species</th>
<th># Collected</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PART 2
Fill in the name of the insect species and number collected from Sample 2. Determine the predicted percentage of insect biodiversity.

<table>
<thead>
<tr>
<th>Insect Species</th>
<th># Collected</th>
<th>Percentage</th>
<th>S1 to S2 Change (+/-)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Sample Size Collected: ____________________________

After completing table above, compare the predicted percentage between Sample 1 and Sample 2. Record the change in percentage in the S1 to S2 Change column.

For example: If the predicted percentage of butterflies in Sample 1 was 70% and in Sample 2 it was 60%, there is a -10% change.
PART 3

Fill in the name of the insect species and number collected from Sample 3. Determine the predicted percentage of insect biodiversity. Compare the predicted percentage between Sample 2 and Sample 3. Record the change in the S2 to S3 Change column.

<table>
<thead>
<tr>
<th>Insect Species</th>
<th># Collected</th>
<th>Percentage</th>
<th>S1 to S2 Change (+/-)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Sample Size Collected: __________________________________________

After completing the chart and determining the change in percentage, discuss the following questions with your group:

- How did our understanding of the pond’s insect biodiversity change with each sample?
- What sample size gives us the most accurate representation of insect biodiversity? Why?
STUDENT RESOURCE C: SPECIMEN STORY

PART 3
Find a story about a specimen that interests you. Use the text panels and specimen information to answer the following questions:

What is the specimen? ____________________________

Where is it from? ____________________________

How many does The Field Museum have? ____________________________

What do you find interesting about this specimen?

What question(s) do scientists have about this specimen?

What has this specimen helped scientists understand?

IMPACT:
How does the scientific research on this specimen impact our understanding of Earth’s biodiversity?

What else do you think scientists could learn or what other questions could they answer by researching this specimen?
IMAGE CREDITS

TITLE IMAGE
GN92092_010d @ Karen Bean (©The Field Museum)

STUDENT RESOURCE A: INSECT SPECIES
Spider @ Oliviu Stoia (thenounproject.com)
Grasshopper @ Oliviu Stoia (thenounproject.com)
Mosquito @ Oliviu Stoia (thenounproject.com)
Wasp @ Oliviu Stoia (thenounproject.com)
Ladybug @ Cassie McKown (thenounproject.com)
Fly @ Emma Gilardi (thenounproject.com)
Dragonfly @ Edward Boatman (thenounproject.com)