# Understanding Ecosystem Changes and Human Impact

Up to 27 days with 45 min period classes


## Authors

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## SUBJECT/GRADE LEVEL

Subject Area: Science

Grade Level: Middle School

## Materials

- Read a loud book: Next time you see a pill bug
- Cameras or smartphones
- Science notebook/science journal
- Bug collecting kit
- Measuring tape
- Colored pencils
- Chart papers
- Pill Bug Specimens
- Measuring tape
- Magnifying glasses
- Transparent containers with lids (for pill bug habitats)
- Soil
- Leaf litter
- Small rocks
- Water
- Thermometers
- Heat lamps
- Ice packs
- Sandpaper (to simulate human disturbance)
- pH test strips
- Data recording sheets

## STANDARDS

### Next Generation Science Standards

- MS-LS2-5. Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*
- MS-LS21 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.
- MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

### Mathematics Standards | Common Core State Standards

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| MP.4 | Model with mathematics. *(MS-LS2-5)* |
| 6.RP.A.3 | Use ratio and rate reasoning to solve real-world and mathematical problems. *(MS-LS2-5)* |

### English Language Arts Standards | Common Core State

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| RST.6-8.8 | Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5) |
| RI.8.8 | Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-5) |

## LESSON OBJECTIVE(S)

Students will be able to understand how changes in an ecosystem's physical or biological component impact populations.

## CAREER CONNECTION(S)

Mentor Background: Maria A. Gonzalez-Morales was born and raised in Puerto Rico where she also completed her B.S. (2016) in Agronomy in Crop Protection in University of Puerto Rico at Mayaguez and her M.S. (2018) in Agricultural biology in Entomology at New Mexico State University under Dr. Alvaro Romero. In 2022, Maria completed her Urban, Medical and Veterinary Entomology Ph.D. from North Carolina State University working in Dr. Coby Schal's Lab. Her dissertation investigated the effects of urban pests on humans and animals, insecticide resistance and the improvement of pest management techniques. Indoor pests such as bed bugs and German cockroaches are known to have serious health effects on humans. Some of highlights from Gonzalez research are; the firsts to document fipronil (pyrole) bed bug insecticide resistance; and the first report of efficacy of fluralaner to control bed bug

infestations in the poultry industry and fipronil resistance status on the German cockroach. Her research aims to develop new and innovative pest management techniques particularly in challenging environments but also reduce cost to make indoor pest control sustainable, effective and affordable for everyone. One of Dr. Gonzalez-Morales biggest passions and inspiration in her career is to create educational platforms for Hispanics and minorities in STEM.

STEM Careers:

1. Ecologist: Studies ecosystems, how different organisms interact, and how changes in the environment affect these interactions.

2. Environmental Scientist: Investigates environmental issues, develops solutions to problems like pollution, and works to protect ecosystems.

3. Conservation Biologist: Works on preserving wildlife and natural habitats, studying the effects of human activities on ecosystems.

4. Wildlife Biologist: Studies animals and their behavior, habitats, and population dynamics.

5. Marine Biologist: Studies marine organisms, their behaviors, and interactions with the environment.

6. Environmental Engineer:Develops technologies and solutions to reduce human impact on the environment.

7. Forester: Manages forested areas for conservation, recreation, and resource extraction while ensuring ecosystem health.

8. Hydrologist : Studies the distribution, movement, and quality of water in the environment.

9. Climate Scientist: Studies climate systems, how they change, and their impact on ecosystems.

10. Agricultural Scientist: Researches ways to improve agricultural practices and reduce negative impacts on ecosystems.

11. Environmental Educator: Teaches communities and students about environmental issues and how to protect ecosystems.

12. Geographic Information Systems (GIS) Specialist: Utilizes GIS technology to map and analyze spatial data related to ecosystems.

13. Biostatistician: Applies statistical methods to biological research, including the study of ecosystems and population changes.

14. Urban Planner: Develops plans and programs for land use that consider environmental impact and sustainability.

## ENGAGEMENT (May take up to 3 days)

Brief Description: Students will explore a designated outdoor area, document its physical and biological components, and create a detailed grid map to analyze the ecosystem.

Procedures:

Materials:

- Book: *Next Time You See a Pill Bug* by Emily Morgan
- Digital projector or document camera (if reading from a physical book)
- Science notebooks or journals
- Chart paper and markers
- Pill bug specimens
- Magnifying glasses

**Activities Part 1:**

1. Read Aloud:

   Activity: Begin by reading *Next Time You See a Pill Bug* aloud to the class.

   Task:

   - Gather students in a comfortable reading area.
   - Read the book with enthusiasm, showing the pictures to the students.
   - Pause periodically to ask questions and encourage observations.

2. Interactive Discussion:

   Activity: Engage students in a discussion about pill bugs and their role in the ecosystem.

   Discussion Questions:

   - What did you learn about pill bugs from the book?
   - Why do you think pill bugs are important to the environment?
   - What surprised you about pill bugs?

3. Observational Activity :

   Activity: Provide students with the opportunity to observe live pill bugs up close.

Task:

- With pill bug specimens, distribute them to small groups along with magnifying glasses.
- Allow students to observe the pill bugs and make notes or sketches in their science notebooks.
- Encourage students to note the pill bugs' physical characteristics, behaviors, and habitat preferences.

4. Creating a KWL Chart:

   Activity: Create a KWL chart (Know, Want to know, Learned) as a class to capture students' prior knowledge, questions, and new information about pill bugs.

   Task:

   - On a large chart paper, draw three columns labeled "Know," "Want to Know," and "Learned."
   - Ask students what they already know about pill bugs and write their responses in the "Know" column.
   - Prompt students to ask questions they have about pill bugs, and write these in the "Want to Know" column.
   - After reading and observing, fill in the "Learned" column with new information gained from the book and observations.

5. Think-Pair-Share:

   Activity: Have students discuss their thoughts and questions about pill bugs with a partner.

   Task:

   - Pair students and have them share what they found most interesting about pill bugs.
   - Encourage them to come up with additional questions they have about pill bugs and their role in the ecosystem.
   - After a few minutes, ask pairs to share their discussions with the whole class.

**Activities Part 2:**

Materials Needed:

- Copies of the "Ecosystem Card Sort"  for each group
- Timer or clock
- Large chart paper or whiteboard for final class consensus

Procedure:

1. Group Formation (5 minutes):

   Organize students into groups of 3-5.

   Ensure each group receives a copy of the "Ecosystem Card Sort" file.

2. Initial Card Sort (15-20 minutes):

   Each group will review the animals and ecosystems listed in their card sort.

   Groups will discuss and come to a consensus on which animal belongs to which ecosystem.

3. Inter-Group Sharing (10 minutes):

   Once consensus is reached, one representative from each group will visit other groups to observe their card sorts.

   Representatives can ask questions and gather insights about the decisions made by other groups.

   Remaining group members will discuss any questions they receive from visiting representatives.

4. Group Reflection and Adjustment (10 minutes):

   Representatives return to their original groups and share observations and insights gathered from other groups.

   Groups will have 10 minutes to discuss these findings and make any necessary adjustments to their card sort.

5. Class Consensus (15-20 minutes):

   After all groups have finalized their card sorts, come together as a class.

   Each group will present their final card sort and justify their choices.

   Facilitate a class discussion to come to a final consensus on the correct categorization for each animal.

   Record the final class ecosystem card sort on a large chart paper or whiteboard for reference.

## EXPLORATION

Brief Description: Students will explore a designated outdoor area, document its physical and biological components, and create a detailed grid map to analyze the ecosystem

Procedures: This process will take six to ten  days

Students will work in the same teams throughout the unit.

**Exploration 1:**

Materials Needed:

- Measuring tapes
- Journals
- Cameras or phones
- Bug kits
- Drawing materials (pencils, colored pencils, markers)
- Large chart paper or poster board

Procedure:

1. Introduction (10 minutes):

   Explain the objective of the activity: to explore and document an outdoor area, identifying its physical and biological components.

   Emphasize the importance of accurate documentation for understanding ecosystems.

2. Preparation (10 minutes):

   Organize students into their pre-assigned teams.

   Distribute materials: measuring tapes, journals, cameras/phones, and bug kits.

3. Outdoor Exploration (30-40 minutes):

   Guide students to the designated outdoor area (playground, school yard, or nearby natural area).

   Each team will select a 6x6 feet area to study.

   Students will use measuring tapes to mark their chosen area.

   In their journals, students will create a grid of the area, drawing and labeling different

components (e.g., rocks, soil, plants, etc.).

4. Documentation (30 minutes):

   Students will search for animal and plant life within their grid.

   Using cameras or phones, students will take pictures of all animal and plant life found.

   Students will document their findings in their journals, noting the location and characteristics of each organism.

5. Classroom Activity (30-40 minutes):

   Return to the classroom and provide each team with large chart paper or poster board.

   Students will recreate a larger version of their grid, including detailed drawings and labels of the physical and biological components they documented.

   Encourage creativity and accuracy in their representations.

6. Gallery Walk Preparation: (Section could be digital)

   Inform students that their grids will be part of a gallery walkthrough later in the unit.

   Encourage teams to refine their grids and prepare brief explanations of their findings.

**Exploration 2:**

Objective:

Students will investigate how human activity, temperature, and other environmental factors affect pill bugs.

Materials:

- Pill bugs (Roly-polies)
- Transparent containers with lids (for pill bug habitats)
- Soil
- Leaf litter
- Small rocks
- Water
- Thermometers
- Heat lamps
- Ice packs

- Sandpaper (to simulate human disturbance)
- pH test strips
- Data recording sheets
- Magnifying glasses

Procedure:

1. Introduction to Pill Bugs:
    - Begin by introducing pill bugs to the students. Explain their habitat preferences, diet, and role in the ecosystem.
    - Discuss how pill bugs are detritivores and contribute to the decomposition process, helping to recycle nutrients in the soil.
2. Setting Up Experiments:
    - Divide students into small groups of previous work and assign each group a different environmental factor to investigate: human activity, temperature, and other factors (e.g., moisture, pH).
    - Provide each group with a transparent container and materials to set up a pill bug habitat.
3. Control Habitat:
    - Have each group set up a control habitat with soil, leaf litter, and small rocks, ensuring that it mimics a natural environment for pill bugs.
    - Introduce a few pill bugs to the control habitat and observe their behavior.
4. Experimental Habitat:
    - Each group will set up an experimental habitat with their assigned variable:
        - Human Activity: Use sandpaper to roughen the soil surface to simulate human disturbance.
        - Temperature: Use heat lamps to increase the temperature in one habitat and ice packs to decrease the temperature in another.
        - Other Factors: Adjust moisture levels by adding more or less water, or alter the soil pH using safe household substances (like vinegar for acidity and baking soda for alkalinity).
5. Observation and Data Collection:
    - Have students observe the pill bugs in both the control and experimental habitats over several class periods.
    - Instruct students to record their observations, noting any changes in behavior, movement, and health of the pill bugs.

- Encourage students to use magnifying glasses to get a closer look at the pill bugs and to take measurements such as temperature and pH levels using the thermometers and pH test strips.

6. Data Analysis:
    - After the observation period, students will compile their data and compare the behaviors and health of the pill bugs in the control habitat to those in the experimental habitats.
    - Guide students in analyzing their data to determine the effects of the different environmental factors on the pill bugs.
7. Discussion:
    - Have each group present their findings to the class.
    - Facilitate a class discussion on how human activity, temperature changes, and other environmental factors can impact pill bugs and, by extension, other organisms in an ecosystem.
    - Discuss the implications of their findings for broader environmental issues such as habitat destruction, climate change, and pollution.

Key Questions:

- How did the pill bugs' behavior change in response to the different environmental factors?
- What impact did human activity have on the pill bugs' habitat and well-being?
- How did changes in temperature affect the pill bugs?
- What other factors influenced the pill bugs' behavior and health?
- What can we infer about the impact of these factors on other organisms in the ecosystem?

## EXPLANATION

Brief Description: Provide opportunities for students to analyze their findings and develop explanations.

Procedures: This process will take two days

1. Data Compilation and Organization:

    Activity: Have students compile all the data they collected from their grid investigations and biodiversity surveys. This includes the number and types of bugs and wildlife found,

as well as environmental factors measured.

Task: Students will organize their data in their science notebooks, creating tables and charts to display their findings clearly.

2. Data Analysis:

   Activity: Guide students in analyzing their compiled data to identify patterns and trends.

   Questions for Analysis:

   - Which areas of the school ecosystem had the highest biodiversity?
   - How did different environmental factors (e.g., light, soil moisture) correlate with the presence of certain species?
   - Were there any unexpected findings or anomalies in the data?

3. Graphing and Visualization:

   Activity: Students will create graphs and charts to visualize their data. This can include bar graphs showing the number of species found in different grid sections, pie charts illustrating species distribution, and line graphs correlating environmental factors with population changes.

   Task: Each group will prepare at least two types of visual representations of their data to help explain their findings.

4. Class Discussion:

   Activity: Facilitate a class discussion where each group presents their findings. Students should use their graphs and charts to support their explanations.

   Guiding Questions:

   - What did your data reveal about the biodiversity in our school ecosystem?
   - How did changes in the physical or biological components of the ecosystem affect the populations you studied?
   - What empirical evidence supports your conclusions?

5. Concept Mapping:

   Activity: As a class, create a large concept map on the whiteboard. Start with the central idea of "Ecosystem Changes and Population Effects" and branch out to include specific findings and evidence from each group's investigation.

   Task: Students will contribute to the concept map by adding nodes and connections based on their data and analyses.

6. Reflection:

   Activity: Provide each student with sticky notes to write down one key finding from their group's investigation and one question they still have about ecosystem changes.

   Task: Have students place their sticky notes on the whiteboard or a designated area,

creating a "Wonder Wall" of findings and questions.

Class Discussion: Review the sticky notes as a class, addressing common themes and discussing any remaining questions.

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## ELABORATE (this will take up to 2 weeks)

Brief Description: Extend students' understanding through additional activities and real-world applications, building on their findings from the Explain section.

Procedures: this is will take up to six days

Materials:

- Science notebooks or journals
- Internet access for research
- Project materials (e.g., poster boards, markers, construction materials)
- Digital tools for creating presentations (e.g., PowerPoint, Google Slides)
- Access to case studies or articles on environmental projects

Activities:

1. Project-Based Learning: Designing Solutions

   Activity: Using their findings from the Explain section, students will work in groups to design a method or device to monitor and minimize human impact on their school's ecosystem.

   Task:

   - Each group will identify a specific problem observed during their investigations (e.g., areas with low biodiversity, presence of pollutants).
   - Research existing methods and technologies that address similar problems.
   - Brainstorm innovative solutions tailored to their school's ecosystem.
   - Create a detailed plan or prototype of their method/device.
   - Prepare a presentation to share their design with the class.

   Guiding Questions:

   - What specific issue in our school ecosystem are you addressing?
   - How does your design aim to solve this problem?
   - What scientific principles are applied in your design?
2. Case Study Analysis: Real-World Applications

Activity: Analyze case studies of successful environmental monitoring and remediation projects.

Task:

- Provide students with case studies or articles about projects such as urban gardening, reforestation, pollution control, and biodiversity enhancement.
- In groups, students will summarize their assigned case study and discuss the methods used and their effectiveness.
- Each group will present their case study to the class, highlighting key takeaways and possible applications to their school's ecosystem.

Discussion Questions:

- What methods were used in the case study to monitor or minimize human impact?
- How successful were these methods, and what challenges were faced?
- How can we apply similar approaches to our school ecosystem?

3. Fieldwork: Implementing Monitoring Techniques

Activity: Implement simple monitoring techniques in the school ecosystem to gather additional data.

Task:

- Students will set up monitoring stations (e.g., water quality testing, soil health checks, insect traps) based on their designs from the Explain section.
- Over a period of time, students will collect and analyze new data to observe any changes or improvements in the ecosystem.
- Document findings in their science notebooks and compare them to initial data collected.

Reflection Questions:

- What changes did you observe in the ecosystem after implementing your monitoring techniques?
- How effective were your methods in improving the health of the ecosystem?
- What adjustments or improvements could be made to your monitoring techniques?

4. Connecting with Experts: Guest Speakers or Virtual Tours

Activity: Arrange for guest speakers or virtual tours with environmental scientists, ecologists, or conservationists.

Task:

- Prepare questions related to their projects and findings for the guest speakers.
- Engage in discussions to gain insights into professional practices and real-world applications.

Guiding Questions:

- How do professionals monitor and address environmental issues?
- What advice do they have for students interested in environmental science and conservation?
- What are some recent advancements or technologies in ecosystem monitoring?

5. Synthesis and Presentation: Sharing Findings and Solutions

Activity: Synthesize all findings and solutions developed throughout the unit into a comprehensive presentation.

Task:

- Each group will create a final presentation or report summarizing their initial findings, project designs, implementation process, and results.
- Use digital tools to enhance their presentations with visuals, graphs, and multimedia elements.
- Present their findings to the class, and if possible, invite other classes, teachers, or community members to attend.

Evaluation Criteria:

- Clarity and organization of the presentation.
- Scientific accuracy and use of empirical evidence.
- Creativity and feasibility of the proposed solutions.
- Effectiveness of communication and engagement with the audience.

## EVALUATION

Brief Description: Assess students' understanding and provide feedback on their learning about ecosystem changes and human impact.

Procedures: this will take up to six days

Project Presentation Evaluation

Activity: Evaluate group presentations on their methods for monitoring and minimizing human impact on the school's ecosystem.

Task:

- Each group presents their design, implementation process, and results.
- Students will explain the scientific principles behind their design and how it addresses human impact.

## Rubric for Project Presentation Evaluation on Monitoring and Minimizing Human Impact

| Criteria | Excellent (4) | Good (3) | Satisfactory (2) | Needs Improvement (1) |
|---|---|---|---|---|
| Design Explanation | Thoroughly explains the design with clear, detailed descriptions. | Explains the design with clear descriptions. | Provides a basic explanation of the design. | Explanation of the design is unclear or incomplete. |
| Implementation Process | Detailed and clear explanation of the implementation process. | Clear explanation of the implementation process. | Basic explanation of the implementation process. | Explanation of the implementation process is unclear or incomplete. |
| Results and Data Analysis | Provides comprehensive results and insightful data analysis. | Provides clear results and data analysis. | Provides basic results and data analysis. | Results and data analysis are unclear or incomplete. |
| Scientific Principles | Thoroughly explains the scientific principles behind the design. | Explains the scientific principles behind the design. | Provides a basic explanation of the scientific principles. | Explanation of the scientific principles is unclear or incomplete. |
| Addressing Human Impact | Clearly connects the design to minimizing human impact | Connects the design to minimizing human impact | Provides a basic connection between the design and | Connection between the design and minimizing human |

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| | on the ecosystem. | on the ecosystem. | minimizing human impact. | impact is unclear or incomplete. |
| Presentation Skills | Excellent presentation skills: clear, engaging, and confident delivery. | Good presentation skills: clear and engaging delivery. | Satisfactory presentation skills: delivery is understandable. | Poor presentation skills: delivery is unclear or unengaging. |
| Team Collaboration | Demonstrates excellent teamwork and equal participation. | Demonstrates good teamwork with mostly equal participation. | Demonstrates basic teamwork, but participation may be uneven. | Lacks teamwork and equal participation. |
| Visual Aids and Materials | Uses high-quality visual aids and materials that enhance the presentation. | Uses good visual aids and materials that support the presentation. | Uses basic visual aids and materials, but they may not enhance the presentation. | Visual aids and materials are lacking or ineffective. |
| Q&A Response | Responds to questions with thorough, accurate, and insightful answers. | Responds to questions with accurate and clear answers. | Responds to questions with basic answers. | Struggles to respond to questions effectively. |
| Overall Impact | Presentation is highly effective and leaves a strong, positive impression. | Presentation is effective and leaves a positive impression. | Presentation is somewhat effective but may lack impact. | Presentation is ineffective and lacks impact. |

Scoring Guide

- Excellent (4): Demonstrates a comprehensive understanding of the project, effectively presents all components, and engages the audience with a clear and insightful presentation.
- Good (3): Demonstrates a good understanding of the project, presents all components clearly, and engages the audience with minor issues in delivery or depth.
- Satisfactory (2): Demonstrates a basic understanding of the project, presents most components, but may lack depth and engagement.
- Needs Improvement (1): Demonstrates a limited understanding of the project, fails to present key components, and struggles to engage the audience.

Summative Assessment: Argument Essay

Activity: Have students write an essay constructing an argument, supported by empirical evidence, on how changes to an ecosystem's components affect populations.

Task:

- Students will use their findings from their investigations to support their arguments.
- The essay should include a clear thesis, supported by specific evidence from their data.
- Discuss potential solutions or further questions raised by their findings.

Rubric for Argument Essay on Ecosystem Changes and Population Effects

| Criteria | Excellent (4) | Good (3) | Satisfactory (2) | Needs Improvement (1) |
|---|---|---|---|---|
| Thesis Statement | Clearly stated, specific, and insightful thesis. | Clearly stated and specific thesis. | Thesis is present but lacks specificity or clarity. | Thesis is unclear or missing. |
| Evidence and Support | Uses strong, relevant empirical evidence to | Uses relevant empirical evidence to | Uses some evidence, but it may be | Lacks relevant empirical evidence to |

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| | support the argument. | support the argument. | incomplete or weak. | support the argument. |
| Analysis and Explanation | Thorough and insightful analysis of the evidence. | Clear analysis of the evidence. | Basic analysis of the evidence, lacks depth. | Little to no analysis of the evidence. |
| Organization and Structure | Well-organized with a clear and logical flow. | Organized with a logical flow. | Some organization, but lacks a clear flow. | Poorly organized, difficult to follow. |
| Addressing Counter Arguments | Effectively addresses counterargumen ts and refutes them. | Addresses counterargumen ts and attempts refutation. | Mentions counter arguments but lacks effective refutation. | Does not address counterargument s. |
| Potential Solutions | Proposes insightful and realistic solutions. | Proposes realistic solutions. | Proposes solutions, but they may be unrealistic or vague. | Does not propose solutions. |
| Further Questions | Raises insightful further questions. | Raises relevant further questions. | Raises further questions, but they lack relevance or insight. | Does not raise further questions. |
| Grammar and Mechanics | Free of grammatical and mechanical errors. | Few grammatical and mechanical errors. | Some grammatical and mechanical errors. | Many grammatical and mechanical errors. |

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| Citation of Sources | Correctly and consistently cites all sources. | Correctly cites sources, with minor inconsistencies. | Inconsistent citation of sources. | Does not cite sources or cites them incorrectly. |

Scoring Guide

- Excellent (4): Demonstrates a thorough understanding of the topic, effectively uses empirical evidence, and presents a well-organized, insightful argument.
- Good (3): Demonstrates a good understanding of the topic, uses relevant evidence, and presents a clear argument with minor issues in organization or depth.
- Satisfactory (2): Demonstrates a basic understanding of the topic, uses some relevant evidence, but lacks depth and organization in the argument.
- Needs Improvement (1): Demonstrates a limited understanding of the topic, lacks relevant evidence, and presents an unclear or poorly organized argument.

## REFERENCES


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