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# K-12 Partnership Lesson Plan

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# *Bug Lyphe!*

*A Next Generation-linked observational study in biodiversity*

## Overview

*NGSS* are about the art of teaching rather than just content expectations. In this lesson, we will teach an ecology lesson about biodiversity this particular way.

Biodiversity is discussed in many objectives ranging from genetic variation, ecosystem dynamics, functioning and resilience, to interdependent relationships in habitats. We will capture insects, an activity related to the BEST plots biodiversity protocol, as a vehicle to discuss differences in biodiversity among natural and disturbed habitats. A follow up discussion in Landscape Restoration can be included.

**Objectives**

At the conclusion of the lesson, students will be able to:

* Define ecosystem and biodiversity
* Design and carry out standardized protocols for conducting biological surveys
* Use a simple dichotomous key to identify organisms
* Graph data and interpret results

**Length of Lesson**

This lesson can be modified to fill 2 class periods or an entire week (5 class periods).

**Grade Levels**

This activity is best suited for 6th-12th grade classrooms

**Standards covered (NGSS)**

Disciplinary Core Ideas:

 *Middle School*

* **MS-LS2-1**: 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.
* **MS-LS2-4**: Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
* **MS-LS2-5**: Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

*High School*

* **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
* **HS-LS2-6**: evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem

Cross Cutting Concepts:

* Patterns
* Systems and system models
* Stability and change of systems

Science and Engineering Practices

* Asking questions and defining problems
* Planning and carrying out investigations
* Analyzing and interpreting data
* Using mathematics and computational thinking
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **L3.p4A**: Recognize that, and describe how, human beings are part of Earth’s ecosystems. Note that human activities can deliberately or inadvertently alter the equilibrium in ecosystems.
* **B3.4A**: Describe ecosystem stability. Understand that if a disaster such as flood or fire occurs, the damaged ecosystem is likely to recover in stages of succession that eventually result in a system similar to the original one.
* **B3.4B:** Recognize and describe that a great diversity of species increases the chance that at least some living organisms will survive in the face of cataclysmic changes in the environment.
* **B3.4C**: examine the negative impact of impact of human activities
* **B5**.**1g**: illustrate how genetic variation is preserved or eliminated from a population through natural selection (evolution) resulting in biodiversity

**Materials**

* Background powerpoint (with follow-up questions)\*
* Shannon-Weaver diversity index excel file\*
* Invertebrate identification guides\*
* Data collection sheet\*
* Sweepnets
* Plastic cups
* Dish or hand soap
* Sticky traps
* Forceps
* Sorting trays

\*These materials can be found on the

**Background**

### Ecosystems are biological communities of interacting organisms (biotic) and their physical environment (abiotic). Biodiversity can be defined as the variety of life in a particular habitat or ecosystem. Biodiversity is not necessarily just the number of types of organisms, but the evenness of those types as well. Ecosystem functions are services provided by ecosystems that benefit humans. These can include the production of food, fiber, and energy, water and air purification, pollination and seed dispersal, as well as ecotourism and recreation. Biodiversity and ecosystem function are often related. Biodiversity is important for ecosystem function for a variety of reasons, one of which has been termed the “insurance hypothesis.” This idea states that with more species or groups, ecosystems are more likely to maintain some functions even if others fail due to disturbance, invasion, disease, etc… Ecosystem function can also promote resilience to global change and provide stability. In this activity, we want to look at how different habitat types have varying levels of biodiversity and ecosystem function and ask why that might be.

### Activities of the session

**Class 1:** Introduction powerpoint to generate discussion of ecosystems, biodiversity, and ecosystem functions. Discuss how to measure biodiversity (study design) and sampling methods. Generate science questions and guide discussion to design experiment together. Agree on adaptations to data spreadsheet if necessary.

**Class 2:** Design/build sampling equipment (pollinator pan traps, Berlese funnels), teach sampling techniques (pan traps, Berlese funnels, sweep-netting, sticky traps, and pit traps). Conduct sweep-netting. Set up various traps to collect from field later.

*NOTE: Class 1 and 2 can be combined into one class if sampling equipment has been prepared already or if the class isn’t using any of the sampling methods that require “construction” (Berlese funnels, pan traps).*

**Class 3:** Collect traps from field and classify insects to order. Collect data and enter into cumulative spreadsheet. Groups report out. Conduct graphing exercises comparing abundance and orders in different habitat types. Adjust to your own logistical issues for travel, walking time, etc.

*NOTE: Sorting insects is one of the most time-consuming parts of this activity, so plan a full day for this part of the lesson.*

**Class 4:** Present wrap-up powerpoint. Discuss what was found during sampling efforts. Groups look at other graphs. Present powerpoint on importance and benefits of biodiversity. Assign homework and/or classwork questions (content-based).

**Class 5:** Go over homework. A discussion of potential ways to restore habitats/ecosystems with low biodiversity can be implemented.

*NOTE: To shorten this lesson, graphing homework can be assigned following Class 3 as long as all students have a copy of their data. Class 4 and 5 can also be combined to one day by conducting work in class instead of assigning homework. A discussion of potential restoration strategies is an extension and not necessary to complete this lesson.*

**Timeline:** This activity is best carried out in late spring or early Fall (during “buggy” months).

Sample Protocols

Pit trap, sticky trap, and sweep-netting protocols can be found on the “KBS GK-12 BEST Plots Lesson Plans page” See website below:
<http://kbsgk12project.kbs.msu.edu/wp-content/uploads/2011/09/Invertebrate-Biodiversity.pdf>

Instructions for construction of Berlese funnels can be found at:
<http://www.cals.ncsu.edu/course/ent525/soil/berlese.html>

To make pollinator pan traps:
Place 4 bowls or cups (one each of white, red, yellow, and blue) at a random location within each habitat type for one day. Each bowl or cup should be ~75% full of a soapy water solution. After bowls or cups have been in field for one day, collect insects from each container and bring back to the classroom to classify.

Bowls or cups can be purchased pre-colored or painted in the classroom. If painting in the classroom, 2-3 layers of paint are usually required. Disposable plastic or Styrofoam cups are sufficient. Acrylic paints are suggested.

Included in the materials on the KBS GK-12 website for this lesson is a supplemental powerpoint for the instructors which has illustrations and additional help for constructing these materials.

**Resources**

* “What Bug is That?” poster (available as a .pdf on the KBS GK-12 website)
* KBS GK-12 “Invertebrate Guide” powerpoint (<http://kbsgk12project.kbs.msu.edu/blog/2012/03/20/best-plots-lesson-plans-2/>)
* [www.bugguide.net](http://www.bugguide.net)
* Dichotomous Key for Winged Insects: <http://www.amnh.org/learn/biodiversity_counts/ident_help/Text_Keys/arthropod_keyA.htm>
* Dichotomous Key for Wingless (or Tiny-Winged) Insects: <http://www.amnh.org/learn/biodiversity_counts/ident_help/Text_Keys/arthropod_keyB.htm>

**Extensions and Modifications**

Modify the biodiversity powerpoint resources and sampling methods as you wish. Not all schools will have the same habitat types and not all sampling techniques need to be used for this study. See “*NOTES*” in the above “Activities of the Lesson” section for advice on shortening this lesson.

**Assessment**

Mathematics

HS: Calculate Shannon-Weaver Diversity Index (see available Excel spreadsheet for classroom data)

HS and MS: Calculate average insect densities and/or average number of orders/habitat type

Graphing

Graph the total numbers of insects captured and the total by insect order (just the ones listed below) for each habitat measured.

Suggested orders to graph: Hymenoptera, Lepidoptera, Diptera, Coleoptera, Odonata, Hemiptera, Orthoptera, Collembola, and any additional orders you wish to study.

Examples:

**Follow up questions:**

1. Human activities can deliberately or inadvertently alter the equilibrium in ecosystems. How did human activity affect the different ecosystems that we measured?

2. Your data shows a difference in carrying capacities for the differing ecosystems. Describe the factors that affect carrying capacity in each of the habitats that you measured insect diversity in.

3. In general, what are the benefits of having high levels of biodiversity in any ecosystem?

4. How do highly diverse insect populations and communities benefit humans?

5. Was there a difference in the types of insect orders found in the various types of traps? What trends did you notice?

6. How could you improve this study to have more confidence that your values are representative of reality?