SCHOOLYARD PLANT AND ARTHROPOD DIVERSITY – Teacher's Guide

DESCRIPTION:

Students measure plant and arthropod diversity in multiple locations around the schoolyard. They use these data to explore possible relationships between the number of plant species and the number of arthropod species.

GRADE LEVEL:

7th

OBJECTIVES: Students will:

- Define species richness.
- Measure biodiversity of plants and ground-dwelling arthropods.
- Examine relationships between plant and arthropod diversity.
- Collect data, make graphs, and use graphs to make interpretations.

NEXT GENERATION SCIENCE STANDARDS:

This activity supports the following Performance Expectations:

MS-LS2-4. Construct an argument supported by evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS2-5. Evaluate competing solutions for maintaining biodiversity and ecosystem services.

This activity is aligned with the three-dimensional learning model of NGSS.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Analyzing and Interpreting Data	LS2.C Ecosystem dynamics, functioning, and resilience LS4.D Biodiversity and humans	Patterns Cause and Effect

COMMON CORE STATE STANDARDS:

English Language Arts

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6.8.4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 6-8 texts and topics.*

Mathematics

7.RP.A.2. Recognize and represent proportional relationships between quantities.

7.SP.A.1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample

is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

BEST PAIRED WITH AMPLIFY:
Populations and Resources Unit

MATERIALS:

- Schoolyard Plant and Arthropod Diversity Student Handouts [1 per student]
- 35 mm film canisters or pill vials with lids [3 per group]
- Flags [4 per group]
- Meter tapes [2 per group]
- Compasses [1 per group]
- Ruler [1 per group]
- Trowels [1 per group]
- Dish detergent
- Large petri dishes or plastic plates [3 per group]
- Forceps
- Hand lenses
- Arthropod identification guides (optional)

BACKGROUND:

Species richness is simply how many different species exist in an area. It is often defined for a particular group or taxon of organisms (e.g. grass species richness or mammal species richness). The drawback of using species richness is that it does not take into account species evenness. For example, a hypothetical habitat with 1,000 honey mesquite and 1 black grama grass plant would have the same plant species richness (2) as a habitat with 500 honey mesquite and 500 black grama grass plants.

Scientists have studied the relationship between plant and arthropod species richness for many years and in many different habitats. The hypothesis is generally that as plant species richness increases, arthropod species richness will also increase. There are many possible reasons for this relationship, including that many arthropods are specialized on particular plants, so increasing plant diversity would also increase the number of different kinds of arthropods that could persist in an area. However, there is not always a positive relationship between plant and arthropod diversity. This activity will allow students to examine the relationship between these two variables in their schoolyard.

TIPS FOR ENTIRE CLASS PARTICIPATION:

- Have students work in small groups (no more than 6 students per group). Each group will collect data on plant and arthropod diversity within one plot, and the entire class's data will be compared to look for relationships between plant and arthropod diversity.

PROCEDURES:

1. Discuss the definition of biodiversity and ask students why they think it is important. Define species richness and discuss how scientists measure it. Discuss arthropods (invertebrates, includes insects, spiders, etc.).

2. Have students make a hypothesis about different areas of the schoolyard where the diversity of plants and arthropods may be different and write it on page 1 of their handout. The class will be creating plots in these areas and measuring plant species richness and arthropod species richness within each plot.

3. Give each group three film canisters and have them fill the canisters ¾ full with water. Add one drop of dish detergent and replace the lid. The detergent reduces the surface tension of the water so arthropods will sink to the bottom of the trap.

4. Each group also gets a compass, ruler, two meter tapes, and four flags prior to going outside to create the plots.

Creating and Sketching the Plots

5. Once outside, have each group go to the location where they will establish their plot. Using the meter tapes, create a square plot measuring 5 meters on each side.
    a. Mark the plot corners with flags.
    b. Use the compass to locate north. On the My Schoolyard Plot Data Sheet, draw a quick sketch of the plot, making sure to indicate where north is located and marking any points of interest (location of trees or shrubs, bare ground, etc.) on the sketch. See Figure 1 for an example.

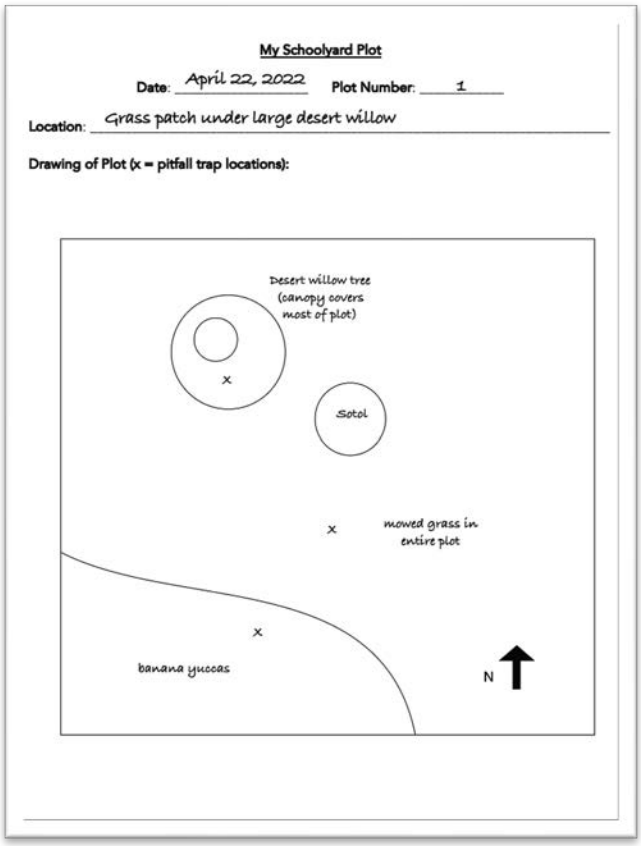

Figure 1. Schoolyard Plot Drawing Example

Measuring Plant Diversity

6. Using the My Observations of Plant Species Richness Data Sheet, carefully examine the plot and record each species of plant found inside the plot. Slowly walk back and forth across the plot to record every species of plant in the plot. For each plant species found, start by classifying the plant and checking one of the boxes, using these definitions:
    a. *Grasses* are non-woody plants with long, narrow leaves with parallel veins. Flowers are hidden within small clusters and lack petals.
    b. *Forbs* are non-woody plants that usually produce noticeable flowers. The leaves are often broad with netted veins, and the flowers usually develop petals.
    c. *Shrubs / trees* are larger plants, usually perennials, with woody parts.

d. *Succulents* are plants like cacti, which have fattened leaves or stems that store water.

7. Write a description of the plant and make a drawing that can be used for future identification. Use rulers to take measurements of the plant to include in the written description. See Figure 2 for an example.

8. Continue moving through the plot until you have recorded information on every plant species found in the plot.

9. At the bottom of the data sheet, write the total plant species richness (i.e., the number of species) and shrub species richness (i.e., the number of tree and shrub species) within your plot.

My Observations of Plant Species Richness Data Sheet

My Name for Species	Type of Plant	Description	Drawing
Grass	☐ Shrub / tree ☐ Forb ☑ Grass ☐ Succulent	Wide blades, dark green	
Round Greenie	☐ Shrub / tree ☑ Forb ☐ Grass ☐ Succulent	Dark green, opposite leaves, very round leaves about 0.5cm	
Lawn Lily Pad	☐ Shrub / tree ☑ Forb ☐ Grass ☐ Succulent	Low to ground (1 cm), individual leaves on long stalk	
Desert Willow	☑ Shrub / tree ☐ Forb ☐ Grass ☐ Succulent	More than 5m high, dark pink flowers	
Sotol	☐ Shrub / tree ☐ Forb ☐ Grass ☑ Succulent	Long toothed leaves, large flower stalk in center	
Banana Yucca	☐ Shrub / tree ☐ Forb ☐ Grass ☑ Succulent	Grayish leaves, long wide leaves with sharp points	
Flat Head	☐ Shrub / tree ☐ Forb ☑ Grass ☐ Succulent	1.5 cm long, pale green	
	☐ Shrub / tree ☐ Forb ☐ Grass ☐ Succulent		
	☐ Shrub / tree ☐ Forb ☐ Grass ☐ Succulent		
	☐ Shrub / tree ☐ Forb ☐ Grass ☐ Succulent		

Total plant species richness (number of plant species) in my plot: 7

Shrub species richness (number of shrub and tree species) in my plot: 1

Figure 2. Plant Species Richness Data Sheet Example

Installing Pitfall Traps

10. Because we are interested in determining the total number of arthropod species in the plot, we will place the pitfall traps in areas of the plot that capture the full diversity of habitats within the plot. For example, if your plot contains a shrub, be sure to place at least one trap under the shrub and one trap further away from the shrub (but still in the 5 m x 5 m plot). Mark the approximate location of the pitfall traps on your sketch of the plot.

11. To install the traps, dig a small hole that is large enough to hold the film canister or pill vial. Place the canister/vial with the lid <u>on</u> into the hole and fill in soil around it. Now remove the lid and make sure that the top of the canister/vial is level with the soil surface, so any arthropod walking by can fall into it.

Measuring Arthropod Diversity

12. After 3 days, have students collect the pitfall traps.

13. Back inside the classroom, have students pour the contents of the pitfall trap into a clean petri dish, making sure all of the specimens are removed. Add water to the petri dish, if needed, to help separate them.

14. Have students use forceps to carefully separate the arthropods into groups of individuals that look alike. Remind them to look at their arthropods carefully while they sort them to make sure all individuals within a group are exactly the same.

15. Have students record their findings on the My Observations of Pitfall Trap Data Sheet. See Figure 3 for an example. This will include making up a name for the species and counting the number of individuals of each species. With older students, you may want to have them use insect identification books to identify each species and classify animals to order and family level.

16. Record each group's data on the Class Plant and Arthropod Diversity Data Sheet. See Figure 4 for an example.

17. Graph total plant species richness and arthropod species richness.

18. Graph shrub / tree species richness and arthropod species richness. See Figure 5 on the next page for an example of both graphs.

My Observations of Pitfall Trap Data Sheet

Description of Species	My Name for the Species	Number of Individuals
Black, medium sized, very long legs	Long-legged ant	4
Large, red head, black abdomen, little hairs on body	Baltimore ant	7
Round, green body, spots	Lime lady bug	1

Total arthropod species richness (number of arthropod species in my plot): 3

Figure 3. Arthropod Species Richness Data Sheet Example

Class Plant and Arthropod Diversity Data Sheet

Plot Number	Total Plant Species Richness	Shrub / Tree Species Richness	Arthropod Species Richness
1	7	1	3
2	3	1	4
3	6	2	6
4	4	0	6
5	6	0	5
6	2	0	3
7	8	1	4
8	2	0	2
9	5	0	1
10	6	1	0

Figure 4. Class Data Sheet Example

CONCLUSIONS:

Allow students to draw conclusions from the graphs. Students should answer the following questions:

- Is there a relationship between total plant species richness and arthropod species richness? If so, is the relationship positive or negative?
- What is the relationship between shrub and tree species richness and arthropod species richness?
- What are some possible explanations for your results?
- What might be the effects on arthropod diversity of using herbicides to get rid of "weeds" in your schoolyard?
- Discuss the sample size of this investigation. Was it enough to make generalizations about the population of arthropods and plants in the entire schoolyard? The entire Chihuahuan Desert?

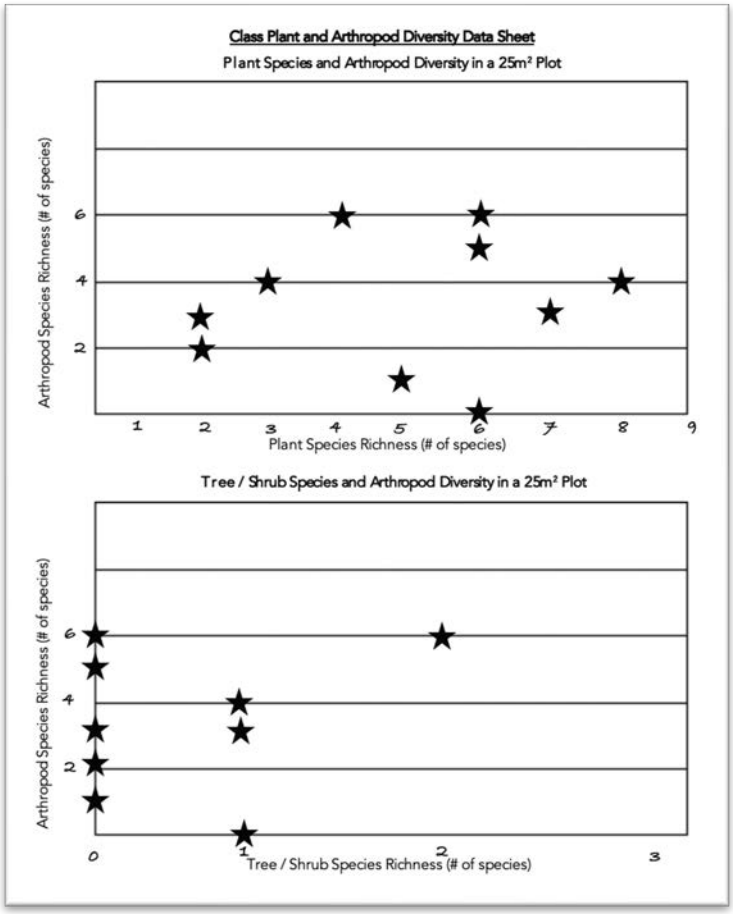

Figure 5. Example Graphs

EXTENSION:

Have students go back to the plots to examine other variables that might be related to arthropod diversity. For example, measure temperature, humidity, or soil type in each plot and see if these variables correlate with arthropod species richness.