CHAPTER 7: WHAT ARE THE CONNECTIONS?

"I'm going to look at a niche and see what's there. For starters, I'm going to select some of the large native grasses that seem like potential hosts. I'm going to begin with an assumption that something eats them, and then I'm going to look and see what it is."

—ERIC QUINTER

(*Selecting a Site*, p.176)

TARGET QUESTIONS: **What kinds of relationships exist among plants, arthropods, and abiotic factors? Can the presence of a plant species predict the presence of an arthropod species, and visa versa?**

PREREQUISITES: Core Activities in Chapters 3, 4, 5, 6

CORE ACTIVITIES:

LESSON 1
Interconnectedness: The Web of Life Game

LESSON 2
Relationships We Have Observed

LESSON 3
Plant and Arthropod Interactions

LESSON 4
Observing Plant and Arthropod Interactions

LESSON 5
Analyzing Data

ASSESSMENTS:

Interconnectedness

WEB COMPONENTS:

FOR STUDENTS

- Investigating Plant-Arthropod Interactions*
- Saving El Imposible: A Biodiversity Puzzler*
- Profile of Amy Berkov*
- Profile of Carlos Ramirez-Sosa*

* All Web reading selections for students are available as blackline masters.

OVERVIEW OF CHAPTER 7

To set the scene for further exploring the topic of interconnectedness, students play a game called the Web of Life. They describe how various living things, inanimate objects, and environmental factors are related and speculate about what might happen if one element were to change.

They review their field journals to create a new chart that describes the interconnected relationships they have observed occurring in their own plots. Then they rework the data to illustrate more ways of looking at the connections between those same relationships.

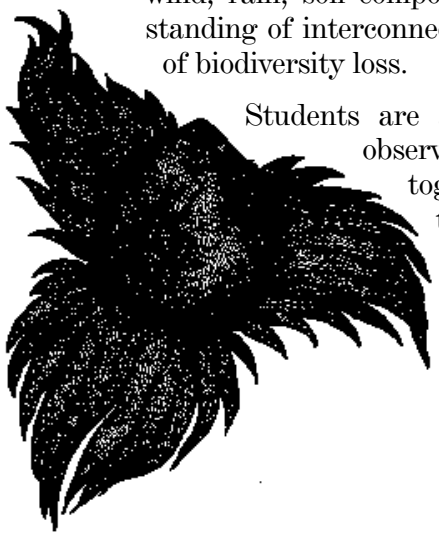
Students revisit the list of abiotic (nonliving) factors that they have been measuring. They add these factors into the discussion and talk about how they influence the relationships described in the plots.

In preparation for their field trip, students draw up a list of the plant species they have surveyed and, on the basis of observations recorded in the journals, predict the arthropod species they expect to find associated with them. Then they go out in the field to collect data that may support their predictions.

Students analyze their data and determine whether the presence of a plant can predict the presence of an arthropod, and vice versa. Then they display their data graphically to detect patterns.

BACKGROUND INFORMATION FOR THE TEACHER

Students have done extensive work at their site and have recorded a wealth of observations on both plants and arthropods. They have also been encouraged to collect data on the abiotic factors that influence the plants and arthropods at their site. Now they will use their own data to look for patterns and to discover relationships. How are all of these elements connected? What relationships exist between one plant and another, between plants and arthropods, and between one arthropod and another? How are all of them influenced by abiotic factors such as amount of sunlight, hours of daylight, wind, rain, soil composition, and temperature? With an expanded understanding of interconnectedness, students can better infer the consequences of biodiversity loss.



Students are asked to analyze not only the relationships they observed but also the ways that organisms are bound together. The connections might include feeding relationships, reproduction, protection, or shelter, to name a few. They will realize that some of these, like feeding, are much easier to observe than others.

1 LESSON

LESSON 1

INTERCONNECTEDNESS: THE WEB OF LIFE GAME

TIME 1 class session (indoors or out)

MATERIALS

- ❑ 1 large ball of twine
- ❑ 1 index card for each student

1. Give an index card to each student. On the card, ask them to write the name of one element they may find in their plot. For example, they might write the name of a plant such as an oak tree, or an animal such as a butterfly; a human-made object such as a fence or trash barrel; a natural inanimate object such as a rock; or an environmental factor such as rainfall or sunlight.

2. Collect the cards. Scan them quickly to make sure there are not too many repetitions and that there are a variety of plants, animals, objects, and environmental factors to work with. Also make sure that all the key elements are presented in some way: sun, water, plants, arthropods, other animals, artificial features.

3. Seat the group in a large circle, about 20 feet in diameter. Holding the class outdoors would probably give you more room and more freedom for a lively exchange, but the activity can also work well indoors on a rainy day.

4. Shuffle the index cards and distribute them, one to each student.

5. Toss the large ball of string to someone in the circle. That person reads aloud the name of the item on his or her index card. Then keeping a tight hold on the end of the string, that person tosses the ball to another person in the circle.

6. The person who catches the ball reads aloud the name of the item on his or her card. The catcher then tries to explain how the items on the two index cards might be related (in ecological terms). The rest of the group can then offer other suggestions and discuss the relationship.

7. Keeping a tight hold on the string, the second person tosses the ball to a third person, and the process of trying to make connections and explain the relationships of the items on the cards is repeated. It is fine for a person to catch the ball more than once. This person has the opportunity to explain the relationship on his or her card to more than one item represented in the circle.

8. The game goes on until the ball of string is used up. The end result is an incredible tangle of string that graphically illustrates the complex web of ecological interactions. Ask students what would happen if you cut the string at some crucial point. What would be the consequences to other elements in the web? How might that affect the ecosystem?

9. Finally, ask students to point out examples of interactions they have observed in their own plots that are similar to the ones represented in their game.

LESSON 2

LESSON 2 RELATIONSHIPS WE HAVE OBSERVED

TIME 1 class session

MATERIALS

- ❑ Several large sheets of chart paper
- ❑ 1 pad of sticky notes
- ❑ Student journals
- ❑ Chart of abiotic factors students generated in Chapter 4

1. ***Continue the discussion on the different kinds of relationships that students have observed in their plots. Hang up a sheet of chart paper titled "Relationships We Observed Between . . ." and set up four columns: Plants and Plants, Plants and Arthropods, Arthropods and Arthropods, and Other.***

2. ***Ask students to get together with their teams and make a list of specific relationships they have observed in their own plots that fall into the first three categories. Encourage them to review their field notes to look for examples. Then distribute the sticky notes and have students record one example per note. If you want to limit the number of contributions, ask for just one example per category from each team, or three examples per team total. Or you might just randomly select three notes from each team.***

3. ***Let each team come to the chart and post its items in each of the first three columns. If they have observed the same relationship as another team, they should group their sticky notes together. The completed chart might look something like this:***

"RELATIONSHIPS WE OBSERVED BETWEEN . . ."

Plants and Plants	*Plants and Arthropods*	*Arthropods and Arthropods*	*Other*
The oak tree shades our grasses. Acorns from the oak have sprouted in our plot. Needles from the pine fall onto the goldenrod. Honeysuckle is climbing up the maple. Leaf litter is deep at the base of the maple.	Grasshoppers eat grasses. Bees collect pollen and nectar from the flowering plants. Bees pollinate the pea plants. A praying mantis made an egg case on the goldenrod. A spider spun a web between the maple and the pine. Acorn weevils have bored holes in acorns. Sowbugs hide in leaf litter.	Ladybugs eat aphids. Ants eat honeydew from aphids. Praying mantids are predators on other insects. Spiders eat a variety of insects. Two butterflies were joined together, mating. Ants carried their eggs away when we turned over a rock.	

These are generic examples. If students have more specific data from their observations or identifications than the examples above (e.g. genus or species identification), encourage them to use them for the chart.

4. Discuss the observations. Use some of these questions:

- Find the places where there are clusters of similar observations coming from different teams. (For example, the two entries about bees in the chart above.) What can you infer about the different plots involved? How might they be alike? Why might bees prefer one plot to another?

  Note: Even though teams may be studying plots with similar features, they may not have chosen to observe the same features and so will not be able to compare results.

- Trace a set of relationships that weaves through all three columns. For example: The honeysuckle used the maple for support. A spider used the maple and the pine as structural support for its web. The honeysuckle attracted insects that got caught in the spider's web. What would happen if we removed the honeysuckle (or the maple, the pine, the spider, the insects) from this set? How might that affect the habitat?

- Ask students to formulate new questions based on their observations. Students might develop questions such as:

  How did the acorns get into our plot?

  What effect might the pine needles have on the goldenrod?

  Why did weevils bore holes in the acorns?

  Are the relationships we observed mutually beneficial to the plant and the arthropod? Or is the relationship harmful to one while beneficial to the other?

- Students may have also recorded observations on other interactions, such as the effects of abiotic factors or the activities of animals other than arthropods. Invite them to contribute some of these observations in the "Other" column. They will help to underscore the constant interplay between biotic and abiotic factors and the complexity of factors influencing the site.

5. Ask students to suggest new ways of looking at the relationships they observed and recorded on their sticky notes. Then have them regroup the sticky notes to illustrate the relationships. Here are two ideas:

- Have students classify the relationships according to the different ways the organisms depend on each other.

  In this case, they would regroup the notes under new categories that represent functions, for example. The new headings might read: Gathering Food/Eating, Reproduction, Protection, Shelter, Other. If students arrange the notes in columns under each heading, they will have created a bar graph. Then they could tally up each type of functional

relationship they observed and talk about where they could have looked for more. Ask questions like: Which kinds of relationships did you notice most/least often? Why do you think you made very few observations about reproduction, for example, but lots about eating?

- Have students regroup the cards by single plant (or by single arthropod) to look at one organism in more depth.

  Focus on one item, such as the acorn weevil from the sample chart above, and ask students to figure out what other elements it connects with. Pose a question such as: If you were going to make a study of the acorn weevil, what other relationships recorded on the sticky notes would you have to consider? Why?

  Then have students collect all the sticky notes they named and, on another sheet of chart paper, display them in a web form. Have them draw lines to connect one note to the other and to explain the connections. Ask what would happen if one of the notes was removed. How might the loss of biodiversity affect the stability of the ecosystem?

6. Revisit the chart of abiotic factors students generated in Chapter 4.

Ask students what they were able to find out about how the factors on their list influence the site. Give them time to review their journals to look for specific examples with data to support them. For example:

- What did you find out about how temperature (or moisture, sunlight, length of daylight, soil composition, human activity) influences the site? Did you record similar/different temperatures on your plot compared to other plots? When? What was the date and the time of day? Then explore the influence of those factors on the relationships students described on the charts.
- Did you notice any correlations between temperature and the activities or relationships developed in our charts today? For instance, does temperature figure into the relationship between the oak tree and the grasses below it? How?
- When did you notice more arthropod activity—at warmer temperatures or cooler temperatures? In sun or shade? What kinds of activities? How did the plant/arthropod relationship change at different temperatures?

  Continue the discussion to include all of the abiotic factors students measured.

7. Ask students to think of ways they could display the data graphically. Use line graphs, pie charts, and histograms to present the data.

LESSON 3

LESSON 3 PLANT AND ARTHROPOD INTERACTIONS

TIME 2 class sessions

MATERIALS
- ❑ Journals

WEB CONNECTIONS

Investigating Plant-Insect Interactions

OPTIONAL: Saving El Imposible: A Biodiversity Puzzler

OPTIONAL: Profiles of Amy Berkov and Carlos Ramirez-Sosa

1. ***Ask students if they think that the presence of a particular plant predicts the presence of a particular arthropod, and vice versa. Have them use examples from their experiences in the field to support their arguments.***

2. ***In their journals, have them list all the plant species (and morphospecies) they surveyed in their plot. Next to each species, ask students to predict the arthropods they may find on that plant.***

3. ***Then ask students to be even more exact. Where exactly on the plant in question would they expect to find the arthropod associated with it? Make the point that they might think of plants as being composed of microhabitats too. Discuss the idea and draw up a list of microhabitats found on plants. For example, depending on the plant and the season of the year, students might list the following:***

Microhabitats Found on Plants

roots
stem
leaves
fruits, nuts, or berries
flowers or buds
bark
wood
conifer cones

4. Give students time to read the selection: **Investigating Plant-Arthropod Interactions.**

Use some of these questions to discuss the reading:

- Why did Amy Berkov choose Cerambydicae and Lecythidaceae as the subjects of her research project?
- Describe what the scientist is trying to find out about the relationship between the beetles and the trees she is studying.
- What are the results of the project? Did the scientist find answers to her questions? How did she feel about the number of new questions that the research generated?

5. In preparation for the field trip, have students summarize the discussions.

- How do arthropods use plants? What parts do they use?
- How can we discover if the arthropod relationship is harmful or beneficial to the plant?
- What will you observe in the field?

4

LESSON

LESSON 4

OBSERVING PLANT AND ARTHROPOD INTERACTIONS

TIME 1 or 2 field trips

MATERIALS

- ❑ Journals
- ❑ Hand lenses

1. ***In the field, review the objective of the observations students are to make. Remind them that they are to observe and describe interactions between arthropods and plants, and that they should try to discover which part of the plant the arthropod is using. They should also include their ideas on whether the relationship is mutually beneficial or harmful to one of the organisms.***

2. ***As students work, circulate among them and ask some of these questions:***

Tasks	*Focus Questions*
To observe microhabitats on plants	What part of the plant are you observing? What kinds of microhabitats have you discovered on the plant?
To observe arthropod presence on a plant	What arthropods are present on the plant you are observing? Exactly where on the plant are they?
To observe arthropod behavior	How is the arthropod using the plant? Do you see interactions between different species of arthropods on the plant?
To encourage speculation	Do you think the plant-arthropod relationship is mutually beneficial, or is it harmful to the plant? If you are not sure, how could you find out?

5

LESSON

LESSON 5 **ANALYZING DATA**

TIME 1 class session

MATERIALS
- ❑ Journals
- ❑ Chart paper and markers

1. ***Discuss the plant and arthropod interactions that students observed and recorded in their journals. Begin by returning to the predictions students made about the associations they expected to find. Do the data support their predictions?***

2. ***Classify the relationships students observed into three categories: mutually beneficial, harmful to the plant, and not certain. Make a chart and have students record their observations in each category. If there is disagreement, or if students are not certain, suggest that they do further research.***

3. ***Ask students to summarize. Can you predict the presence of a plant by the presence of an arthropod, and vice versa? Why do you think so?***

4. ***Have students record their findings graphically. The resulting graphs will help to illustrate and detect patterns in the data. They may plot variables such as plant or arthropod species against several different parameters, such as temperature, precipitation, or soil type.***

ASSESSMENT: INTERCONNECTEDNESS

1. Remind students that they will be creating an exhibit as their culminating activity. Ask them to think about which of the relationships they observed in their plots could be used in the exhibit to illustrate interconnectedness. Ask why they think the relationships they describe would help visitors understand more about the web of life.

2. Ask students to explain why understanding interconnectedness is vital for understanding biodiversity.

3. Return to the explanation of biodiversity students have been developing. Record their new understanding of interconnectedness on the chart or concept web.