LENGTH: 60 MINUTES

GRADES/AGES: GRADES 3-7

Lesson Overview:
Become an adventure scientist by exploring the biodiversity of your schoolyard. Use a field journal to plan and prepare for your adventure, collect data in the field, and draw conclusions from your findings.

NOTE: This lesson’s activities can be completed after each corresponding lesson or as a whole project at the end of the unit.

LEARNING OBJECTIVES

Students will be able to:

1. Select, describe and map an area for study.
2. Use field skills to record observations about an ecosystem.
3. Calculate the biodiversity of an area of study.
4. Explore the effects of climate change on a local species.

DIRECTIONS:

1. Choose your own adventure.
   a. Tell your students that they will be planning and “going on” an adventure just like university researchers do.
   b. As a class help your students choose an appropriate place for their adventure. (This adventure will be used as an area of study for the entire lesson.) Begin by giving your students a boundary that will limit their travel. For example, tell your students that the location they choose for their adventure must be within walking distance.
   c. Once the natural area has been selected, ask your students if they need to get permission or permits. Students may need permission to collect data on the species that live in this area from a principal or superintendent, maybe even the property owner. Students may need to get permission to travel from parents or school administrators. If appropriate, include students in the process to get permission, by writing a letter to the appropriate authority figure.
   d. Distribute a Field Journal to each student. Explain that these field journals will be used throughout the study.
   e. With your class, establish a research question for their study. This question should be focused on one species you know is present in the area. For example, some Montana Institute on Ecosystems researchers focus on lake trout; others study mountain pine beetles. Your schoolyard study can focus on a tree species, bird, or small animal that you and your class want to learn more about. The species you chose must be abundant enough that students will be able to find signs of life from this species in your chosen area.
   f. Tell your students that part of the mission of Montana Institute on Ecosystems scientists is outreach or sharing what they learn with people. With your students, determine what outreach your adventure will have. Students may share what they have learned by writing letters home to family, publishing their adventure in a school newspaper or newsletter, posting information on a school bulletin board, or including what they have learned on a class or school blog.
   g. Have students document the planning and approval process for their adventure using the Project Proposal in the field journal.

2. Describe own adventure.
   a. Tell your students that part of the planning process for an expedition is mapping the route before leaving. Have your students make map of the study area chosen. (If needed, or if time allows, do this activity at your adventure site.)
b. Ask each student to use the blank map template in their field journal to lead them through the map-making process by drawing your own version on a white board or chart paper.

c. Have your students describe the area they are visiting as part of the preparation process. Have your students use the Study Area Description page of their Field Journal to describe the area’s natural characteristics.

3. Diagram the study area ecosystem and learn more about the species of study.

a. Brainstorm plant and animal species that students expect to find in the study area. Have students record these anticipated species on the Ecosystem page of their field journal.

b. Ask each student to make an ecological structure diagram of the adventure area’s ecosystem using the Ecosystem Pyramid model. (To learn more about this model, see Lesson 1: Explore the Ecosystem). Have students use the species the class identified in the research question as the key species of the model (listed at the top of the pyramid at the organism level) and incorporate other identified species in the larger ecological groups including community and ecosystem.

c. Answer the following questions about what students found in the field journal:
   • What are the ecosystems present in your community?
   • Can the concept of ecosystem be used at the microscopic level? Why/why not? Expand on your answer using detailed examples.

d. Using the Species of Interest page of the field journal, have your students conduct research on the species identified in your research question.

4. Students collect scientific data in their schoolyard.

a. Tell students that they will be visiting the chosen area and collecting data.

b. Use the map your class created of entire study area in the previous activity and divide into smaller study areas – one for each small group. If possible, before the lesson, mark these areas for students. Have them draw the divisions onto their field journal maps.

c. Assign each small group an area (that you have pre-determined and marked on a map) within the larger study area. Have each group circle their area on their map.

d. Tell your students that when they go outside, they will be looking for signs of life and collecting scientific data to show what evidence of life they found.

e. Show your students the Data Sheet in their Field Journal. Tell your students that to be a good scientist, they will need to walk slowly and listen and look carefully within their area to find signs of life. Using the examples provided on the data sheet, introduce how each group will collect their data. Go over proper collection techniques (listed in the Background Information) and school rules for the schoolyard.

f. Visit the schoolyard and make observations and complete worksheets for each smaller area to collect data. In addition to making observations, your students may use additional optional techniques used by researchers such as:
   • Using GPS units to record the locations of the evidence they find.
   • Collecting the evidence they find. (Use tweezers to put hair/scat in plastic bags/envelopes. Use plaster to record tracks. Use cameras to document signs you cannot bring back to your classroom.)
   • Discussing with your students where good locations for wildlife cameras would be for their schoolyard.

g. Back in the classroom, have each group share what they found. As a whole class, discuss what species are the most common in your schoolyard and how you know. Discuss which species are rare and how you could protect these species (bird houses, natural areas, etc.)

h. Have students work together to analyze the data they have and answer questions about the population on a worksheet.
   • How many different individuals can you estimate are present without DNA analysis?
   • What patterns in behavior can you find for this species?
   • Where are the individuals most abundant?
   • Is the final number of species found by the class all there are? Why/why not?
   • What other ways of collecting are there? What are the advantages/disadvantages of each?
   • Are there any species we did not find a representative of? Why/Why not? Explain.
5. Calculate a biodiversity index of your schoolyard.
   a. Explain to students that a biodiversity index is measured by counting the number of species in an area as well as the number of individuals in each population. Explain that there are different formulas or way to calculate biodiversity.
   b. Have each small group calculate the biodiversity of their study area using the Biodiversity page of the field journal. (Two different difficulty levels are available.) Although students will not know the exact number of individuals of each they found in their area because they do not have access to DNA analysis, they can make their best guess as to if each sign of life they found was from different individuals or the same individual who left multiple signs of life. (For more information on calculating a Biodiversity Index, see Lesson 3: Biodiversity Basics.)
   c. Discuss the biodiversity of the entire schoolyard area.
   d. Which sample area of the schoolyard was the best representation of the entire classroom? Which sample area has the most biodiversity? Which had the least?

6. Students study the impacts of climate change on your species.
   a. Tell students that many animals around the world are being affected by climate change. Briefly review with students the causes of climate change and how it is affecting ecosystems worldwide.
   b. Have students use their knowledge from the research they conducted in a previous activity to identify adaptations that your species of study has to help it survive in its environment in the first column of the Climate Change and Your Species of Study page of the field journal. Explain how climate change will impact this species as a result of each adaptation using the second column.
   c. Review student answers and discuss the impacts climate has on your species of study as a class.
   d. Brainstorm with your students what daily activities of theirs contribute to climate change.
   e. Discuss how their actions can affect species and ecosystems worldwide including their species of study. Brainstorm what behaviors students can to reduce climate change.

Tips and Modifications
To adapt this lesson to a different age group, use the following modifications:

1-6. Older students may record data in a notebook, creating their own tables and diagrams instead of using the provided field journal. This will be more similar to how data is collected during an expedition.

4.b. For older students, have them be a part of the process to divide the schoolyard. Have them think about where they would anticipate finding more signs of life. Have students mark the boundaries with you in the schoolyard.

5. Use the appropriate worksheet to adapt these two activities to your students’ abilities.

Assessment:
Review the Field Journal for completion and accuracy.

Extending the Learning:
Complete other activities from the Exploring Ecosystems unit to learn more about each step of the adventure and science research expedition process.

Research local conservation issues in your community and how research like your students conducted in this lesson impact decision making.

Conduct or participate in a BioBlitz.

PREPARATION:
MATERIALS YOU PROVIDE
- Pencils
- Clipboards
- Rulers

RESOURCES PROVIDED
Handouts and Worksheets
Field Journal (one per student)

REQUIRED TECHNOLOGY
- Internet Access: Required
- Tech Setup: Several computers for student research

Other Notes
This lesson, “Schoolyard Biodiversity Study,” provides an opportunity for students to participate in all the steps of a scientific research expedition. This lesson may be completed in portions at the end of the first four lessons to reinforce each lesson’s major ideas.
BACKGROUND AND VOCABULARY:

SIGNS OF LIFE EXAMPLES

- Tracks
- Hair/Fur
- Feathers
- Scat
- Nests
- Burrows
- Spider webs
- Bones
- Sounds/calls
- Digging and scratching marks on trees
- Leaves and branches with pieces missing
- Holes in dead trees and logs from insects

PROPER SIGNS OF LIFE COLLECTION TECHNIQUES

- Be careful while you are collecting, making sure not to damage any trees or plants.
- Don’t touch scat, dead animals, or trash without a gloved hand.
- Don’t put anything you find in your mouth including plants, berries, mushrooms, and leaves.
- Don’t reach into places you can’t see.
- Return rocks and logs you move to where you found them.
- Wash your hands as soon as you return to your classroom. Do not touch your face without washing your hands first.

WILDLIFE ECOLOGY

DATA COLLECTION METHODS

Wildlife studies modify data collection techniques to fit the unique needs of the location and species to be studied.

Occupancy studies attempt to determine the proportion of suitable habitat that is inhabited by a species. With repeated surveys, this approach can help researchers and managers understand changes in population over time, and whether a relationship exists between distribution, occupancy, and landscape processes.

In wildlife studies, when expedition team members discover a track, the researchers will backtrack to seek a DNA sample from fur or scat.


Prior Knowledge

- Ecosystems
- Biodiversity

Vocabulary

This lesson uses vocabulary from the entire Exploring Ecosystems unit. Please see related lessons for vocabulary terms.
FIELD JOURNAL

INSTITUTE ON ECOSYSTEMS

SCHOOLYARD BIODIVERSITY STUDY

RESEARCHER’S NAME: ____________________________________________________________

DATE OF STUDY: ______________________________________________________________
FIELD RESEARCH PROJECT PROPOSAL:

Team members: ________________________________________________________________

Name of study area: ____________________________________________________________

Location of study area: _________________________________________________________

Brief description of study area: _________________________________________________

Permission to study this area given by: _____________________________________________

Dates of adventure: _____________________________________________________________

Method of travel: _______________________________________________________________

Permission (permit) to travel given by: _____________________________________________

Research question: ______________________________________________________________

Method of outreach: ______________________________________________________________
MAP OF STUDY AREA (INCLUDING LEGEND)
STUDY AREA DESCRIPTION

Team members:

Name of study area:

Location of study area:

City:

County:

State:

Country:

General description of study area:

Type of habitat (select as many as applicable):

☐ Grass/meadow – maintained (mowed)
☐ Grass/meadow/shrub – not maintained (“wild”)
☐ Savannah/wooded grassland – mixed trees and grass
☐ Forest – mostly coniferous (needles)
☐ Forest – mostly deciduous (leaves)
☐ Forest – even mix of both coniferous and deciduous
☐ Wetland/marsh
☐ Sand/beach
☐ Agriculture/Farms
☐ Developed – Suburban (houses, some green space)
☐ Developed – Urban (in the city, little/no green space)
☐ Water – large pond, lake or ocean
☐ Other – describe: _________________________________________________________________

Sources:
Expected animal species: ______________________________________________________________
__________________________________________________________________________
Expected plant species: ______________________________________________________________
__________________________________________________________________________

ADVENTURE AREA ECOSYSTEM MODEL

What are the ecosystems present in your community?

Can the concept of ecosystem be used at the microscopic level? Why/why not? Expand on your answer using detailed examples.
SPECIES OF INTEREST:

Common Name:

Scientific name:

Group: Mammal, reptile, amphibian, bird, etc.

Characteristics:

Status (native, threatened, endangered, and invasive)

Connected species:

What role does this species play in the adventure area's ecosystem?

Why is this species important?
For each sign of life, write down what you think it is, what animal it is from and what scientists can learn from this specimen.

<table>
<thead>
<tr>
<th>SPECIMEN #</th>
<th>WHAT IS IT?</th>
<th>WHAT ANIMAL IS IT FROM?</th>
<th>WHAT CAN IT TELL US?</th>
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<tbody>
<tr>
<td>EXAMPLE</td>
<td>A track</td>
<td>Deer</td>
<td>How fast the deer was walking/running, where it was going, how big it is</td>
</tr>
</tbody>
</table>
SIGNS OF LIFE DATA SHEET

How many different living things did you find?

Where did you find different things?

Were species evenly distributed across your area or did you find a greater variety in a particular location?

If there were diversity differences, what area had the greatest diversity?

Do you think as a whole group you found everything out there?

What factors may have affected the number of species you found?

What was the hardest part of the study?

Were you surprised by anything you found?
**BASIC BIODIVERSITY INDEX**

Calculate the biodiversity index (or how diverse and healthy an ecosystem is) of your study area.

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<tr>
<th>SPECIES NAMES</th>
<th>POPULATION (# of individuals found)</th>
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**TOTAL # OF SPECIES:** **TOTAL NUMBER OF ORGANISMS:**

How many different species are in your sampling area?  
What species has the largest population?  
How many organisms total are in your sampling area?  

Calculate the biodiversity index for your sampling area:  
TOTAL # OF SPECIES ÷ TOTAL NUMBER OF ORGANISMS = BIODIVERSITY INDEX  
_________________________ + ___________________ =  
_________________________  

Compare your biodiversity index to your classmates and answer the following questions.  
Is your sampling area rich in diversity? Why or why not?  
Do all sampling areas have the same biodiversity index?  
Would taking just one sample of the entire ecosystem give you an accurate picture of the biodiversity? Why or why not?  

What can scientists use this biodiversity index for?
**SIMPSON BIODIVERSITY INDEX**

Calculate the Simpson Biodiversity Index (or how diverse and healthy an ecosystem is) of your study area.

<table>
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<th>SPECIES NAMES</th>
<th>POPULATION (# of individuals found)</th>
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(A) Total: (Richness)  
(B) Total:  
(C) TOTAL

Calculate the Simpson Index of Diversity for your sampling area.

The equation for this method is: 

\[ D = \sum \frac{n_i(n_i - 1)}{N(N - 1)} \]

Where:

- \( D \) is the index we are calculating
- \( n \) is the number of individuals of a given species
- \( N \) is the total number of individuals present in your sample

Calculate the Simpson Index of Diversity. Show your work and answers below.

Subtract the total number of species (number in box A) by 1.

Multiple this number by the total number of species (number in box A).

Divide the sum of \( n(n-1) \) (number in box C) by this answer.

The answer is \( D \) value which ranges between 0 and 1.

With this index, 1 represents infinite diversity and 0, no diversity. Describe the diversity of your sampling area and how you came to your conclusion.

Compare your biodiversity index to your classmates and answer the following questions.

Is your sampling area rich in diversity? Why or why not?

Do all sampling areas have the same biodiversity index?

Would taking just one sample of the entire ecosystem give you an accurate picture of the biodiversity? Why or why not?

What can scientists use this biodiversity index for?