Desert Biodiversity
Field Experience

Objectives:
Students will be able to:

▪Conduct a scientific protocol to document plant biodiversity.

▪Compare plant diversity among areas with different microclimates

▪Observe and document various plant adaptations to the environment

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Time:
1 hour in the field
1 hour in the classroom

Grade Level
7-12

Standards

AZ Science Strands
Inquiry; Life sciences

AZ Social Studies
Geography

NGSS - Core Ideas
Ecosystems; Inheritance of traits; Natural selection; Biodiversity and humans

Practices
Questions; Developing models; Investigations; Analyzing and interpreting data; Using computational thinking; Obtaining information

Crosscutting Concepts
Patterns; Proportion; Structure and function; and more

Specific AZ, Common Core, and NGSS standards on page 3.

Background:
The foundation of all ecosystems is the community of plants that make up the base of energy flow through the system as well as providing habitat, shade, building materials for nests, and many other interactions. The first step in characterizing an ecosystem is often an assessment of the biodiversity and population makeup of the plant community present. .A plant ecologist is usually trying to answer three basic questions about the plant community:

1. What plants are present in the ecosystem?
2. How many of each type of plant are present and how do the various species of plants interact with each other and their environment?
3. How are the various plants adapted to survive in the ecosystem?

It would be impossible to count and identify every plant in an ecosystem, so sampling techniques are used to help ecologists develop an idea of the kind of plants which make up the ecosystem and the relative population of each plant type Many different sampling techniques are available, but the one we will use here is called a transect line study. In this technique a straight line of known length is run in a given direction through the area to be studied. A compass is used to help keep the line straight. Every plant that overhangs the line or is within one meter of the line is mapped and identified. Data is also collected on abiotic factors such as temperature, humidity, solar radiation, soil texture and minerals, as well as evidence of animal activity in the study area

Below is a list of essential tasks that must be carried out at each study site. Make sure you organize the work so that all the observations of interactions, adaptations, populations, and abiotic factors are made, and that soil samples are collected from each study site for later analysis in the lab.

Vocabulary:
dominants - dominant plants cover more space (they may also be larger but not necessarily) and may influence other organisms.

plant distribution - refers to the arrangement of plants in the area

limiting factors - biotic or abiotic factors that limit the distribution of plants (or animals). Ecologists do research to find limiting factors. Quite often limiting factors are things like light, nutrients, and water. Plants and animals adaptations are also important in determining distribution.

biodiversity - sometimes called species richness, this is the number of different species living in the same area

community - in ecology, a community refers to all the plants and animals in a particular area. This study looks specifically at the plant community.

transect lines - a method in ecology to survey plant diversity. There are a number of different transect line protocols, the one outlined here is appropriate for deserts.

community (interspecific) interactions: refers to positive and negative associations

between species that favor or inhibit growth of populations. Types of interactions include: predation, herbivory, mutualism, commensalism, parasitism, competition.

Advanced Preparation:
Different groups will be assigned to map certain sections of the transect line and will be responsible for at least one specific duty: setting up the transect line or collecting data on abiotic factors. Back in the classroom, the data from all teams will be combined to produce a larger version of the transect line map.

Materials:
- compasses
- graph paper
- 50 meter measuring tape
- thermometers
- small shovels
- baggies
- soil thermometers (if available)
- psychrometers (if available)
- wind meters (if available)
- data sheets

Recommended Procedure:

Engagement

1) Visually inspect the site with the students. What kind of variation do you see? What types of plants are in the area and how are they arranged. Do you see any types of species interactions? Select at least two sites to sample; these should have different kinds of vegetation so you can compare them. For example, you may want to do a north-facing slope vs. a south-facing slope.

Exploration

Transect Line Protocol

2) Set up at least one 50 meter transect line. Use the compass to make sure the transect line is straight along a compass bearing. Mark the line at 10m intervals. Assign each student group a 10m x 2m section to record data (so 5 groups would do a 50m line). Give each group a starting point and primary direction.

3) Have the students construct a biota map for their section of the transect study area, using the graph paper on the data sheet as their map. Mark the location of each plant on the graph paper map. Have students create a plant key for the plants in their transect (i.e. o = brittle bush). Back in the classroom, the group will generate a key for the complete map so that different shapes represent different plant species.

4) Estimate the approximate height and area of each plant and record these on the map and data collection sheet.

5) Indicate on the map the location of any animals or evidence of animal activity. *Examples:* insects, nests, burrows, scat, foot prints

6) For each plant type encountered, record any specialized adaptations for survival in arid (dry) conditions and any examples of community interactions that you observe. Examples: evidence of predation, herbivory, mutualism, commensalisms, parasitism, competition

7) Collect data on the abiotic factors present including:

- Air temperature in the sun and shade, and if you have the equipment:
- Soil temperature in the sun and shade (at the surface and at 10 cm depths.)
- Relative humidity
- Wind speed and direction

8) Collect a soil sample in a plastic bag and label (if you plan to do any soil analysis).

See the following pages for specific group instructions to collect additional abiotic data.]

If you only plan to collect air temperatures, assign each group a section of the transect line (see above) and then have the first group that finishes collect the air temperatures.

Explanation

In the Classroom:

9) Provide students with a large roll of paper and have them transfer the data from their part of the transect onto the paper. Use the appropriate scale, which will be dependent on the length and width of the paper you provide. If you don't have one large roll of paper, provide each team with the same-sized paper and then tape them together.

10) Make sure all the students have agreed on the same plant key (ie. o = brittlebush, + = mesquite).

11) Compile all the plant data (types & numbers) on the white board and/or one date sheet. Sum the total numbers of each plant type along the 50m transect.

For each plant type determine the number of plants per sq. meter.

- Example: If you have 10 agaves along the 50m transect and a total sample area of 100m^2., 10/100 = 1 agave/m^2

12) Compile other observations (evidence of animal activity, plant adaptations, community interactions).

13) Collect the rest of the abiotic data on one data sheet, analyze the soil samples.

14)Have students answer the questions.

Evaluation:

1)Participation in data collection at the field site

2) Completion of the data sheet and questions

Expansion and/or Extensions:

Based on student responses to *question 5*, choose specific community interactions you observed to investigate more deeply. Possible examples could include invasive species competing with native organisms, mutualisms such as nurse plants shading seedlings, or parasites such as mistletoe in trees and cochineal insect on cactus. Students may conduct literature/web research on the association. Further exploration could include designing and conducting a study to measure the frequency of the community interaction/association at the study site or compared to other sites and evaluating the biotic and abiotic conditions required for the interaction.

Based on student responses to *question 7*, choose an abiotic factor, such as soil temperature or humidity and develop testable questions about the effects of this factor on a specific organism you observed. Design a field or classroom experiment to manipulate this variable and measure the effects on the organisms over an appropriate time period.

Standards

Arizona Science Standards

S1-C1-GRHS-PO1-2
S1-C2-GR7-8-PO1
S1-C2-GR7-8-PO4
S1-C2-GR7-8-PO5
S1-C2-GRHS-PO1
S1-C2-GRHS-PO5
S1-C3-GR7-8-PO1
S1-C3-GRHS-PO1
S1-C3-GRHS-PO5
S4-C3-GR7-PO3
S4-C3-GR7-PO5
S4-C3-GRHS-PO1-2
S4-C4-GR8-PO4
S4-C4-GRHS-PO4

Arizona Social Studies Standards

Geography
S4-C1-GR7-8-PO1
S4-C1-GRHS-PO1
S4-C3-GRHS-PO1,3,4
S4-C5-GR7-8-PO3
S4-C5-GRHS-PO4-5
S4-C6-GR7-8-PO3

NGSS Core Ideas

ESS2.E: Biogeology
LS2.C: Ecosystem dynamics, functioning, and resilience
LS3.A: Inheritance of traits
LS4.A: Evidence of common ancestry and diversity
LS4.B: Natural selection
LS4.C: Adaptation
LS4.D: Biodiversity and humans

NGSS Practices

Asking questions
Developing and using models
Planning and carrying out investigations
Analyzing and interpreting data
Using mathematics and computational thinking
Obtaining, evaluating, and communicating information

NGSS Crosscutting Concepts

Patterns
Cause and effect
Scale, proportion and quantity
Structure and function
Stability and Change

AZCCRS/ELA Literacy

RST7: Integration of knowledge and Ideas
SL1: Comprehension and Collaboration

AZCCRS/Mathematics

Domains: Number and Quantity, Measurement and Data
Math Practices:
4. Model with mathematics.
8. Look for and express regularity in repeated reasoning.

Student Worksheet
Group Assignments

Group 1:

- Your job is to set up the transect line. You should have a 50 meter tape and a compass from your instructor. Your instructor will show you where the transect line begins and in what direction to travel. Lay out the tape 50 meters long in a straight line. Use the compass to be sure you are traveling in the right direction and in a straight line. The tape should remain as straight as possible and as flat on the ground as possible.
- After all groups are done, you are responsible for collecting the compass and tape and returning it to the instructor.
- You are also responsible for mapping the section of the transect line from the 40m mark to the 50m mark . Refer to steps 1 through 5 of the protocol for this.

Group 2:

- Your job is to measure air temperature. You should have a thermometer from your instructor. You will take two air temperature readings. First, find a nearby tree or large shrub that provides shade. Hold the thermometer in the shade and observe until the temperature stabilizes. Do not place the thermometer on the ground; this will create an error in your reading. Next, repeat this process holding the thermometer in the direct sun. Record both measurements in the correct spot on your data sheet.
- You are responsible for returning the thermometer to the instructor.
- You are also responsible for mapping the section of the transect line from the 30m mark to the 40m mark . Refer to steps 1 through 5 of the protocol for this.

Group 3:

- Your job is to measure soil temperature. You should have a soil thermometer from the instructor. You will take two soil temperature readings. First, find a nearby tree or large shrub that provides shade. Push the thermometer completely into the ground in the shade. If you meet resistance, there is probably a rock beneath the surface. Do not force it or you will damage the thermometer. Try a new spot until you can insert it in completely. Observe until the temperature stabilizes. Next, repeat this process in the direct sun. Record both measurements in the correct spot on your data sheet.
- You are responsible for collecting a soil sample from our study area. You should have a small shovel and a baggie from the instructor. Choose a location inside the transect area. Dig up a small amount of soil (approximately two handfuls of soil). Be sure that you dig into the ground rather than just scrape off the surface. You should create a hole that is at least 3-5 cm deep. Place the soil into the baggie and smooth the ground out level over the hole you dug.
- You are responsible for returning the thermometer, shovel and baggie of soil to the instructor.
- You are also responsible for mapping the section of the transect line from the 20m mark to the 30m mark. Refer to steps 1 through 5 of the protocol for this.

Student Worksheet
Group Assignments

Group 4:

- Your job is to measure relative humidity. You should receive a psychrometer from the instructor. This is a device with two thermometers attached to the end of a short pole. One thermometer has a cloth covering the bulb at the end. You also should have an instruction sheet for use of the psychrometer from the instructor. Follow the instructions to determine the relative humidity. You will need a small amount of water to do this. Have someone in your group bring a water bottle with you. Record this information on your data sheet.
- You are responsible for returning the psychrometer and instructions to the instructor.
- You are also responsible for mapping the section of the transect line from the 10m mark to the 20m mark. Refer to steps 1 through 5 of the protocol for this.

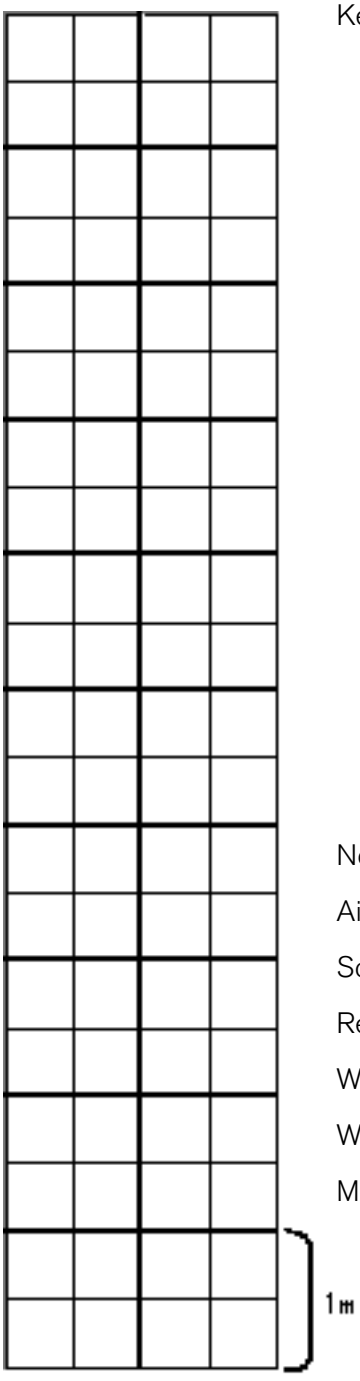
Group 5:

- You are responsible for measuring the wind speed and direction. You should have a wind meter and a compass from the instructor. First, measure the direction of the wind. Use the compass to determine the direction the wind is moving. Wind direction is always measured as the direction it is moving toward, not where it is coming from. Keep that in mind. Once you know the direction, you can measure the wind speed. Look inside the meter. There should be a small white ball at the bottom. If not, it is stuck inside the top. Tap it and it will fall to the bottom. The instructions for using the wind meter are printed on the back of the device. Record both wind speed and direction on your data sheet.
- You are responsible for returning the wind meter and compass to the instructor.
- You are also responsible for mapping the section of the transect line from the 0m mark to the 10m mark. Refer to steps 1 through 5 of the protocol for this.

Student Worksheet
Field Data Collection

_____ meters

Use this graph paper to create your section of the transect line map.



Key: Record the symbols you used to represent various plant species.

Notes:

Air temperature: sun: shade:

Soil temperature: sun: shade:

Relative humidity:

Wind speed:

Wind direction:

Misc notes:

Student Worksheet
Questions

Name:

1. Which plant is the most common along the transect line?

2. Are some plants found in every section of the transect line? If so, which plants?

4. Which plant is the least common along the transect line?

5. Describe one plant adaptation to living in the desert. Explain how it helps the plant survive or reproduce.

5. Describe one community interaction that you or your classmates observed along the transect line.