

SECTION 1:

WHAT IS BIODIVERSITY?

“If each individual talks about what he or she likes about what was observed and why he or she thinks the rest of us should care about it, the result could be a very rich and personal tour of the ecosystem.”

—NILES ELDREDGE
(Design an Exhibit with Passion)

TARGET QUESTION:

What is biodiversity?

PREREQUISITES:

How To — Site Selection
(Teacher Preparation)



CORE ACTIVITIES:

LESSON 1

What is Biodiversity?

LESSON 2

Experiencing the Outdoor Site



LESSON 3

Reporting Back on Site Experiences

Optional Activity

- Creating a Map of the Outdoor Site



ASSESSMENTS:

Baselines

Developing Criteria for Scientific Observations

Digging Deeper



WEB COMPONENTS:

FOR TEACHERS

- Guide to Finding Local Specialists
- Directory of Local Specialists
- Establishing Rules for Field Trips
- More Information on Biodiversity (Resources)

FOR STUDENTS

- Drawing as a Way of Looking at the Natural World*
- Keeping a Field Journal 1*
- Keeping a Field Journal 2*
- Profile of Barrett Klein*
- Profile of Sally Goodman*

* All Web reading selections for students are available both online and as PDFs.

OVERVIEW OF SECTION 1

In the opening discussion, students begin to learn about the term biodiversity at its most basic level. Students continue to develop their understanding of the concept throughout the unit.

On their first field trip, students observe a natural space and report on what they see. They also begin to see the need for keeping written records, since memory is not always a good enough tool. As the curriculum develops, students will learn how to make scientific observations of their site and become more systematic in their recording methods.

A series of optional mapping activities begins in this section. Students attempt to draw a map of the site based solely on their impressions. In subsequent mapping activities, they will continue to develop more detailed and representational maps derived from their observations and their data.

Both teachers and students will discuss their initial site experiences and observations and begin to use the resources available on the Web site.

BACKGROUND INFORMATION FOR THE TEACHER

Biodiversity is the spectacular variety of life on Earth and the essential interdependence among all living things. Initially, students will find it difficult to verbalize even the most rudimentary understanding of that. In the course of the unit, however, they will have many opportunities to develop an understanding of the term. By the conclusion of the unit, students will have had opportunities to do firsthand work in the field, search the Web site for articles by and about Museum scientists conducting similar research, view a video, and exchange observations and collected data on plants and animals with their peers all over the country. These experiences will help each student develop a more sophisticated definition of biodiversity, acquire important scientific skills, and develop a sense of stewardship for both the local and global environment.

Biodiversity Counts is based on five key concepts that provide the context for the unit. These key concepts are the foundation for all the activities.

HERE IS A BRIEF SUMMARY OF THE FIVE KEY CONCEPTS:

1. *Life on Earth is extraordinarily diverse.*

From microscopic bacteria to mammoth whales, from firmly rooted redwoods to highly mobile humans, from marshy wetlands to the high chaparral, life on Earth is diverse, at the level of species as well as at the level of ecosystems.

In Biodiversity Counts: Students will look closely at organisms, searching for answers that relate to their class site. They will investigate such questions as:

- What is out there?
- How many species of living things are there?
- How are they related?
- What is the life history of an organism?
- Where does it live?
- How does it obtain nutrients?
- What does it do?
- What is its role in the habitat?
- How does it reproduce?
- How does it defend itself?
- How are plants and arthropods adapted to the habitats at our site?

2. *Species are the entities we observe, describe, and discuss when we study biodiversity.*

Species are genetically distinct entities with discrete histories.

They retain their genetic distinction because, under most circumstances in nature, a member of a particular species can breed only with another member of the same species.

The genetic code that distinguishes a species usually determines a set of unique characteristics that enables us visually to tell one species from another. Each species is somehow distinct in form and has a unique evolutionary history that is not shared with any other species. Although 1.75 million species have been described so far, scientists estimate that as many as 10 million distinct species exist on Earth today.

In Biodiversity Counts: Students will emulate the work of systematic biologists and conservation biologists to identify plants and arthropods at their site.

3. *Living things are bound together in intricate, interconnected webs.*

The natural world is a vast network of complex communities, connected through shared environments. The interconnected webs serve to sustain biodiversity.

For example, certain flowering plants depend on bees for pollination. The bees depend on the flowers for their food (nectar or pollen). After pollination, the plants produce fruits, receptacles for the seeds of the next generation.

Birds are attracted by the bright color and sweet aroma, and they eat the fruits. The seeds pass through the birds' digestive system and are dispersed in their droppings, and new plants grow, often some distance away from the parent plants. Beetles may eat their way into the same fruit. Small rodents gnaw into the fruits searching for beetles. The rodents themselves may be prey for birds, reptiles, and larger mammals.

If one component is removed—if the bees are killed by insecticides, for example—reverberations are felt throughout the network. Without bees to transport pollen, plants cannot produce seeds to ensure a new generation. Without seeds and their fruity packaging, there is no food for other wildlife.

In Biodiversity Counts: Students will have opportunities to observe the complex ecological relationships among the different living things at their site.

4. Human activity on the planet has had a profound effect on the diversity of species.

Biological diversity is threatened by an array of human factors, including overpopulation, loss and fragmentation of habitat, introduction of non-native, or exotic species, overexploitation of commercially valuable species, pollution and contamination due to pesticides and acid rain, and changes of global dimensions such as warming and the depletion of the ozone layer. The result is that species loss seems to be occurring at a higher rate than ever before as a result of human activity.

In Biodiversity Counts: Students will examine and assess the impact of human activity on their local site.

5. The causes of biodiversity loss are complex, and the consequences are equally complex, extensive, and long term.

In order to make sound political, economic, and ecological decisions, we will need to know more about what species exist, where and how species live, how they are related, and how they interact both with each other and with their environments.

There is hope, and there are positive steps we can take. To begin, we must stabilize population growth, reduce our consumption and waste, develop environmentally clean technologies, and limit the harvesting of our natural resources.

In Biodiversity Counts: Students can learn more about the body of knowledge that exists about biodiversity. It is hoped that their hands-on experience at the site will increase their appreciation and their feeling of stewardship for the natural world, first for their home site and then for the world as a whole.

GOING OUTDOORS

Depending on your location, students may or may not be accustomed to going outdoors for part of their academic day. In most cases, a trip outside generates a lot of excitement, and while it is important that students enjoy the experience, it is also important in this initial foray to set a purposeful tone, to establish some routines, and to develop safety rules.

It is also a good idea to enlist the help of other adults to supervise students outdoors. You may be able to find support staff in the school, or among parents or college students who are willing to help you manage field trips.

This first outdoor task is less directed than future tasks. There is, however, a stated objective: Students are to observe, record, and then interpret their impressions of living things at the site. The purpose of the activity is to provide the class with a vehicle for contrasting this type of impressionistic interpretation with the more factual and objective types to come. The activity also points out the need for accurate record keeping in science, since memory is not always a reliable tool.

Field trip lessons and field trip activities are identified in this book with this icon:



Each field trip has specific tasks and focus questions for students to help guide them in their field work. The tasks and focus questions are organized in matrices within the lessons and as single sheets that you can copy and take out into the field.

ENLISTING THE HELP OF LOCAL SPECIALISTS

We encourage you to enlist the help of local specialists who are knowledgeable about plants and arthropods. They may well become some of your most valuable resources. They can help you select an appropriate site for the project, guide students in identification, and provide background information on the local ecosystem. Try making contacts at the local university, botanical garden, museum, nature center, or garden club. Please see Guide to Finding Local Specialists and Directory of Local Specialists on the Web for more practical information.

SELECTING THE SITE

Selecting an appropriate study site for the project is a crucial first step. If you have already recruited local naturalists in your area to work with you on the project, they may also be able to assist you in site selection.

There are a number of criteria to consider when selecting the study site for your class:

Size of the Area

A site measuring somewhere between the size of a basketball court and a football field is ideal. Students need room to spread out and to walk around without stepping in one another's plots. The area should be large enough so that students can find a variety of interesting life-forms yet still be one that the teacher can manage easily. That is, students stay in sight, and you can circulate and communicate easily with the group.

Urban environments present special problems because space is often limited, and what exists tends to be highly maintained and restricted and therefore less rich in biodiversity. If there are no school grounds, or if they are not suitable, consider getting permission to use a vacant lot, a neighborhood park, a community garden, or even a nearby graveyard.

Safety and Permission

Safety is of paramount concern, as is respect for private and public property. Consider the risks of the prospective site and how you would get proper permission to use it.

Convenience and Accessibility

An ideal site is within easy walking distance. It also is available at various times of the year and preferably over several years.

It is better to use a site that is slightly less stimulating but easily accessible than to select a great site that is difficult to visit.

Biotic Richness

Because the study focuses primarily on plants and arthropods, a site with a variety of vegetation works best. This might include trees, bushes, weeds, grasses, herbs, and wildflowers, as well as dead plant materials such as fallen limbs and leaf litter. Stones, boards, trash, and other materials on the ground may also provide microhabitats for invertebrates.

Water of any kind adds to the possibilities for finding diverse species. Look for areas with puddles, ponds, fountains, or sprinklers.

FIELD JOURNALS

Record keeping is essential to the success of Biodiversity Counts. Make sure that each student has a journal in which to record data in many ways: text (prose), measurements, and drawings. Every field activity in the project requires that students make observations, collect data, and record their findings. They then use their records in a number of different ways:

- *To compare data*, students may use their own data to make comparisons with findings made by classmates.
- *To create graphic displays of data*, students increase their understanding and analytical abilities through multiple representations of data.

As a means of consolidating and synthesizing information, students use their own data to develop several different types of graphs (histograms, line graphs, pie charts). In their final presentations they can use the graphs and charts to communicate their information to a larger audience.

All of these activities underscore and validate the reasons for keeping good records. By engaging in these activities, students emulate the work of real scientists—make observations, record data, communicate and compare their findings with colleagues, consolidate and organize their data, and formally present their research to others.

OBSERVATIONAL RENDERING

Many people find drawing a stumbling block, and are reluctant to include drawings in their journals. It is important to make the point with students that, in science, drawings serve a special purpose. Although scientific illustrations can be quite beautiful, their purpose is not primarily to please the eye, but to record and communicate information.

In order to draw what they see, students are forced to make close and focused observations. Observational renderings then, are an aid to observation itself, and help the observer to key in on details. The renderings are also a memory aid, graphic reminders of what they found, saw, and did. Your students will find they see more when they draw than when they photograph.

Please review the teacher reader “Helpful Hints for Field Sketching” on the next page, an instructional guide on field sketching written by Willard Whitson, former Associate Director of the Exhibition Department at the Museum.

TEACHER READING: HELPFUL HINTS FOR FIELD SKETCHING

Seeing and observing are two different things. When we look at something, we usually are seeing just to identify. We might look at a person, a tree, or a building, and we may later recall the identity of the person we were looking at, or tell if a tree was in bloom or even if the building was made of brick or concrete.

However, if asked whether the person had narrow-set eyes, or whether he or she held one shoulder lower than the other, or what exactly was the color of his or her hair—well, our ability to recall becomes less exact. Was the building or tree—or person!—taller than it was wide? How would you describe the color of the leaves? Were they yellow-green or blue-green? You get the picture, don't you? Observation is a discipline, and drawing is, in a sense, a way of training ourselves to observe. Many people assume that they don't have talent, that they lack that ability to draw. They think that drawing skills are somehow magically bestowed on "artists" alone. As with many assumptions, this one is incorrect. Drawing is a skill that one can learn. As with many other skills, some people will exhibit more aptitude than others, but everyone can improve his or her abilities with some time and effort.

The kind of drawing we are discussing here is observational rendering—trying to capture on paper in two dimensions some aspect of what you are observing. The first thing to do is determine what aspect(s) of your subject you want to record. For example, do you want to know the relative height and width of your subject? Are you recording color? Do you want to show the volume of the subject? How much detail are you interested in? Some of these questions are answered by two factors: the medium you are using and the amount of time you want to spend on drawing. Obviously, if you are using a graphite pencil or charcoal on paper, you are not recording color. And if you intend to spend only a few minutes drawing, you will not be recording a lot of detail.

Hint #1 Proportions

One of the most difficult aspects of drawing is perhaps the most easily resolved. When you draw you are usually creating an image that is smaller in size than the object you are rendering. You do not have to know the actual measurements, only the relative height and width. For example if you are drawing a sleeping cat, you need to know how wide the animal is in relation to how tall it appears to you from your perspective. That is, from where you are observing the animal, you will see a particular and unique set of relationships between height and width. If you move to a new observing position, you will see a different set of relationships. So how do you determine what those relationships are? Remember, you do not have to know the actual size of the object you are observing. What you must do is first establish one element. Let's start with the width of our sleeping cat. Simply mark off on your drawing how wide you want your cat to appear on the page. This can be accomplished by making two light marks to establish these outer boundaries. Next you must establish a relationship between the tallest part of the sleeping cat (as you view it from your observing point) and your now established width. A simple way to accomplish this task is to hold your pencil or even a stick or any straight object at arm's length and sight down your arm to the subject. Turn the stick sideways and align one end with the right or left side of the object and move your thumb to mark the end of the other side on the length of the stick. You now have created your own optical measurement from your viewing location. You can use this measure-

ment to establish the relative sizes of anything you see from your particular and unique viewing position. For example, you can turn your stick vertically, while still holding it at arm's length (with your thumb still holding the mark), and compare the width of the cat with its height, as seen from your vantage point. You can now use that relative size to mark off the upper boundaries of the size of the cat on your page. you can use this method to establish all of the proportions of what you see on your drawing, such as the distance between the cat's eyes, or the size of the space between the sleeping cat and the rock on the ground next to it. And so on. You will find that with practice you can create very naturalistically proportioned drawings.

Hint #2 Perspective

Things appear smaller the farther away from you they are. This phenomenon is called perspective. For example, if you look at a tree that is a few feet away from you and, using the method for establishing relative size from hint #1, compare the size of a tree as observed from a fixed viewing point to a similarly size tree that is farther away, you will see that it appears smaller. The actual relationship of size of distant objects and their placement on the page can be established the same way you drew the proportions of the cat.

Hint #3 Volume

If you are trying to create a sense of volume or fullness of what you are drawing, you need to establish the source of light. Light falling across a form creates a sense of volume or fullness in a three-dimensional object. Volume is established by the relative lightness or darkness of areas of a volumetric surface as is viewed. For example, if you look at light falling on a tree trunk, one side probably will appear darker than the other. The side of the trunk that is in the direction of the light source will appear lighter, and the side of the trunk farther away from the source of light will appear darker. If you squint your eyes when looking at a subject, it helps to establish these relative values of lightness and darkness, because we are not confused by the details. And speaking of details, when you draw the rest of the tree, don't try to draw it a leaf at a time. Again squint your eyes and look at the volume created by the whole bunch of branches and leaves and draw that volume rather than each individual leaf. You can always add detail later if you want to or have the time.

Hint #4 Simplify

As with drawing the leaves of tree, look for the general shapes. Start with the basic proportions and then add detail. If you start with the details first, you will have only a record or inventory of objects. You will not have a convincing drawing.

Hint #5 Practice a lot

Drawing is a discipline that can be learned. The more you do it, the better you get. Like playing ball or learning to play the piano, the more you practice, the better you get.

Hint #6 Have Fun

This is the most important hint. Have fun. You will be surprised at how much "talent" you never knew you had.

1 LESSON

LESSON 1 WHAT IS BIODIVERSITY?

TIME 2 class sessions

MATERIALS

- Chart paper and markers
- Student journals
- OPTIONAL:** An artistic interpretation of a site or of a living thing (such as a poem, painting, photo, song, or dance).

PREPARATION

1. Prepare two charts for recording students' ideas. Label one *Rules for Field Trips* and the other *Explanations of Biodiversity*. Display both of these throughout the unit, so that students can add to them.
2. **OPTIONAL:** Select an artistic interpretation of some natural object(s) to share with the class. You may want to involve other faculty members, such as the English, art, history, language, and math teachers, in the site interpretation activity.

WEB COMPONENTS: STUDENT READING SELECTIONS

Drawing as a Way of Looking at the Natural World

Keeping a Field Journal 1

Keeping a Field Journal 2

OPTIONAL: Profiles of Barrett Klein and Sally Goodman

1. Introduce students to the idea that they will take part in the Biodiversity Counts project. To open the discussion on biodiversity, you might ask:

Questions	Possible Responses
<i>What do all of the following have in common: dogs, mosquitoes, daffodils, seventh graders, plankton, eagles, squid, rice, frogs, elephants, amoebas, and rats?</i>	The common thread is that they are all living organisms. In spite of their remarkable diversity, they all share the characteristics that distinguish living from nonliving things.
<i>List some characteristics of living things.</i>	Living things grow, respond to stimuli, adapt to changes in their environment, reproduce, and carry on respiration.
<i>How do organisms differ?</i>	Students may point out differences in size, shape, color, mobility, body covering, habitat, food, and behavior, among other things.

Ask students to use all this information to come to a simple definition of biodiversity. Have them record what they understand of the concept in their journals.

2. Ask students to discuss the following points:

- Give some examples of the variety of biologically diverse forms of life that exist on Earth.
- Name some of the diverse types of habitats in which life exists.
- How do humans depend on other life-forms? Give some specific examples.
- What are some of the reasons that increasing numbers of species are becoming extinct?
- What are some of the solutions to the problem of biodiversity loss?

Then work together to construct a collaborative explanation of what students understand about biodiversity based on new information in the video. Record this explanation and save it until the end of the section. At that time you will develop another explanation and compare the two.



ASSESSMENT: BASELINES

The individual explanations of biodiversity students recorded in their journals will give you a good sense of each student's baseline knowledge on the topic. You may want to refer to them at the end of the unit as evidence of student progress.

The collaborative explanation may seem simple or naive at this point, but that is to be expected. Let students know that you will return to this explanation often to revise and expand it as they work through the unit.

3. *To bolster students' recording skills and to encourage them to draw what they observe, ask them to read the essays "Drawing as a Way of Looking at the Natural World," "Keeping a Field Journal 1," and "Keeping a Field Journal 2." Discuss the following points:*

In the essay "Drawing as a Way of Looking at the Natural World"

- What are some of the tools that Sally Goodman and Barrett Klein recommend as aids to drawing?
- How do they like to begin making a drawing?
- Explain how you can draw proportions accurately.

In the essays "Keeping a Field Journal 1" and "Keeping a Field Journal 2"

- Give some examples of why Eleanor Sterling thinks it is important to keep field records.
- What basic information does she record for every field session?
- Brian Boom has a system for record keeping in the field and for translating information to a specimen label. Explain his system in your own words. Could you adopt some of his techniques for your field work, or do you have other ideas for a recording system of your own?

4. *Tell students that, over the coming months, they are going to study an outdoor site in great detail, just as scientists do. They will look primarily at arthropods, plants, or both. Explain that they will engage in all the activities that scientists do: observing, collecting, classifying, recording, analyzing data, and communicating their findings with other students. The first visit is to get to know their site. They are free to use any means they like to record their impressions. Ask for their ideas on possible ways to record and express what they experience. Ideas may include drawing, writing a short story or poem, composing a song or a dance, or taking photographs. Ask them to bring in any special equipment they might need for the activity.*
5. *Optional: Share with the class an artistic interpretation of nature such as a painting, photograph, poem, or musical selection.*
6. *Before you go outside for the first time, develop a list of safety rules with the class. Please see Establishing Rules for Field Trips in the Resources area on the Web site for more information.*

2 LESSON



LESSON 2

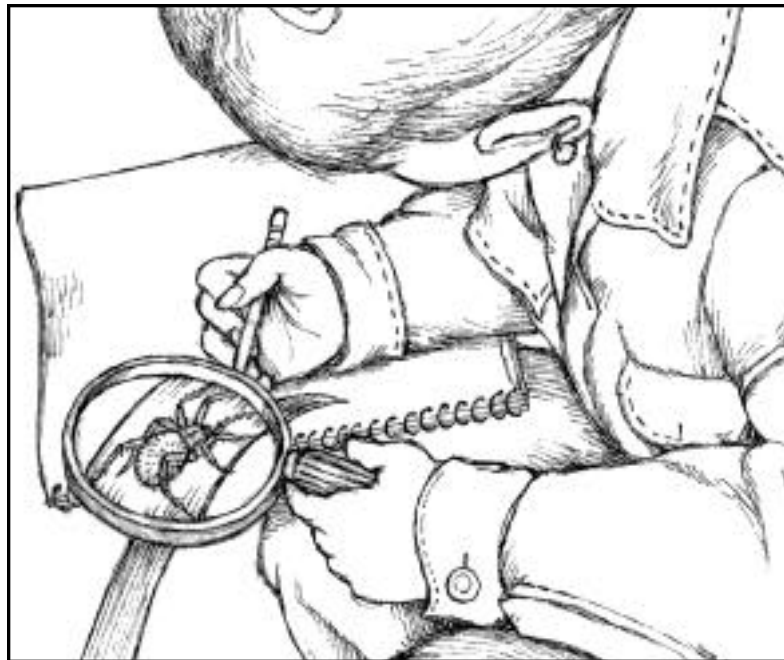
EXPERIENCING THE OUTDOOR SITE

TIME 1 field session

MATERIALS □ A variety of materials for recording student impressions of the outdoor site. These may include art supplies, audiovisual equipment, cameras, and musical instruments.

PREPARATION

1. Discuss the decisions involved in your selection of a site for the outdoor activity.
2. Have students bring in materials for recording their impressions.



1. *In the classroom, ask students to predict what they think they'll see when they visit their site: How many arthropods or plants? How many different kinds?*
2. *Explain to students that they are free to observe, explore, and enjoy the area in as many ways and using as many senses—but never taste—as they safely can.*
3. *Take them to the area that you have selected for the activity. Remind them of their safety rules. Be sure to point out the boundaries of the area and ask students to stay within them. Set a time limit and ask that students report back to you at a specified time. Review the senses that are relatively safe to use—sight, hearing, and smell. They may work individually or in small groups. Then send them off to begin recording their impressions of the living things at the site.*
4. *As students work, circulate among them to observe their approaches to the task. You might use some of these questions to help them keep on task:*

Tasks	Focus Questions
<i>To observe living things at the site</i>	What living things have you observed so far? Have you looked at both plants and animals?
<i>To use more than one sense to make observations</i>	How many different senses have you used to make observations?
<i>To record observations</i>	How are you recording your observations? How would you report them to someone who has not been to the site?

Point out to students that they will be sharing information with other students. Ask them to begin thinking about which of their observations they would want to share with others.

5. *Before you leave the site, have students check that it is in good order and that they have left nothing behind.*

The task and focus questions on the following page can be copied and distributed to students.

TASKS AND FOCUS QUESTIONS

SECTION 1

LESSON 2

FIELD TRIP

EXPERIENCING THE OUTDOOR SITE

<i>Tasks</i>	<i>Focus Questions</i>
<i>To observe living things at the site</i>	What living things have you observed so far? Have you looked at both plants and animals?
<i>To use more than one sense to make observations</i>	How many different senses have you used to make observations?
<i>To record observations</i>	How are you recording your observations? How would you report them to someone who has not been to the site?

3 LESSON

LESSON 3

REPORTING BACK ON SITE EXPERIENCES

TIME

2 or 3 class sessions

MATERIALS

- Student products generated during the field trip

 - For the Optional Mapping Activity:
A blank map of the outdoor site on overhead transparency film, markers, and an overhead projector; or a large sheet of craft paper and markers
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PREPARATION For the Optional Mapping Activity:

On a sheet of transparency film or on a large sheet of paper, draw an outline of the outdoor area students visited.

1. Allow students time to organize their observations and to prepare brief presentations (three to five minutes). Then let them share their impressions of the living things at the outdoor site.

Presentations will vary, so make the point that there are many different ways to look at a place and many ways to record observations of an area. Each type is good for a different purpose, and each type yields different information.

2. Hold a discussion on the difference between evidence and impressions. Use some of these questions to guide the discussion:

- If your task in the field had been to collect facts and evidence about the variety of life-forms you observed, how would your presentations have been different? Students should mention that scientific observations would require collecting and recording data about the site, taking precise measurements, and gathering information that can be replicated.



ASSESSMENT: DEVELOPING CRITERIA FOR SCIENTIFIC OBSERVATIONS

After discussing the differences between impressionistic observations and scientific observations, ask students to list the criteria they think are important for making good scientific observations.

- Do you think your presentations included every living thing at the site? What else might be there? What might be there that you didn't see?

OPTIONAL MAPPING ACTIVITY

ACTIVITY	CREATING A MAP OF THE OUTDOOR SITE
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TIME	1/2 class session
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1. When students have finished their presentations, show a blank map of the area. Ask students to come up to the map and add details based solely on the information they included in their presentations. They may not have included much detailed or factual information in their renderings and so may have little to add to the map. Assure them that this is acceptable for this activity, because it was not part

of what they were originally asked to do, but it will be interesting to find out what they can add. Make it clear that nothing they present is either right or wrong, that all suggestions are valid.

Recognize, too, that students may argue or debate some points. Encourage them to do so. Then ask what evidence they need to collect to settle the debate.

2. After they have filled in the map as best they can, ask:

- Would someone else be able to recognize the area from this map? If not, why not? What is missing?
- How could you gather more factual data about the site?

Note: Label the map Number One and save it to use again in the Optional Mapping Activity in Section 2.



ASSESSMENT: DIGGING DEEPER

TIME 1/2 to 1 class session

In Lesson 1, students recorded their first explanations of what they understand about biodiversity. These explanations are useful as measures of their baseline knowledge.

Then students began to acquire new information through the video, their first experiences in the field, and discussions. Hold a brief discussion as closure. Ask:

- Summarize what you have learned from your first experience outdoors in the field.
- Look at the explanation of biodiversity you recorded in Lesson 1. How have your ideas about biodiversity grown or changed because of your experiences in Section 1? How would you explain biodiversity now?
- Work together to develop a collaborative explanation of biodiversity and record it on a class chart.



TEACHING TIP: CONCEPT WEB

One way to track the development of students' understanding of biodiversity is to keep a running record of their explanations. You may keep them in a list form, or construct a concept web or mind map to which students can add information as new ideas develop. Webs and maps have the advantage of laying out students' thinking in a visual format.