Activity 2
Biodiversity

Objectives: Students will be introduced to biodiversity concepts, why it is important, and how it is measured as well as participate in a random sampling exercise to determine the biodiversity index of three local habitats.

Terminology: Adaptation, analyze, biodiversity, black water creek, classification, community, data, ecologist, ecosystem, electro shocking, habitat, habitat management, hypothesis, independent variable, inference, invertebrates, land forms, observation, pine plantation, population, prediction, random sampling, sample, sampling, sandhills, species, stream corridor, Upper Coastal Plain, watershed.

Grade Level: 4-7th

Ideal Class Size: 24 students divided into six groups of four

Subject Areas: Life Science, Earth Science, Inquiry Skills, and Math-Algebra-S1

Time
1 hour introduction and presentation
1 hour hands on biodiversity activity

Materials
PowerPoint presentation
Flip chart or writing board
Eraseable colored markers
Pencils
Clipboards
Blindfolds 12-18 (1 per pair)
Calculators 12-18 (1 per pair)
Labeled habitat population bags containing "species" cards (3 each)

- Pine Plantation
- Sandhills
- Upper Three Runs Creek – each with 1,000 plant cards and 500 animal cards

Plastic cups or trays, small (1/pair of students)
Color photo booklets of plants and animals from each habitat (3 each)
Various examples of sampling equipment, including:

- Hula hoop
- Seine
- Snare
- Minnow trap
- DBH tape
- Prism
- Line and pole (plant sampling)
- Compass
- PVC frame/quadrat
- Tree corer and core

Posters:

- SAFE Rules
- Methods of Science
- Data Sheet for Biodiversity Sampling (large laminated version)
- Upper Three Runs Creek Ecosystem
- Sandhills Ecosystem
- Pine Plantation Ecosystem
- Biodiversity Indexes of three Coastal Plain Habitats (laminated graph)
- Pie Chart Examples

Copies:

- Data Sheet for Biodiversity Sampling (1/student)
- Biodiversity Definitions (1/student)
- Follow-up Questions (1/student + teacher's version)
- Pie Chart Examples (1/student)
- Biodiversity Word Search Puzzle (1/student)

Mini Species Posters:

I am a Gopher Tortoise
I am a Pine Snake
I am a Longleaf Pine tree
I am a Persimmon tree
I am a Gar
I am a Dwarf Waterdog
I am Switchcane
I am Spanish Moss
I am a Ground Skink
I am a Centipede
I am Wax Myrtle
I am a Dogwood

Advanced Preparation

Wash and fold 12-18 bandana blind folds prior to each class.

To prepare the Habitat Population Bags you will need to label 18 large brown paper grocery bags, three of each, as follows: Pine Plantation – Plants, Pine Plantation – Animals, Sandhills – Plants, Sandhills – Animals, Upper Three Runs Creek – Plants, Upper Three Runs Creek – Animals. Photo examples of each habitat type can be pasted to individual bags.

The composition of each habitat includes common and rare plants (1,000 individuals) and animals (500 individuals) that could be encountered in Aiken County, SC. Individual plants and animal species are designated by letters of the alphabet (plants) or by numbers (animals) copied onto card stock, using a different color paper for each habitat. Numbered/lettered 1" squares are then cut up and put into large paper grocery bags labeled with the habitat and the type of organisms to be sampled (plants/animals). Three sets of plant and animal species bags should be prepared for each of the three habitats to be sampled. (See Appendix 1 for specific composition of each habitat)

Before class copy the "Task List Objectives," included at the end of this lesson plan, on to a classroom writing board or flip chart. This will help you complete all the steps in the scheduled amount of time.

Safety Notes: Remind students of the SAFE Rules

Background Information

In the United States most land can be categorized or classified as desert, prairie, mountains, forest or wetlands. These ecosystems are used by humans for agriculture, recreation, government, residences, and commercial use.

Ecologists have developed methods to monitor the health of an environment by measuring its biodiversity. Biodiversity is a measurement of the number of different species of plants and animals that live in a particular habitat. It is believed that the more varied the species that exist in an area, the healthier the ecosystem and visa versa; the fewer the number of different species that exist in a certain ecosystem the more fragile the habitat.

Many different non-biased, random sampling techniques and tools exist to estimate numbers of plant and animal species living in an ecosystem. Once data are collected a biodiversity index can be calculated that helps ecologists confirm the relative health of a habitat. A biodiversity index that is low indicates that there is a small diversity of plants or animals living in a particular ecosystem. A high biodiversity index is usually a sign that an ecosystem is teaming with a wide variety of animal and plant life and that the environment itself, such as soil, water and air, are relatively clean and healthy. One local stream habitat in the Upper Coastal Plain of South Carolina--Upper Three Runs Creek (UTR)--is a black water stream corridor that has been found to have the highest biodiversity of aquatic macroinvertebrates of any stream system in the world. The Upper Coastal Plain also boasts a large number of pine plantations where monocultures of loblolly pine trees are grown for the timber and paper industry. It has been the job of scientists to determine whether or not pine plantations have a high biodiversity index or a low biodiversity index.

Another important factor in the study of biodiversity is the presence of "keystone species." Keystone species are plants or animals that have been found to create a mini ecosystem within a larger habitat. For example, there are regions within the Upper Coastal Plain called sandhills habitats that don't seem to exhibit a lot of biodiversity. On first glance an observer might only notice barren areas of scraggly pine trees, low shrubs, and sandy soils that don't retain moisture and are hot and dry. It doesn't seem like the best place to live, but on closer inspection one finds a very unique keystone species--the Gopher Tortoise--living there. Gopher tortoises are well adapted to living in upland sandhills habitats and their presence makes it possible for upwards of 350 other species to live in this same environment. Gopher tortoises dig deep, long burrows in the sand reaching up to 10 meters in length and 2 to 3 meters deep in which they live, lay eggs, and hide from the hot sun. Hundreds of other species also take advantage of this burrow environment and have adapted to living side by side with the gopher tortoises, including insects, spiders, snakes, lizards, and small mammals. It becomes quickly apparent that the existence of the gopher tortoise plays a huge role in the biodiversity of the sandhills habitat.

This biodiversity activity will provide students with an opportunity to study all three of the local habitats mentioned above as well as teach them how to measure biodiversity indexes, and provide them with a better understanding of the impact human activity has on the health of local environments.

Activity 2: Biodiversity
Task List Objectives

LECTURE AND DEMONSTRATIONS (1 hour)

I. Introduction (10 minutes)
- A. Today's Topic - Biodiversity
- B. Today's Task List: to help keep us on task
- C. Review SAFE Rules
- D. Review the Methods of Science

II. PowerPoint Presentation: Biodiversity (15 minutes)

III. Lecture and Demonstrations (35 minutes)
- A. Introduction
- B. Predicting high or low biodiversity (15 minutes)
  1. Sandhills ecosystem
  2. Pine plantation ecosystem
  3. Upper Three Runs Creek ecosystem
- C. Random sampling, probability and collection techniques (20 minutes)
- D. Recording data
- E. Calculating the Biodiversity Index and proving your predictions

BIODIVERSITY ACTIVITY (1 hour)

I. Sampling for Biodiversity (25 minutes)
- A. Preparing for the activity (5 minutes)
- B. Biodiversity sampling (20 minutes)

II. Science Seminar (20 minutes)
- A. Graphing data
- B. Interpreting data
- C. Completing the lesson
- D. Reading species cards

III. Closure (15 minutes)
- A. Wrap up questions
- B. Biodiversity Rap
- C. Follow-up activities

LECTURE AND DEMONSTRATIONS (1 hour)

I. Introduction (10 minutes)

A. Today's Topic: Biodiversity - what it is and why we need to know about it.

We'll highlight the biodiversity research of two SREL scientists, Tracey Tuberville who is a herpetologist and Dean Fletcher who is an ichthyologist. Do any of you know what a herpetologist does? How about an ichthyologist? Today you'll have a chance to help us sample the biodiversity of three local habitats. And if we get everything done on time today we'll teach you the Biodiversity Rap!

B. Today's Task List: *[Remind students that we will follow a task list to help us keep on track.]*

C. Review SAFE Rules

D. Review the Methods of Science

What does it mean to be a Junior Scientist? Who remembers what we did last time we were here? *[Relate each step of the Methods of Science to an activity we did during our last visit. Example: "How did we wonder and observe during our last class?" "What were some of the questions we asked?" Show the students some of the folded planes/helicopters from the last class to help jog their memories. Ask if any of them made more planes/copters and conducted their own experiments at home.]*

II. Power Point Presentation (15 minutes): Biodiversity and SREL scientists

III. Lecture and Demonstrations (35 minutes)

A. Introduction

Today we are going to do an activity to simulate how ecologists measure biodiversity. We want you to be able to predict which habitat might have the highest and lowest biodiversity, learn how to randomly sample for plant and animal species, use the right tools to sample for those species, know how to collect and record data, and then be able to convert all that information into a biodiversity index that will tell you if your initial predictions were correct.

B. Predicting High or Low Biodiversity (15 minutes)

As scientists we are always thinking about the Methods of Science to help keep us organized and today's activity is no different. We've come to you today with a question: Which habitat has the highest biodiversity? But is "questioning" the first step in the Methods of Science? Let's review: observe, wonder, question, hypothesis, predict, data, variables, independent variables, dependent variables, design experiments, controls, repeated trials, observations, analysis, conclusions, and further questions.

We've skipped a few steps, like "observing" and "wondering," and would like you to form a "hypothesis" or make a "prediction" as to which habitat has the highest biodiversity. But first we need to give you some basic information about the different habitats before you can make any predictions at all! Remember, an hypothesis isn't just guessing, it is an "educated guess" based on things that you have "observed" and "wondered" about.

1. Sandhills Ecosystem

Sandhills habitats are habitats that have grown up on hills of sand. *[show the Sandhills Ecosystem poster.]* They are characterized by rolling hills capped by deep coarse sands.

They are wedged between the Coastal Plain and Piedmont regions of North and South Carolina. Here is a poster of the Sandhills Ecosystem – just like the slide you saw earlier. If there were no plants growing here it would look like the beach! As a matter of fact, sandhills are actually ancient sand dunes left behind when the ocean used to be much farther inland than it is today. The beach used to be right here instead of a three hour drive east to the Atlantic Coast. Do any of you have tons of sand in your front yard?

Because sandhills contain dry, nutrient-poor soil made mostly of sand, this habitat contains only hearty, well-adapted plants. Longleaf pine trees and turkey oaks are the most common plant species in these habitats and their root systems have adapted to allow them to extract water from various soil depths. Sandhills plant species are also adapted to survive frequent fires that are caused by lightning strikes. You know how many thunder storms we get here don't you! Longleaf pines have a thick, fire-resistant bark, and turkey oaks killed by fire will re-sprout because the fire does not damage their root systems. Because of all the frequent fires there are not a lot of shrubs or hardwood trees associated with the longleaf forests. They never get a chance to start growing, but there are plenty of grass species that live in the sandhills that even flower better after fires. Examples include wiregrass, which is a keystone plant species, sorghastrum, broomsedge and three-awn grass.

Speaking about keystone species, who remembers the name of the animal we talked about during the slide presentation that we called a key stone species? Yes. The gopher tortoise. Take a look at this poster and tell me some names of the other types of animals that we might find living in a gopher tortoise burrow.

One last fact about Sandhills habitats is that it is estimated that before the 1600's there used to be 90 million acres of longleaf pine forests in the Southeast that extended north to Virginia and south into Texas. Over the past 500 years these forests have been reduced to about 3 million acres total. Who has some ideas as to where all those trees might have gone? *[Longleaf pine timber is very rot resistant and was used to make ships during the 1600's by the navy. Pine sap or "tar" was used to preserve ropes and to make caulking. Forests were cut down to build farms, towns and cities. Today much of the native longleaf pine forest system has been replaced by pine plantations for the timber and paper industry. Because longleaf pine forests had adapted to irregular but frequent burn cycles, when burning was prevented, non-native species of trees and shrubs began to creep in and take over the native forests.]* It is important that ecologists study the biodiversity of the sandhills habitats and how we can live in balance with these fragile habitats.

2. Pine Plantation Ecosystem

Now let's take a look at a pine plantation ecosystem *[show the pine plantation ecosystem poster]*. How does a pine plantation look different from a sandhills forest? Lots and lots of one kind of tree, not much light, no small grasses, flat ground with lots of pine needles on it.

Pine plantations are considered "managed forests." They are big pine tree farms, where the crop is the loblolly pine tree. Loblolly pines grow fast and straight and are planted and harvested at regular time intervals. They are used in the timber industry to make wood for building things like houses and furniture, and for pulpwood that goes into making all the paper we use to write on and cardboard boxes that hold our cereal and video games. Pine

plantations are pretty important places. They help us save our natural forested lands by not having to cut down trees like the longleaf pines in the sandhills.

Let's look at our picture again for a minute. If you were a rabbit would you find it easy to live here? Probably not. There is no place to hide and it doesn't look like there is much food here to eat either. In the early days of pine plantation farming ecologists worried that biodiversity would decrease in a field of pine trees where the close-growing tall trees blocked out all the sunlight and where there were no bushes or grasses for shelter or food for forest animals. So they suggested that pine tree farmers space out the trees more, plant some different species of trees, and shrubs and grasses with the pine trees and observe what would happen. Do you think the biodiversity increased? You'll get to find out the answer to that question in just a minute. We have one more habitat to introduce you to before you can make any predictions about biodiversity.

3. Upper Three Runs Creek Ecosystem

Upper Three Runs Creek is a 20-mile waterway that meanders through hardwood and cypress forests southeast of Aiken and extends into the Savannah River Site *[show the Upper Three Runs Creek ecosystem poster]*. The creek is a black water stream. High concentrations of naturally occurring tannic acid cause the water to look like tea. Scientists, like Dean Fletcher, have been studying Upper Three Runs Creek and found that it is cool and clean and makes a great home for lots of plants and animal species. Just how many? Let's find out!

C. Random Sampling, Probability and Collection Techniques (20 minutes)

1. Random Sampling and Probability (10 minutes)

Now that you know something about each of the habitats we'll be sampling today you can make your own prediction about which habitat has the highest biodiversity. Once you've made your prediction you need a way to see if your prediction is correct.

What do we need to do next? Collect some data. How are we going to do that? We have to design an experiment and choose the right tools for the job. If I want to see how many plant species live in the sandhills habitat, would I stick an electro-shocker in the ground and count how many grasses and trees shrivel up? No way.

If I were a botanist, I might take a hula-hoop and place it on the ground where there are a lot of plants growing and identify and count all of them inside of the hula-hoop's circumference. That might tell me a lot about the number and kind of plants growing inside of the hoop-hoop, but would it give me a clear picture of all the plant species growing in the Sandhills? I would have to figure out how many hula hoops would fit inside the entire forest and ten calculate how many plants must be there. If there were 10 plants inside the hula hoop and I knew that 500 hula hoops would fit on the forest floor side-by-side than there must be 5,000 plants in the forest. Just multiply 10 by 500 and you get 5,000!

But wait a minute, what about the bare area over there and over there? They looked boring to me and I just didn't want to think about those spaces. What is the "probability" that I will calculated a good estimate of the number and variety of plant species that grow in the sandhills habitats by the method I just used? I probably calculated an inaccurate answer by

just putting the hula hoop where ever I wanted and only doing it one time. *[Demonstrate this sampling technique by placing the hula hoop on the floor and discussing the information above.]*

From just one sample, I might be fooled into thinking--or be biased--that all of the sandhills are covered in grasses, and mosses, vines, and shrubs. Is there another way to estimate how many and what kind of plant species are in the sandhills habitat without having to spend an entire lifetime counting and identifying every single plant in the entire sandhills habitat? Yes! It's called "random sampling!"

When scientists use random sampling techniques they don't get to "choose" where they put the hula hoop down. They have to close their eyes and randomly toss the hula hoop out and then count the number and kinds of plants inside of its circumference. *[Demonstrate by gently tossing the hula hoop out into the classroom trying to encircle a few students in the process. Then collect the hula hoop and toss it several more times.]* Scientists do this lots of times because they like to do "repeated trials" so they get a true, unbiased estimate of how many and what kind of plant species actually live in an ecosystem. Random sampling helps scientists stay objective and gather useful data.

2. Collection Techniques (10 minutes)

Let's look at some more sampling and collection tools that scientists like Dean Fletcher and Tracey Tuberville use in their work: seine nets, snares, minnow traps, DBH tape, prism *[measures basil area or density of trees]*,line & pole *[plant sampling analogues to the hula hoop method]*, compass, PVC frame/quadrat *[analogues to the hula hoop method]*, tree corer and core. *[This part of the demonstration must be improvised based on the equipment at hand and the amount of time available.]*

D. Recording Data

Now that we've shown you some sampling methods, take a quick look at the data sheet that you' use to record your data. We'll explain more about how to use it in a minute.

E. Calculating the Biodiversity Index and Proving Your Predictions

Lastly you'll take the data you collected and covert it into a Biodiversity Index. The Biodiversity Index is a number that can be graphed and compared to the Biodiversity Indexes of other habitats to help answer the question, "Which habitat has the highest biodiversity?"

BIODIVERSITY ACTIVITY (1 hour)

I. Sampling for Biodiversity (25 minutes)

A. Preparing for the Activity (5 minutes)

Divide students into groups of four to conduct their own biodiversity sampling activity for one of the three habitat types: pine plantation, sandhills or a black water stream corridor. Within each group of four, one pair of students will sample the plant species of their assigned habitat type and the other pair will sample the animal species.

B. Biodiversity Sampling (20 minutes)

Follow the directions on the student data sheets for biodiversity sampling of the three representative SE habitats.

For each sampling trial, the **SAMPLER** will shake up the habitat bag and, without looking, draw a species card and hand it to the **DATA RECORDER**. At this point the sampled card can be matched up with the plant or animal listed on the "Habitat Species Key" to determine what species was just sampled. The **DATA RECORDER** should write the number (indicating plant species) or letter (indicating animal species) onto the first line provided for Trial # 1 on the data sheet. Then place the species card in the plastic cup--not back in the bag.

The sampling and recording will continue *rapidly* until 20 species have been drawn from the bag. Point out that the species letter or number must be recorded in the exact order that they are drawn from the bag. Return all 20 species cards to the sampling bag and move on to Trial #2. Calculations will be completed on these letters and numbers after all **six** trials are complete.

STEP 3: DATA ANALYSIS

Some students will complete the data collection portion of this activity very quickly. Instruct those students to count the total number of individual plant or animal species they sampled for all six trials and to record the numbers on the "Habitat Species Key" in the Total Sampled column. The totals are obtained by counting all of the A's, then all of the B's, and so on until all the species from all six trials are tallied.

Compute the Biodiversity Index by performing the calculations on the data sheet.

II. Science Seminar (25 minutes)

A. Graphing Data (5 minutes)

When students have calculated the Biodiversity Index for plants or animals in their assigned habitats, go around the room and have one member of each pair call out their results. Record the numbers on the large laminated graph titled, "Biodiversity Indexes of Three Coastal Plain Habitats."

Spend a few minutes discussing the bar graph and introduce the students to the pie chart examples. Explain that a pie chart represents 100% of all the species in a bag and that the smaller shaded areas represent the smaller populations of species that, when added together, make up the whole. They will have the opportunity to create their own pie chart using their own data during a follow-up exercise.

B. Interpreting Data (10 minutes)

Once the data for the entire class have been collected, have the students spend a few minutes answering questions on the back of their "Data Sheet for Biodiversity Sampling." Encourage them to use the graphs and charts on the board, as well as their "Habitat Species Key" to find the answers to their questions. If they cannot finish during class time encourage them to complete the assignment at a later date. There teacher will be provided with copies of the graphs and charts for them to use in class.

C. Completing the Lesson (10 minutes)

At this time call upon each pair of junior scientists to stand up in front of class and read from the Mini Species Posters about one of the plants or animals that live in the habitat that they sampled during the activity. This gives the other students an opportunity to hear about species in habitats that they might not have sampled. One member of the team can hold the posters while the other member reads out loud from the poster.

III. Closure (10 minutes)

A. Wrap-up questions

Take a minute to answer questions the students may have come up with during the activity and to assess their comprehension of the material covered.

B. Biodiversity Rap

YES!!! It's time to play – and sing – and dance – and learn the Biodiversity Rap. And you thought science and scientists were boring!

Have all the students stand up and read through the Rap one time out loud. Then call on students who like to rap to come up front and hand out some "rap" props like sunglasses and some cool hats or bandanas. Make sure the kids know that these props will be collected after class. Put the Rap Sound Track on and Rap away!

Appendix 1: Habitat Composition for Biodiversity Activity

Pine Plantation			Sandhills			Upper Three Runs Creek		
designation	***organism***	***actual population***	***designation***	***organism***	***actual population***	***designation***	***organism***	***actual population***
A	loblolly pine	690	A	turkey oak	250	A	switch cane	80
B	bluestem grass	20	B	longleaf pine	250	B	red maple	200
C	blackberry	70	C	poison oak (clumps)	40	C	aquatic grass (clumps)	80
D	muscadine	40	D	needle grass	30	D	alder	120
E	wax myrtle	60	E	hawthorne	100	E	wax myrtle	100
F	sweetgum	30	F	prickly pear cactus	60	F	birch	100
G	dogwood	20	G	yucca	40	G	sweetgum	100
H	goldenrod	15	H	nettle	40	H	greenbriar	50
I	bracken fern	25	I	sassafras	80	I	mushroom	50
J	reindeer moss (lichen)	20	J	reindeer moss (lichen)	50	J	chain fern	50
K	turkey oak	5	K	persimmon	30	K	poison ivy	40
L	black gum	5	L	gopher weed	30	L	Spanish moss	30
Total plants		**1,000**	**Total plants**		**1,000**	**Total plants**		**1,000**
1	oak toad	5	1	southern toad	30	1	gar	3
2	southern toad	15	2	spadefoot toad	65	2	darter	25
3	narrowmouth toad	100	3	pine snake	3	3	redbreast sunfish	20
4	red-bellied snake	5	4	so. hognose snake	3	4	southern toad	25
5	scarlet snake	4	5	gopher tortoise	5	5	dwarf waterdog	20
6	scarlet kingsnake	3	6	box turtle	2	6	leopard frog	10
7	black racer	5	7	racerunner	40	7	brown water snake	5
8	copperhead	2	8	glass lizard	5	8	queen snake	3
9	fence lizard	15	9	broadheaded skink	7	9	box turtle	4
10	ground skink	100	10	ground skink	15	10	softshell turtle	5
11	cotton mouse	6	11	armadillo	3	11	green anole	20
12	star-nosed mole	10	12	cotton rat	7	12	river otter	5
13	turkey	10	13	scorpion	20	13	moth catepillar	25
14	beetle	10	14	grasshopper	60	14	crayfish	80
15	millipede	10	15	ant mounds	30	15	water striders	70
16	lynx spider	30	16	wolf spider	40	16	damselflies	50
17	fritillary	10	17	red centipede	70	17	caddisflies	40
18	cricket	100	18	crickets	90	18	diving beetles	60
19	brown centipede	60	19	beetle	5	19	orb weaver spider	30
Total animals		**500**	**Total animals**		**500**	**Total animals**		**500**