TERRESTRIAL INVERTEBRATES

THEME: Effects of Air Pollution on Terrestrial Invertebrates
BEST TIME TO PLAN TRIP: Fall or Spring

UNIT RATIONALE

All plants and animals are important to the ecosystem. Although often overlooked, terrestrial invertebrates are as important to the ecosystem as the large vertebrates are. The functional responses of terrestrial invertebrates to soil pH, soil temperature, and air temperature provide a complete assessment of the ecosystem model. During this study students will be assisting in monitoring the population of terrestrial invertebrates in a predetermined area. Students will be studying the species richness (the number of different species in a given area), diversity (the number of species in an area and also their relative abundance), species evenness (a measure of how evenly members of a sample are distributed across the species), and density (measurement of population per unit area).

NORTH CAROLINA CURRICULUM CORRELATIONS

NORTH CAROLINA EARTH/ENVIRONMENTAL SCIENCE ESSENTIAL STANDARDS

Essential Standard EEn.2.2 **Understand how human influences impact the lithosphere**
    EEn 2.2.1   Explain the consequences of human activities on the lithosphere past and present.
Essential Standard EEn.2.5 **Understand the structure of and processes within our atmosphere**
    EEn 2.5.5   Explain how human activities affect air quality
Essential Standard EEn.2.7 **Explain how the lithosphere, hydrosphere, and atmosphere individually and collectively affect the biosphere.**
    EEn 2.7.1   Explain how abiotic and biotic factors interact to create the various biomes in North Carolina
    EEn 2.7.2   Explain why biodiversity is important to the biosphere.
    EEn 2.7.3   Explain how human activities impact the biosphere.

NORTH CAROLINA BIOLOGY ESSENTIAL STANDARDS

Essential Standards Bio.2.1 **Analyze the interdependence of living organisms within their environments**
    Bio.2.1.1   Analyze the flow of energy and cycling of matter (such as water, carbon, nitrogen and oxygen) through ecosystems relating the significance of each to maintaining the health and sustainability of an ecosystem)
    Bio.2.1.2   Analyze the survival and reproductive success of organisms in terms of behavioral, structural, and reproductive adaptations.
    Bio.2.1.3   Explain various ways organisms interact with each other (including predation, competition, parasitism, mutualism) and with their environments resulting in stability within ecosystems.
    Bio.2.1.4   Explain why ecosystems can be relatively stable over hundreds or thousands of years, even through populations may fluctuate (emphasizing availability of food, availability of shelter, number of predators and disease).
Essential Standards Bio.2.2 **Understand the impact of human activities on the environment (one generation affects the next).**
    Bio.2.2.1   Infer how human activities may impact the environment.
    Bio.2.2.2   Explain how the use, protection and conservation of natural resources by humans impact the environment from one generation to the next.

AP BIOLOGY GOALS AND OBJECTIVES

Competency Goal 1: The learner will develop abilities necessary to do and understand scientific inquiry.

1.01 The learner will identify questions and problems that can be answered through scientific investigations.

1.02 The learner will conduct scientific investigations to answer questions about the physical world.

1.03 The learner will formulate and revise scientific explanations and models using logic and evidence.

1.04 The learner will apply safety procedures in the laboratory and in field studies.

Competency Goal 6: The learner will develop an understanding of the unity and diversity of life.

6.02 The learner will survey the diversity of life.

6.03 The learner will analyze and apply current phylogenetic classification.

6.04 The learner will analyze evolutionary relationships.

6.05 The learner will examine the structure and function of plants and animals.

Competency Goal 7: The learner will develop an understanding of basic ecological principles.

7.01 The learner will analyze population dynamics.

AP EARTH AND ENVIRONMENTAL SCIENCE (APES) GOALS AND OBJECTIVES

Competency Goal 1: The learner will develop abilities necessary to do and understand scientific inquiry.

1.01 The learner will identify questions and problems in the earth and environmental sciences that can be answered through scientific investigations.

1.02 The learner will conduct scientific investigations to answer questions related to earth and environmental science.

1.03 The learner will formulate and revise scientific explanations and models using logic and evidence.

1.04 The learner will apply safety procedures in the laboratory and in field studies.

Competency Goal 2: The learner will build an understanding of the interdependence of Earth's systems.

2.05 The learner will investigate the biosphere.

Competency Goal 5: The learner will build an understanding of air, water and soil quality.

5.01 The learner will analyze the sources of major pollutants.

Competency Goal 6: The learner will build an understanding of global changes and their consequences.

6.01 The learner will investigate human effects and consequences on the atmosphere.

TABLE OF CONTENTS

Activity   Page

PLANNING A SUCCESSFUL TRIP

SCHEDULE FOR A DAY OF ACTIVITIES IN GREAT SMOKY MOUNTAINS NATIONAL PARK AT PURCHASE KNOB

- Meet park ranger at Purchase Knob
- Use restrooms
- Large group introduction
- Break into two groups
- Participate in activities
- Lunch
- Switch groups
- Large group conclusion

- Check the weather before you go. Lunch will be eaten outside.

- School buses can park at the program site.

- The pre-visit activities included in this packet are specific to the theme of your program and should be presented prior to your scheduled visit. The post-visit activities are designed to reinforce and build upon the park experience.

- A map to the Appalachian Highlands Science Learning Center Purchase Knob can be found on page 7

- All students, teachers, and chaperones will meet the park rangers at the Appalachian Highlands Science Learning Center at Purchase Knob.

- The maximum number of students for this trip is 60. We require an adult or teacher for every ten students to create a positive and rewarding experience. The on-site instruction is conducted by a park ranger. However, your assistance is needed with discussion and discipline. Please feel free to contact the Park at (828) 926-6251 if you have any further questions.

•Dressing for the Weather
Please remind your students to wear appropriate footwear and clothing for an extended outdoor program. Short pants, flip flops, or sandals are not recommended. Temperatures in the mountains can be 10-15 degrees colder than at your school. You may wish to alter portions of the program should inclement weather appear.

•Restrooms and Water
Restrooms and water fountains will be available at the program site.

•Lunch
Lunches will be eaten picnic style on the grounds of the Learning Center. Lunches should be put in a box for storage and kept on the bus until needed. Lunches, snacks, and drinks should be provided by the students. There are no concessions at Purchase Knob.

•Safety
Purchase Knob is a remote location, far from any medical facilities. Students will spend most of their time away from buildings, so please bring a cellular phone. Notify the park ranger of any special concerns or medical conditions including students with allergies, asthma or other medical conditions.

•Cancellation
Should anything unforeseen occur preventing you from keeping your appointment, please contact the park at (828) 926-6251 to notify us of your late arrival or cancellation.

BACKGROUND INFORMATION

Park Description:

The National Park Service is charged with the management and preservation of the nation's most precious natural and cultural resources. These resources are woven into our natural heritage, and they provide opportunities for recreation, appreciation of beauty, historical reflection, cultural enrichment, and education.

Great Smoky Mountains National Park is one of the largest protected land areas east of the Rocky Mountains. With over 500,000 acres (800 square miles) of forest, the Smokies contain an enormous variety of plants and animals. In terms of biological diversity, a walk from a mountain's foot to its peak is comparable to the 2,000 mile hike on the Appalachian Trail from Georgia to Maine.

Because the National Park Service is charged with protecting resources and natural systems, the park engages in comprehensive research programs, such as air quality monitoring, to foster an understanding of park resources and to show how they are affected by local, regional, and global influences. Since the Smokies are so biologically diverse, the park is designated as an International Biosphere Reserve by the United Nations. The international system contains over 320 reserves in over 80 countries with the primary objectives of conserving genetic diversity and coordinating environmental education, research, and monitoring.
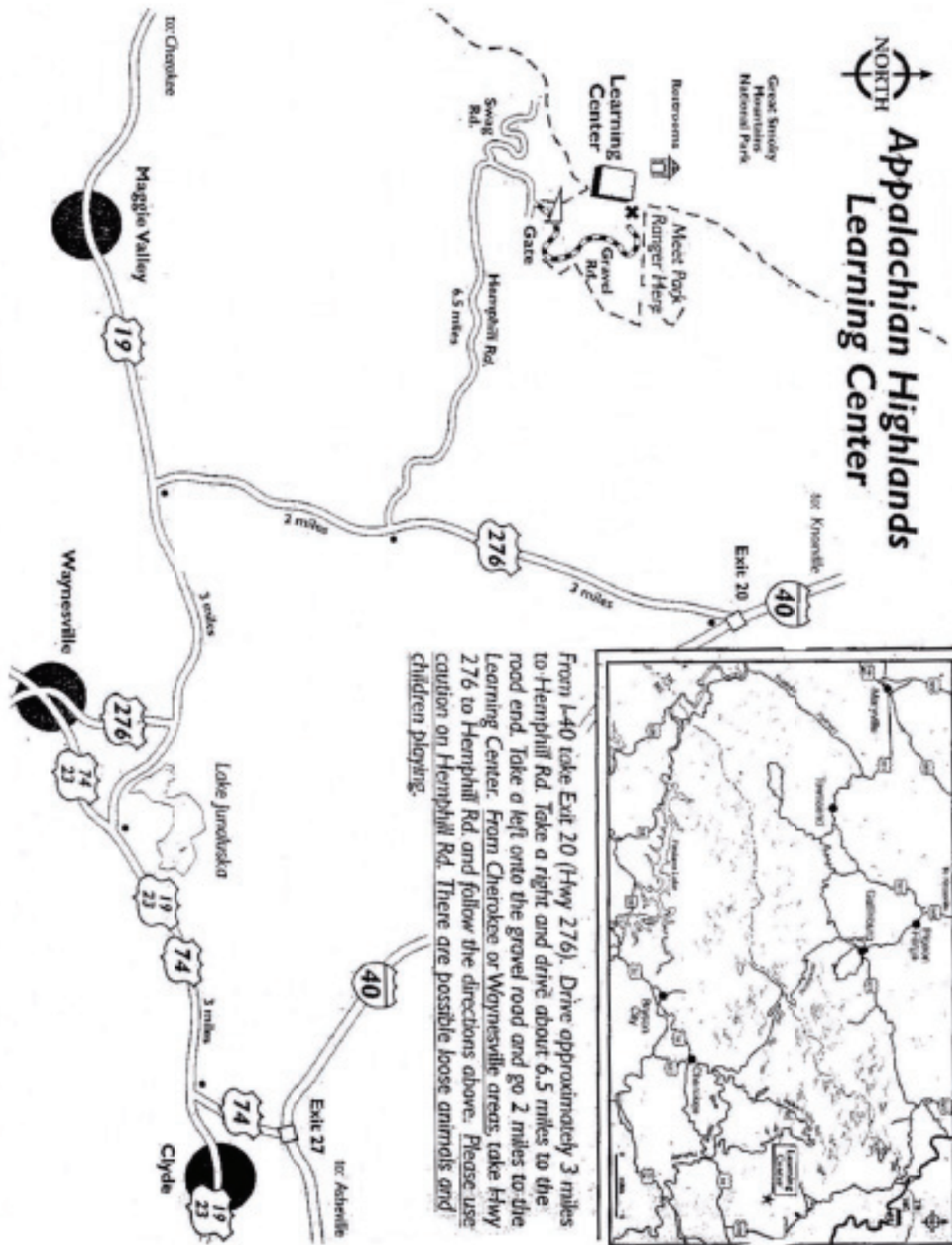
The Smokies also have a rich cultural history. Native Americans have lived in this area for thousands of years, and permanent white settlement began around 1800. The coming of commercial logging around 1900 stripped trees from two-thirds of what is now park land. Established in 1934, the park was created from more than 6,000 tracts of private and commercial land that was bought mostly with money raised and privately donated. Centrally located within a two-day's drive for half of the nation's population, Great Smoky Mountains National Park has the highest visitation of all the national parks in the country.
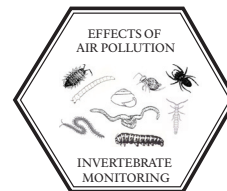
Purchase Knob Description:

The Purchase Knob property, over 530 acres in size, was donated to Great Smoky Mountains National Park by Katherine McNeil and Voit Gilmore in January 2001. Situated at an elevation of over 5,000 feet, the area contains old-growth forests, mountain meadows and high elevation wetlands. It also rests on geological formations that aren't found anywhere else in the park, lending to a unique and diverse habitat for the study of plants and animals. The house is the location of the Appalachian Highlands Science Learning Center, whose mission is to provide a space for researchers to perform biological inventory and monitoring while offering education programs for students and teachers on these same subjects.

Appalachian Highlands
Learning Center

NORTH

Great Smoky Mountains National Park

Restrooms

Learning Center

Meet Park
Ranger Here

Swag Rd.

Gate

Gravel Rd.

Hemphill Rd.

6.5 miles

to Cherokee

Maggie Valley

19

to Knoxville

276

Exit 20

2 miles

2 miles

40

3 miles

Waynesville

Lake Junaluska

276

74
23

19
23

74

40

3 miles

74

Exit 27

Clyde

19
23

to Asheville

From I-40 take Exit 20 (Hwy 276). Drive approximately 3 miles to Hemphill Rd. Take a right and drive about 6.5 miles to the road end. Take a left onto the gravel road and go 2 miles to the Learning Center. From Cherokee or Waynesville areas, take Hwy 276 to Hemphill Rd. and follow the directions above. Please use caution on Hemphill Rd. There are possible loose animals and children playing.

Pre-Site Activity: Biodiversity

Grade Level: High School

Subject Area: Science

Activity time: 45 minutes

Setting: Classroom

Skills: Analyzing, Listening, Listing, Organizing

Vocabulary:

•**All Taxa Biodiversity Inventory:** also called the ATBI. A research project in Great Smoky Mountains National Park and other national parks to inventory every life form in the park. It is estimated that we currently know only 14,000 of an estimated 100,000 species.

•**Aspirator:** a piece of scientific equipment that uses suction to collect specimens that are too small to be picked up by hands or with tweezers.

•**Baseline Information:** information about how things are now, at this point in time, so we will know if there is a change the next time we look at them.

•**Biodiversity:** the variety, distribution and abundance of life forms and ecological processes in an ecosystem; includes the ways in which different life forms interact.

•**Biological Inventory:** a technique scientists use to study the various life forms in a given area. In Great Smoky Mountains National Park, inventories are done in study plots.

•**Biological Monitoring:** a technique scientists use to check the condition of a particular species or ecosystem over time.

•**Canopy:** the top layer of the forest; the treetops.

•**Community:** all populations of species existing in the same area.

•**Density:** the number of individuals of a given species within a certain area.

•**Diversity:** the number of species in an area and also their relative abundance.

•**Dichotomous Key:** an identification method that narrows down a species in question using a series of pairs of choices.

•**Ecosystem:** a system formed by the interaction of groups of organisms with each other and their environment.

•**Evenness:** a measure of how evenly members of a sample are distributed across the species.

•**Humus:** the part of the soil profile that is composed of decomposed organic matter from dead and decaying plants and animals. Also called the duff layer.

•**Hypothesis:** a proposition based on assumptions that can be evaluated scientifically.

•**Invertebrate:** an animal, such as an insect that does not have a backbone.

•**Lithosphere:** the outer layer of soil and rock on the planet, named after the Greek word "lithos", which means stone.

•**Litter:** the covering over soil in a forest made up of leaves, needles, twigs, branches, stems, and fruits from the surrounding trees.

•**Macroinvertebrate:** an animal that lacks a backbone, and that is large enough to be seen without a microscope.

•**Population:** all organisms of the same species living in the same area.

•**Richness:** the number of different species in a given area.

•**Sample:** a count of a random selection of individuals from the larger community.

•**Taxonomy:** the classification of plants and animals according to their natural relationships.

Objectives:

1) become familiar with the vocabulary associated with the invertebrate lesson
2)) understand the biodiversity of the Great Smoky Mountains National Park
3) recognize that many plants and animals in the park that live only in the Park are known as endemic species
4) learn of the threats that are effecting the plants and animals of the Park
5) learn about several terrestrial invertebrates that students may find during their field trip.

VOCABULARY AND DEFINITIONS FOR INVERTEBRATE STUDY
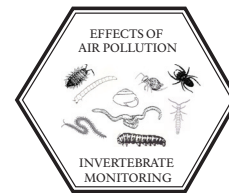
Materials:
•Vocabulary listed on previous page
•Computer(s) with internet connection

Background:
E.O. Wilson describes invertebrates as, "the little things that run the world" (Wilson,1987). The functional responses of invertebrates to soil pH, soil temperature, and air temperature provide a more complete assessment of the ecosystem model. Samways (1994) states "Why consider conserving insects? . . . In short, they make ecosystems tick. . . They cannot be ignored." Soil invertebrates modulate the following to varying degrees: soil temperature, moisture, nutrients, plant species composition, soil compaction, mixing, trace gas production, aggregate formation and stability, soil crusting, aeration, runoff, carbon storage, organic matter stabilization, macropores, water transport, and microbial community structure (Anderson, 2000; Whitford, 2000). Invertebrates are particularly important as linkages at critical interfaces: land/air, root/soil, and land/water (Coleman and Hendrix, 2000).

Procedure:
Have the students read over the vocabulary associated with the terrestrial invertebrate monitoring (pages 8-9). Most if not all of the definitions will be used within the terrestrial invertebrate monitoring session. Students will probably be familiar with most of the definitions but reviewing the list before the trip is essential.

To view the Biodiversity podcast video go to **http://www.thegreatsmoky-mountains.org/eft/10modules. html**. Turn the microscope knob that appears on the computer screen to Section 1, Understanding Biodiversity. Click "Watch Video" to view video.

To view the Spruce Fir podcast video go to **http://www.thegreatsmoky-mountains.org/eft/10modules. html**. Turn the microscope knob that appears on the computer screen to Section 2, A Connected Web. Click "Watch Video" and view video.

To play the Bucket of Bugs game go to **http://www.thegreatsmoky-mountains.org/eft/10modules. html**. Turn the microscope knob that appears on the computer screen to Section 4, Studying Diversity. Click "Play Game" and follow instructions.

References:
Anderson JM (2000) Food web functioning and ecosystem processes: problems and perceptions of scaling. In: Coleman DC,

Hendrix PF (eds) Invertebrates as webmasters in ecosystems. CABI Publishing, Oxon, UK, p 3-24

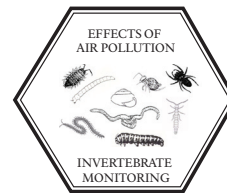Coleman DC, Hendrix PF, eds (2000) Invertebrates as webmasters in ecosystems. CABI Publishing, Oxon, UK, 336 p

Samways MJ (1994) Insect Conservation Biology. Chapman & Hall, London, 358 p

Wilson EO (1987) The little things that run the world (the importance and conservation of invertebrates. Conservation Biology 1:344-346

ON-SITE ACTIVITY
TERRESTRIAL INVERTEBRATE STUDY

Grade Level: High School
Subject Area: Science
Activity time: 75 minutes
Setting: Outdoors in the park
Skills: Analyzing, Applying, Calculating, Classifying, Communicating, Comparing, Discussing, Gathering information, Hypothesizing, Measuring, Predicting, Summarizing

Objectives:
1) recognize the diversity of soil invertebrates in the park
2) understand why soil invertebrates are important
3) identify soil invertebrates to the taxonomic level of order

Materials: all materials are supplied by the ranger
•data sheets
•clip boards
•pencil
•insect collecting supplies

Background:
Why is it important for park biologists to monitor the biodiversity of species in the park soil on a regular basis? The students will be assisting in monitoring the population of terrestrial invertebrates in a special area set up for that purpose. We will be studying the species richness (the number of different species in a given area), diversity (the number of species in an area and also their relative abundance), species evenness (a measure of how evenly members of a sample are distributed across the species), and density (measurement of population per unit area).

All plants and animals are important to the ecosystem, and learning about the smallest of animals is as important as learning about the big animals like bears and deer. Why do you think this is the case? What are some of the possible threats to the soil and, therefore, the soil invertebrates? The first step in inventorying invertebrates is collecting. Students will be shown the techniques they will use to collect insects.

Procedure:
The students will be divided into groups to collect invertebrates that live in soil. After 12 minutes of collecting, students will be brought back to classroom area to view invertebrates under the video microscope. Students will work together to identify invertebrates to the Order/Class level. Discussion will be on special adaptations, food chain importance and other unique features. Data will be posted to the Hands on the Land website (**www.handsontheland.org**) for future comparisons. The data collected during the field trip is part of a larger monitoring project. The field trip's data is just a snapshot of what is currently happening. The information becomes most meaningful when compared over time. This is what park rangers do to monitor the health and condition of park resources.

Post-Site Activity
Terrestrial Invertebrate Diversity
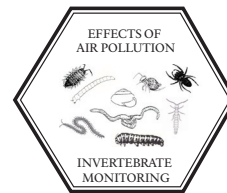
Grade Level: High School

Subject Area: Science

Activity time: 60 minutes

Setting: Classroom/Computer room

Skills: Analyzing, Applying, Calculating, Charting, Comparing, Evaluating, Interpreting, Summarizing

Objectives:
1) explain why long term monitoring is used to study soils health
2) explain richness and evenness as they relate to measures of diversity
3) calculate species evenness and evaluate their results.

Materials:
• Terrestrial invertebrate worksheets (pages 11-14)
• Answer key (pages 15-17)
• Computer(s) with internet connection
• Calculator

Background:
Biodiversity is a measure of the variety of living organisms in a community. Richness and evenness are two measures of diversity. Richness is how many different types of organisms are found in an area, and evenness is the abundance of each organism. Scientists use these measures as a way of stating ecosystem health, with a higher richness and evenness indicating a more stable ecosystem.

Long-term monitoring studies are used in the park to gather baseline data, catalog new species, and monitor ecosystem health. Park scientists study terrestrial invertebrates because they have a pivotal role in forest communities, returning nutrients to the soils and providing prey for larger organisms. By tracking terrestrial invertebrate populations, the park can track the health of the soils in which the invertebrates live. Changes in data over time may indicate environmental changes such as lowering of soil pH as a result of increased acid rain.

Procedure:
In small groups, have students select a data sample from two different sample sites using the Hands on the Land website: **http://www.handsontheland.org/** Samples should be as close as possible in date to allow for comparison. Using the worksheet, have students calculate species evenness and richness for the sample from each site they choose.

Select two terrestrial invertebrate samples (different sites) and compare the samples using a spreadsheet program and the worksheet(s) provided.

Have each group discuss what they found with the class. What patterns did they notice? What invertebrate orders were most abundant? Least? What environmental factors might affect the results of a sample (temperature, soil moisture, pH)? Viewing one sample is often not enough to get a full picture of biodiversity at a site. What would help to get a more accurate view of biodiversity in the sample area? (Look at several samples from same site, replicate)

INSECT ORDER KEY
TERRESTRIAL INVERTEBRATE STUDY
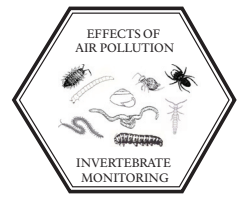
Order	Common Name
Acari	Ticks and Mites
Amblipygi	Tailless Whip-Scorpions
Amphipoda	Scuds
Anoplura	Sucking Lice
Araneae	Spiders
Coleoptera	Beetles
Collembola	Springtails
Decapoda	Crabs, Lobsters, Crayfish, and Shrimp
Dermaptera	Earwigs
Dictyoptera (Suborder: Blattaria/Blattodea)	Cockroaches and Woodroaches
Diplura	Japygid
Diptera	Flies
Embioptera	Webspinners
Ephemeroptera	Mayflies
Hemiptera	True Bugs
Homoptera	Cicadas, Hoppers, Aphids, Scales, and Others
Hymenoptera	Ants, Bees, and Wasps
Isopoda	Sowbugs and Pillbugs
Isoptera	Termites
Lepidoptera	Butterflies and Moths
Mallophaga	Chewing Lice
Mantodea	Mantids
Mecoptera	Scorpionflies
Neuroptera	Nerve-Winged Insects
Odonata	Dragonflies and Damselflies
Opiliones	Harvestmen or Daddy-long-legs
Orthoptera	Crickets, Katydids, and Grasshoppers
Phasmatodea	Walkingsticks
Plecoptera	Stoneflies
Protura	Proturans
Pseudoscorpiones	Pseudoscorpions
Psocoptera	Booklice and Barklice
Uropygi	Whip-Scorpions or Vinegaroons
Scorpiones	Scorpions
Siphonaptera	Fleas
Solifugae	Wind-Scorpions or Camel-Spiders
Strepsiptera	Twisted-Winged Parasites
Thysanoptera	Thrips
Thysanura	Silverfish and Bristletails
Trichoptera	Caddisflies
Zoraptera	Zorapterans

Class	Common Name
Chilopoda	Centipedes
Diplopoda	Millipedes
Gastropoda	Snails
Oligochaeta	Earthworms

Terrestrial Invertebrate Diversity

Go to the website: **http://www.handsontheland.org/monitoring/projects/inverts/search.cfm**
Select a terrestrial invertebrate sample from two different sites using the "Review" button on the Terrestrial Invertebrates home page. Using the pre-worksheet and the table provided, determine the richness, evenness, and diversity of one sample and complete the worksheet below. Repeat with the second sample on the second sheet. Site description is found under "Site List" on Terrestrial Invertebrates home page.

Sample 1:

Site Name _____

Date Collected _____

Collectors _____

Site description _____

1) How many invertebrate orders/classes were found in this sample (Richness = s)?_____

2) Complete the chart below with your selected sample.

Order/Class Found	Common Name	# of the order/class (n_i)	# Total Insects Collected (N)	Relative Abundance of this order/class $(pi)=n_i/N$	Calculate $(n_i/N)^2$ for each order/class	Simpsons Diversity Index $(1/\Sigma(n_i/N)^2)$	Evenness $\dfrac{(1/\Sigma(n_i/N)^2)}{N}$ (# will be between 0-1)
Sum (Σ) of the Relative Abundance of all Order/Classes Found $(n_i/N)^2$:							

EFFECTS OF
AIR POLLUTION

INVERTEBRATE
MONITORING

Repeat process with another sample.

Sample 2:
Site Name _____
Date Collected _____
Collectors _____
Site description _____

3) How many invertebrate orders/classes were found in this sample (Richness = s)? _____

4) Complete the chart below with your second selected sample site (be sure it is at a different location).

Order/Class Found	Common Name	# of the order/class (n_i)	# Total Insects Collected (N)	Relative Abundance of this order/class $(pi)=n_i/N$	Calculate $(n_i/N)^2$ for each order/class	Simpsons Diversity Index $(1/\Sigma(n_i/N)^2)$	Evenness $\dfrac{(1/\Sigma(n_i/N)^2)}{N}$ (# will be between 0-1)
Sum (Σ) of the Relative Abundance of all Order/Classes Found $(n_i/N)^2$:							

5) How does the species richness compare between the two samples?

6) Evenness is constrained between 0 and 1. The less variation in communities between the species, the higher Evenness is. How does the species evenness compare between the two samples?

7) What order/class has the highest relative abundance in Sample 1? In Sample 2?

8) If the evenness is the same in the two samples but the species richness is higher in the second sample, what does this tell you about the diversity of the second sample?

9) If the species richness is the same in the two samples but the evenness is lower in the second sample, what does this tell you about the diversity of the second sample?

10) What are the "ideal" conditions of a plot of land to be most diverse: (a) High species richness and most even, (b) High Species richness and least even, (c) Low species richness and most even, or (d) Low species richness and least even.

TERRESTRIAL INVERTEBRATE DIVERSITY ANSWER KEY EXAMPLE
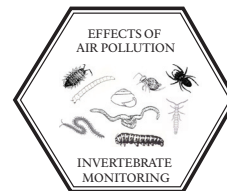
Sample 1:

Site Name _____Purchase Knob_____

Date Collected _____10-20-2008_____

Collectors _____Haywood Christian Academy_____

Site description _____none_____

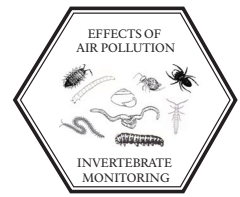1) How many invertebrate orders/classes were found in this sample (Richness = s)? __12____

2) Complete the chart below with your selected sample.

Order/Class Found	Common Name	# of the order/class (n_i)	# Total Insects Collected (N)	Relative Abundance of this order/class (pi)=n_i/N	Calculate (n_i/N)^2 for each order/class	Simpsons Diversity Index (1/Σ(n_i/N)^2)	Evenness (1/Σ(n_i/N)^2) / N (# will be between 0-1)
Gastropoda	Snail	2	51	.039	.002		
Oligochaeta	Earthworm	14	51	.274	.075		
Araneae	Spider	4	51	.078	.006		
Opiliones	Daddylong legs	1	51	.019	.00004		
Acari	Mites/Ticks	2	51	.039	.002		
Diplopoda	Millipedes	8	51	.157	.025		
Chilopoda	Centipedes	3	51	.059	.003		
Collembola	Springtails	7	51	.137	.019		
Hemiptera	True Bug	1	51	.019	.00004		
Coleoptera	Beetle	2	51	.039	.002		
Diptera	Flies	5	51	.098	.009		
Diptera (larvae)	Flies	1	51	.019	.00004		
Hymenoptera	Ants	1	51	.019	.00004		
Sum (Σ) of the Relative Abundance of all Order/Classes Found (n_i/N)^2:					.134	7.463	.146

TERRESTRIAL INVERTEBRATE DIVERSITY
ANSWER KEY EXAMPLE CONTINUED

EFFECTS OF
AIR POLLUTION

INVERTEBRATE
MONITORING

Sample 2:

Site Name _____Cataloochee_____

Date Collected _____10-25-2008_____

Collectors _____Teacher Workshop_____

Site description _____none_____

3) How many invertebrate orders/classes were found in this sample (Richness)? __13____

4) Complete the chart below with your second selected sample. (be sure it is at a different location).

Order/Class Found	Common Name	# of the order/class (n_i)	# Total In-sects Col-lected (N)	Relative Abundance of this order/class $(pi)=n_i/N$	Calcu-late $(n_i/N)^2$ for each order/class	Simpsons Diversity Index $(1/\Sigma(n_i/N)^2)$	Evenness $\dfrac{(1/\Sigma(n_i/N)^2)}{N}$ (# will be be-tween 0-1)
Gastropoda	Snail	16	78	.205	.042		
Araneae	Spider	22	78	.282	.079		
Acari	Ticks/Mites	2	78	.026	.0007		
Pseudoscopiones	Pseudoscorpi-ons	1	78	.013	.0002		
Diplopoda	Millipedes	6	78	.077	.006		
Chilopoda	Centipedes	5	78	.064	.004		
Collembola	Springtails	6	78	.077	.006		
Orthoptera	Crickets, Katydids, & Grasshoppers	1	78	.013	.0002		
Oligochaeta	Earthworms	1	78	.013	.0002		
Coleoptera	Beetles	3	78	.038	.001		
Isopoda	Sowbugs & Pillbugs	12	78	.154	.024		
Hemiptera	True Bugs	1	78	.013	.0002		
Hymenoptera	Ants, Bees & Wasps	2	78	.026	.0007		
Sum (Σ) of the Relative Abundance of all Order/Classes Found $(n_i/N)^2$:					.164	6.097	.078

5) How does the species richness compare between the two samples?

Purchase Knob sample site had the higher species richness with 14; however, the Cataloochee sample site had only one species less with 13

6) Evenness is constrained between 0 and 1. The less variation in communities between the species, the higher Evenness is. How does the species evenness compare between the two samples?

Sample 2 is the least even of the two sites.

7) What order/class has the highest relative abundance in Sample 1? In Sample 2?

In Sample 1: Oligochaeta (Earthworms)
In Sample 2: Araneae (Spiders)

8) If the evenness is the same in the two samples but the species richness is higher in the second sample, what does this tell you about the diversity of the second sample?

The second sample site has a higher diversity

9) If the species richness is the same in the two samples but the evenness is lower in the second sample, what does this tell you about the diversity of the second sample?

The second sample site has a lower diversity

10) What are the "ideal" conditions of a plot of land to be most diverse: High species richness and most even, High Species richness and least even, Low species richness and most even, or Low species richness and least even.

High species richness and most even equals highest diversity