

TARDIGRADES



THEME: Biodiversity in Microorganisms

GRADE Level: Eighth

BEST TIME TO PLAN TRIP: Fall or Spring

UNIT RATIONALE

When most students imagine national parks and nature in general they probably think of large animals such as bear and deer. Although bear, deer, and other visible animals are important parts of the ecosystem, there are other pieces that we often overlook. Tardigrades and other microorganisms are some of the most numerous and most biodiverse organisms on Earth. This unit explores the biodiversity of these microscopic organisms. During the study students will be introduced to the process of collecting lichens and isolating resident tardigrades and other microscopic organisms.

SCIENCE 8TH GRADE NORTH CAROLINA STANDARDS

NATURE OF SCIENCE

Students are involved with science as a human endeavor that relies on reasoning, insight, skill and creativity as they participate in on-going research projects at the Great Smoky Mountains National Park. Students are exposed to science's universal laws through a systematic study of the rules, patterns and cycles in nature.

SCIENCE AS INQUIRY

Students are involved in scientific investigation that involves the collecting of relevant evidence, the use of logical reasoning and the application of imagination to devise hypotheses and explanations to make sense of collected evidence. Students use tools of investigation to collect data and mathematics to gather, organize and present data.

SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

Students make personal and societal connections to the issues facing the Great Smoky Mountains National Park. Specifically, they will be exposed to the form and function of interacting systems.

Competency Goal 1: The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

- 1.01 Identify and create questions and hypotheses that can be answered through scientific investigations.
- 1.02 Develop appropriate experimental procedures.
- 1.03 Apply safety procedures in the laboratory and in field studies.
- 1.08 Use oral and written language to communicate findings.

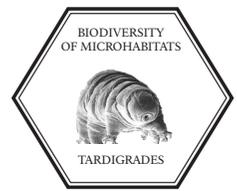
Competency Goal 3: The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of the hydrosphere.

- 3.04 Describe how terrestrial and aquatic food webs are interconnected.

Competency Goal 6: The learner will conduct investigations, use models, simulations, and appropriate technologies and information systems to build an understanding of cell theory.

- 6.02 Analyze structures, functions, and processes within animal cells.
- 6.03 Compare life functions of protists.
- 6.04 Conclude that animal cells carry on complex chemical processes to balance the needs of the organism.





ENGLISH/LANGUAGE ARTS 8TH GRADE NORTH CAROLINA STANDARDS

Competency Goal 1: The learner will use language to express individual perspectives through analysis of personal, social, cultural, and historical issues.

- 1.02 Analyze expressive materials that are read, heard, and/or viewed by
- 1.03 Interact in group activities and/or seminars
- 1.04 Reflect on learning experiences

Competency Goal 2: The learner will use and evaluate information from a variety of resources.

- 2.01 Analyze and evaluate informational materials that are read, heard, and/or viewed
- 2.02 Use multiple sources of print and non-print information to explore and create research products in both written and presentational forms

Competency Goal 3: The learner will continue to refine the understanding and use of argument.

- 3.01 Explore and evaluate argumentative works that are read, heard and/or viewed
- 3.02 Continue to explore and analyze the use of the problem-solution process

MATH 8TH GRADE NORTH CAROLINA STANDARDS

Competency Goal 1: The learner will understand and compute with real numbers.

- 1.01 Develop number sense for the real numbers
- 1.02 Develop flexibility in solving problems by selecting strategies and using mental computation, estimation, calculators or computers, and paper and pencil.

Competency Goal 4: The learner will understand and use graphs and data analysis.

- 4.01 Collect, organize, analyze, and display data (including scatterplots) to solve problems.
- 4.02 Approximate a line of best fit for a given scatterplot; explain the meaning of the line as it relates to the problem and make predictions.
- 4.03 Identify misuses of statistical and numerical data.



CORRELATION TO THE NATIONAL SCIENCE EDUCATION STANDARDS CONTENT STANDARDS GRADES 5-8

CONTENT STANDARD A

Science as Inquiry: All students will develop abilities necessary to do scientific inquiry and an understanding of scientific inquiry. This includes:

- answering questions through scientific investigation,
- conducting a scientific investigation,
- using appropriate tools and materials to gather, analyze and interpret data,
- thinking critically to make relationships between evidence and explanations,
- recognizing and analyzing alternative explanations and predictions
- communicating scientific procedures and explanations
- using mathematics in all aspects of scientific inquiry
- using technology to gather data and analyze

CONTENT STANDARD C

Life Science: All students will develop an understanding of structure and function in living systems, regulation and behavior, populations and ecosystems and diversity and adaptations of organisms. Specifically students will understand:

- The structure and function of whole organisms and their ecosystems
- All organisms must be able to obtain and use resources, grow, reproduce and maintain stable internal conditions while living in a constantly changing external environment.
- An organism's behavior evolves through adaptation to its environment.

CONTENT STANDARD D

Science and Technology: All students should develop abilities of technological design and an understanding about science and technology. This includes:

- designing a solution or product
- implementing a proposed design
- evaluating completed products
- communicating the process

CONTENT STANDARD E

Science in Personal and Social Perspectives: All students should develop an understanding of personal health, populations, resources and environments, natural hazards, risks and benefits and science and technology in society.

CONTENT STANDARD F

History and Nature of Science: All students should develop understanding of science as a human endeavor and the nature of history and science

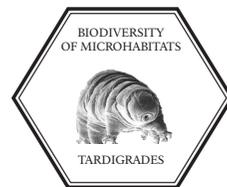
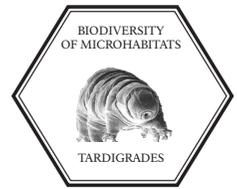


TABLE OF CONTENTS

Activity	Page
Unit Rationale/State Learning Standards	1-3
Table of Contents	4
Planning your Trip and Safety Considerations	5
Background Information.....	6
Map to Purchase Knob.....	7
Pre-Site Activities.....	8
ATBI and Tardigrades	9
Tardigrade Information	10
On-Site Activity	
Park Ranger Directed Lessons: Tardigrade Study	11
Post-Site Activity	
Extreme Creations	12
Stewardship.....	13
Appendix	
Parent/Chaperone Letter	14





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 rest rooms
- 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 30. 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.

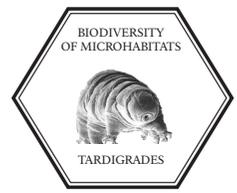
•Safety

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.

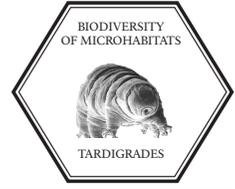
Great Smoky Mountains National Park is one of the largest protected land areas east of the Rocky Mountains. With over 500,000 acres (800 square miles) of forest, the Smokies contain an enormous variety of plants and animals. In terms of biological diversity, a walk from a mountain's foot to its peak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

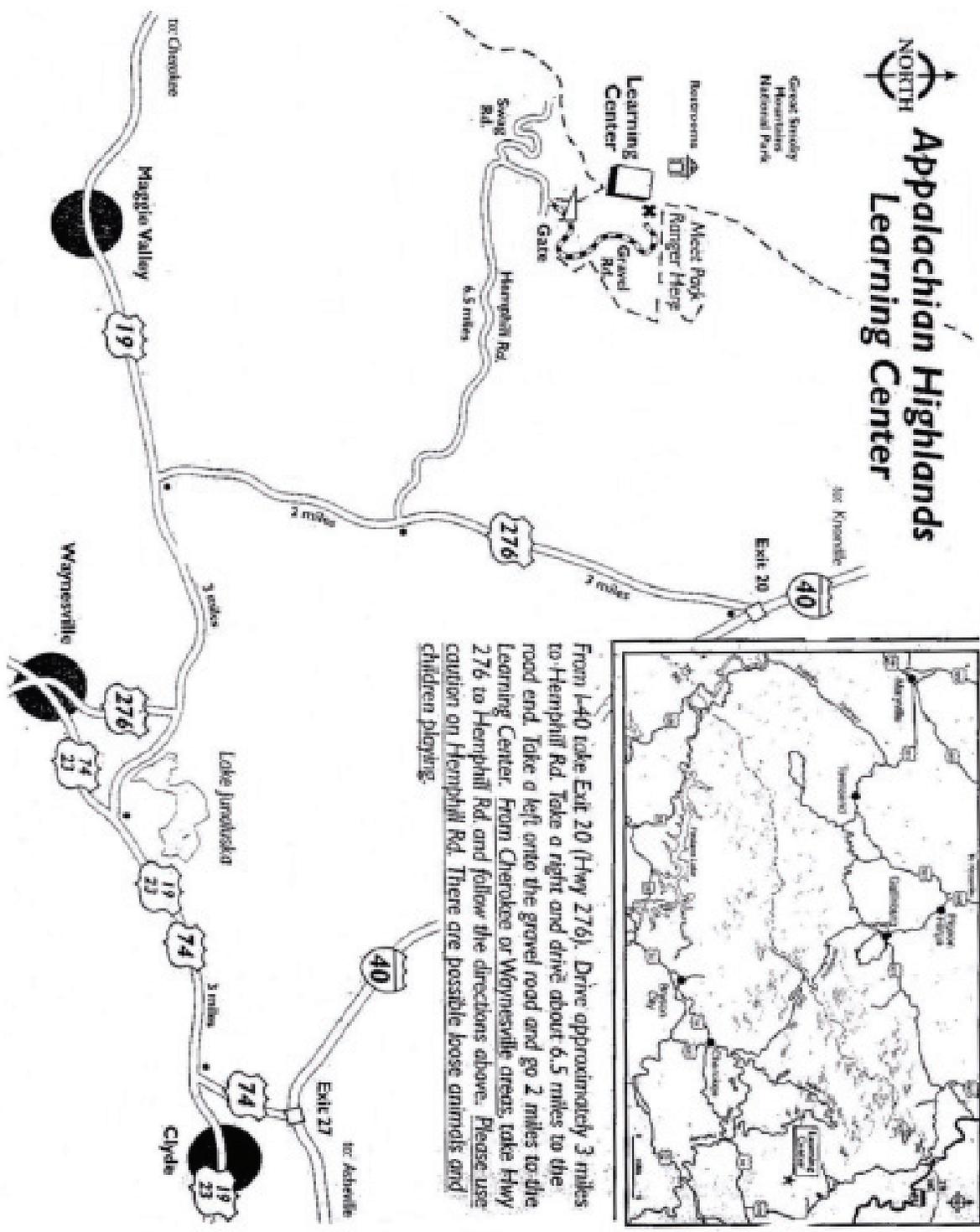
The Smokies also have a rich cultural history. Native Americans have lived in this area for thousands of years, and permanent white settlement began around 1800. The coming of commercial logging around 1900 stripped trees from two-thirds of what is now park land. Established in 1934, the park was created 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.



MAP TO PURCHASE KNOB

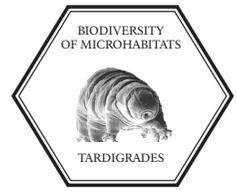


From I-40 take Exit 20 (Hwy 276). Drive approximately 3 miles to Hemphill Rd. Take a right and drive about 6.5 miles to the road end. Take a left onto the gravel road and go 2 miles to the Learning Center. From Cherokee or Waynesville areas, take Hwy 276 to Hemphill Rd. and follow the directions above.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



PRE-SITE ACTIVITY

TARDIGRADE INFORMATION



Grade Level: Eighth grade

Subject Area: Science

Activity time: 30 minutes

Setting: Classroom

Skills: Analyzing, Categorizing, Collecting information, Communicating, Connecting

Vocabulary:

- **Bilateral symmetry:** symmetrical arrangement, as of an organism or a body part, along a central axis, so that the body is divided into equivalent halves.
- **Cryptobiosis:** the metabolic state some organisms enter in response to adverse environmental conditions such as freezing, drying, or oxygen deficiency. In this state, all metabolic processes stop, preventing reproduction, development, and repair until environmental conditions return to being hospitable. When this occurs, the organism will return to its metabolic state of life as it was prior to cryptobiosis.
- **Eutardigrada:** a class of Tardigrada without lateral appendices. These species are primarily found in lichens, mosses, and leaf litter, but many species are found in freshwater habitats such as lakes, rivers, and streams.

• **Extremophile:** an organism that thrives in and even may require physically or geochemically extreme conditions that are detrimental to the majority of life on Earth.

• **Heterotardigrada:** a class of tardigrades comprised of two orders: the armored terrestrial tardigrades and the marine tardigrades. Heterotardigrades have a lateral appendage between the head and the shoulder plate.

• **Meiofauna:** animals inhabiting the bottom of a river, lake, or sea that are nearly invisible to the naked eye with dimensions in the range 0.1 to 1 mm.

• **Micrometazoa:** extremely small multicellular animals.

• **Parthenogenesis:** form of reproduction in which an unfertilized egg develops into a new individual; no males are present in the population.

• **Polyextremophiles:** an organism which has several extremophilic features.

• **Tun:** cryptobiotic state of the tardigrade in which the appendages are drawn inward and metabolism stops.

Materials:

- Vocabulary (page 8)
- Computer with internet connection
- Tardigrade information worksheet (page 10)
- ATBI and Tardigrades worksheet (page 9)

Objectives:

- 1) understand the biodiversity of the Great Smoky Mountains National Park
- 2) learn several characteristics of tardigrades
- 3) learn the vocabulary related to the tardigrade study

Background:

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" and view video.

When students visit the Smokies on their field trip they will be collecting, isolating, and viewing tardigrades. This lesson will introduce tardigrades and their characteristics. Read aloud to the students the following information regarding the ATBI and Tardigrades (listed to the right). Students should read individually the vocabulary and definitions worksheet and tardigrade information worksheet. After the students have finished their reading, discuss the characteristics of tardigrades and what adaptations they have in order to live in extreme environments.

ATBI AND TARDIGRADES



The All Taxa Biodiversity Inventory (ATBI) is a project of Discover Life in America (DLIA) that seeks to inventory the estimated 100,000 species of living organisms in Great Smoky Mountains National Park. The project has developed checklists, reports, maps, databases, and natural history profiles that describe the biology of this rich landscape to a wide audience. The species level of biological diversity is central to the ATBI, but the project is developed within an ecological and conservation context and encourages understanding at other levels of organization, including genetic variation within species and ecosystem descriptions. As of December 2009, discoveries include 907 species new to science and 6,582 species new to the Park.

The Great Smoky Mountains National Park is a 2,200 square kilometer (800 square mile) reserve that straddles the mountainous divide between the states of Tennessee and North Carolina. The park contains some of the highest peaks in eastern North America, and has very complex geology. The park is known for its temperate forest richness and extensive old-growth forests; however, the park is challenged with a number of threats to its ecological integrity. These threats include invasive, exotic organisms in both terrestrial and aquatic systems; very high depositions of nitrogen and sulfur, as well as high ozone levels; and increasing insularity as a result of human development and fragmentation of adjacent natural areas.

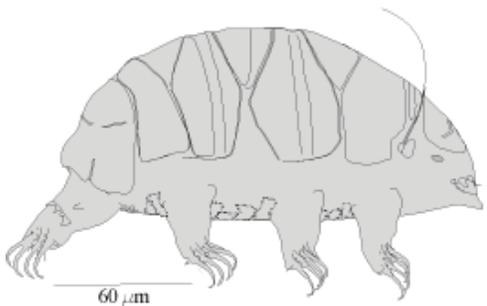
Prior to the ATBI project there were only 3 species of Tardigrades known in the park. Since the ATBI began there have been 55 species of tardigrades found new to the park and 18 new to science for a total of 76 known to be in the park as of December 2009.

TARDIGRADE INFORMATION

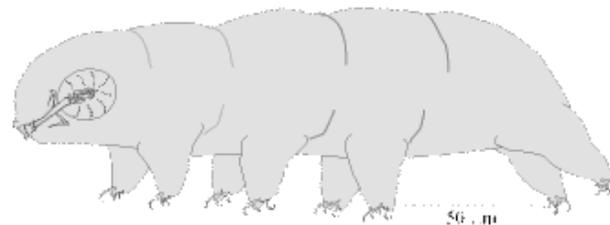
Tardigrades (“water bears”) are members of the phylum Tardigrada. They are microscopic segmented animals with eight legs. These tardigrades were first described by Johann August Ephraim Goeze in 1773 (Kleiner Wasserbär = little water bear). The name Tardigrada means “slow walker” and was given by Lazzaro Spallanzani in 1777. The name water bear comes from the way they walk, similar to a bear’s gait. The largest adults may reach a body length of 1.5 mm, the smallest below 0.1 mm. Freshly hatched juveniles may be smaller than 0.05 mm.

More than 1000 species of tardigrades have been described. Tardigrades occur over the entire world, from the high Himalayas (above 6,000 m) to the deep sea (below 4,000 m) and from the polar regions to the equator. They are polyextremophiles and are able to survive in extreme environments from temperatures of -273°C (close to absolute zero) to temperatures as high as 151°C (303°F). They can survive 1,000 times more radiation than other animals, including humans, a year without water, and even the vacuum of space.

The most common place to find tardigrades are in the sediment between lichen or moss and its substrate (tree, rock, etc.). Tardigrades are most common in moist environments, but can also be found in dry habitats that are periodically wet. The animals must have a film of water around the body in order to be active. Tardigrades are one of the few groups of species that are capable of reversibly suspending their metabolism and going into a state of cryptobiosis in response to drying, freezing, or low oxygen.



Heterotardigrada



Eutardigrada

Water bear, oh water bear,
 On the stones and on the stair,
 I’m sorry I did not see you there.
 Oh water bear, water bear,
 Survival skills are beyond compare
 Our tiny friends are everywhere.
 --Frank Glubbah

ON-SITE ACTIVITY

TARDIGRADE STUDY



Grade Level: Eighth grade

Subject Area: Science

Activity time: 75 minutes

Setting: Outdoors in the park

Skills: Analyzing, Categorizing, Classifying, Estimating, Listing, Summarizing

Materials:

- Lichen samples
- Microscopes
- Sieve
- Erlenmeyer flask
- Pipette
- Deep well slides
- Water
- Funnel

Objectives:

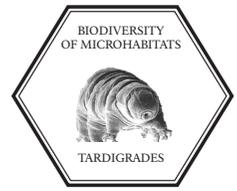
- 1) collect lichens
- 2) isolate and view tardigrades
- 3) view other microscopic organisms (such as rotifers, nematodes, and protozoans)

Background:

The ranger will explain the methods and techniques for collecting lichens and the three main types of lichens. The students will work in groups to collect lichen, isolate tardigrades and other microorganisms from the lichen sediment, and then observe them under the compound or dissecting microscope.

POST-SITE ACTIVITY

EXTREME CREATION



Grade Level: Eighth Grade

Subject Area: Science

Activity time: 45 minutes

Setting: Classroom

Skills: Communicating, Connecting, Describing, Drawing

Vocabulary:

• **Extremophile:** an organism that thrives in and even may require physically or geochemically extreme conditions that are detrimental to the majority of life on Earth.

Materials:

- Computer with Internet connection
- Colored pencils, crayons, or colored markers
- Blank paper

Objectives:

- 1) understand the definition and classification of extremophiles
- 2) be able to list examples of earthly extremophiles
- 3) create their own extremophile creation

Background:

Students were able to experience one type of extremophile during their field trip in the Smokies, the tardigrade. In this lesson students are able to explore in more depth other examples and classifications of extremophiles. Additionally this lesson allows for discussion on how people must adapt to living in extreme environments and different time periods and how inventions have changed those living conditions.

Procedure:

Go to the following websites for information about extremophiles:

1. Examples of earthly extremophiles: http://nai.arc.nasa.gov/poster/poster_images/astrobioactivity1-studenthandout.pdf
2. Life in extreme environments: <http://www.spaceref.com/news/viewnews.html?id=463>

Either download the information from the websites for students or have the students themselves read it from the computer. Discuss what they have learned about extremophiles.

Ask students to imagine an extreme environment on earth and what you would need in order to survive in those conditions. After imagining these extreme conditions, create an imaginary animal with characteristics to withstand these extreme conditions. List the characteristics and the name of animal to the side of the imaginary animal drawing. Have students present their animal creations.



POST-SITE ACTIVITY

STEWARDSHIP



Grade Level: Eighth Grade

Subject Area: Science

Activity time: 30 minutes

Setting: Classroom

Skills: Communicating, Connecting, Applying

Vocabulary:

•Stewardship: Our responsibility to care for our natural resources - land, air, wildlife and water - sustainably, so future generations can enjoy them.

Materials:

- Computer with Internet connection

Objectives:

- 1) understand what the term “Stewardship” means
- 2) how the students can become a steward in their school and their community

Procedure:

To view the Stewardship podcast video go to <http://www.thegreatsmokymountains.org/eft/10modules.html> Turn the microscope knob that appears on the computer screen to Section 7, Backyard Stewardship. Click “Watch Video” and view video. Ask students how they can become stewards within their own school and community.

PARENT/CHAPERONE LETTER



Greetings Parents/Chaperones:

Park rangers are pleased to be presenting an educational program to the students in Great Smoky Mountains National Park. In order to achieve the goals for a successful program, the park rangers will need your assistance in the following ways:

(These points will help to ensure that park rangers and teachers will be able effectively conduct the lessons and activities throughout the trip.)

- The program will be conducted outside and there will be some hiking throughout the trip. Prepare your student with appropriate footwear, long pants, layers, and raingear.
- If your child is bringing a lunch from home, we recommend that students bring water to drink and a lunch with minimal packaging. Soft drinks are usually left unfinished by students, and remaining sugary drinks cannot be poured out on the ground. (Minimally packaged lunches lead to less trash being left behind or scattered by the wind. Additionally, this reduces the accumulated trash to be disposed of).

If you are a chaperone attending the field trip:

- Please be an active part of the lessons. Keep up with the group and listen to the information being given in the case that you may be called upon to assist (handing out materials, sub-dividing groups etc.).
- Please do not hold conversations with other chaperones or use a cellular phone while the rangers are teaching the students.
- Refrain from smoking during the trip. If you must smoke, please alert a ranger or teacher and remove yourself from the group.
- Please be aware that the program will be conducted outside and that there will be some hiking throughout the trip. Prepare yourself with appropriate footwear, long pants, layers, and raingear.
- We recommend that parents and students bring a small towel in their backpacks to sit on at lunch (there are no picnic tables at the program site).

Thank you for your needed assistance. We look forward to meeting you on the program!

Sincerely,

The Education Staff at Great Smoky Mountains National Park

