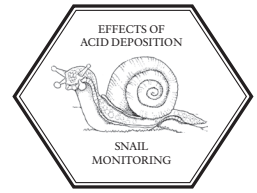


SNAILS



Theme: Snails and Air Quality

Best Time to Plan Trip: Fall or Spring

Unit Rationale

Our soils in the park, especially at high elevations such as Purchase Knob, are exposed to high levels of acid rain (or rain with low pH). Soils with a pH of 5.5 or lower have a low availability of calcium and other nutrients but an overabundance of aluminum and iron. Park managers are very concerned about how this affects soils and the availability of nutrients to plants and animals. The majority of snail species in the park are calcium-based, and snails are an important part of the soil's food chain. During this study students will search and identify snails, explain why scientists are concerned about snail populations, and learn about the role snails play in the soil food chain.

NORTH CAROLINA CURRICULUM CORRELATIONS

EARTH/ENVIRONMENTAL SCIENCE GOALS AND OBJECTIVES

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.

EEn.2.2.2 Compare the various methods humans use to acquire traditional energy sources.

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.2.7.2 Explain why biodiversity is important to the biosphere.

EEn.2.7.3 Explain how human activities impact the biosphere.

BIOLOGY GOALS AND OBJECTIVES

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.2.1.4 Explain why ecosystems can be relatively stable over hundreds or thousands of years, even though populations may fluctuate.

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

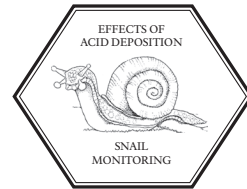
Competency Goal 1: The learner will develop abilities necessary to do and understand scientific inquiry.

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 3: The learner will develop an understanding that cellular processes are based on physical and chemical changes.

3.02 The learner will examine the structure and function of organic molecules.

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.

6.05 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.

7.02 The learner will examine the actions and interactions of communities and ecosystems.

7.03 The learner will assess current global issues.

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.

2.04 The learner will investigate the atmosphere.

2.05 The learner will investigate the biosphere.

Competency Goal 4: The learner will build an understanding of the distribution, ownership, use and degradation of renewable and nonrenewable resources.

4.04 The learner will analyze biological resources.

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.

5.02 The learner will investigate the effects of pollutants.

5.03 The learner will analyze and investigate pollution reduction, remediation **and control measures.**

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.

Competency Goal 7: The learner will build an understanding of environmental decision making.

7.03 The learner will recognize significance of major environmental laws and regulations: regional, national and international.

7.04 The learner will develop an awareness of environmental options.

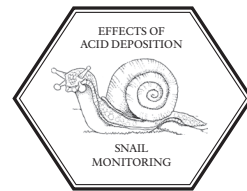
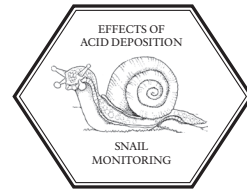


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PLANNING A SUCCESSFUL TRIP

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 6

• 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.

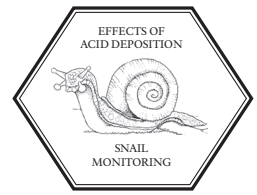
•Safety

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.

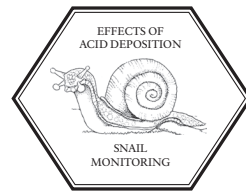
Great Smoky Mountains National Park is one of the largest protected land areas east of the Rocky Mountains. With over 500,000 acres (800 square miles) of forest, the Smokies contain an enormous variety of plants and animals. In terms of biological diversity, a walk from a mountain's foot to its peak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

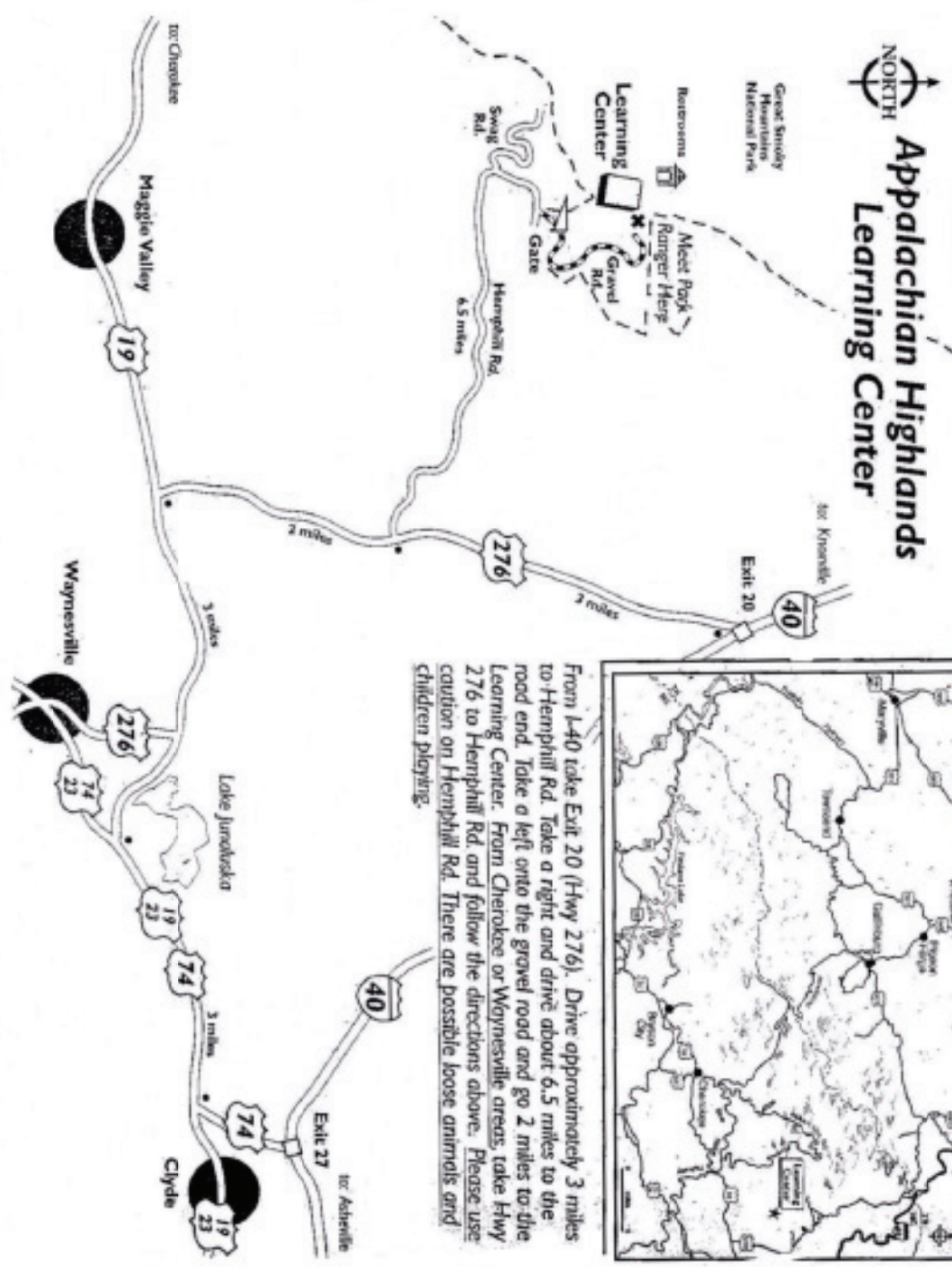
The Smokies also have a rich cultural history. Native Americans have lived in this area for thousands of years, and permanent white settlement began around 1800. The coming of commercial logging around 1900 stripped trees from two-thirds of what is now park land. Established in 1934, the park was created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

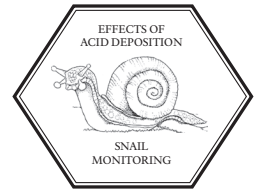


MAP TO PURCHASE KNOB



PRE-SITE ACTIVITY

SNAIL INFORMATION



Grade Level: High School

Subject Area: Science

Activity time: 60 minutes

Setting: Classroom

Skills: Analyzing, Classifying, Categorizing, Comparing, Describing, Gathering information, Researching

Vocabulary:

- **Apex:** the tip of the shell where the embryonic whorl begins.
- **Aperture:** opening or mouth of the snail shell.
- **Aspirator:** a piece of scientific equipment that uses suction to collect specimens that are too small to pick up with hands or tweezers.
- **Basal tooth:** refers to the tooth on the basal (lower) lip.
- **Biological Monitoring:** a technique used by scientists to check the condition of a particular species or ecosystem over time.
- **Embryonic whorl:** the first of a series of whorls.
- **Hermaphrodite:** possessing both male and female reproductive organs.
- **Lip:** the end of the aperture.

• **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.

• **Palatal tooth:** refers to the tooth located on the outer lip.

• **Parietal tooth:** refers to the tooth located on inner wall of the aperture or body of the snail shell.

• **Periphery:** the part of the whorl farthest from the central axis.

• **Radula:** a ribbon-like organ with many fine teeth used in rasping food.

• **Umbilicus:** an opening in the center of the axis of the shell bottom.

• **Whorl:** one complete turn of a gastropod shell.

Materials:

- Vocabulary and Definitions (listed above and on left)
- Snail information worksheet (page 9)
- Snail identification worksheet (page 10)
- Computer with internet connection.

Objectives:

- 1) understand the biodiversity of the Great Smoky Mountains National Park
- 2) recognize that many snails here

- are endemic species, meaning they are known to live only in the park
- 3) recognize that snails only live in certain geologic areas
- 4) describe physical characteristics that make one snail shell different from another
- 5) learn the definitions associated with snails
- 6) explain why land snails are important to an ecosystem.

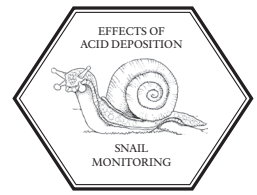
Background:

Land snails belong to the phylum Mollusca, a large and very diverse group of animals in the class Gastropod, meaning “stomach foot.” Snails can be found anywhere, but in general prefer a habitat offering adequate moisture, an abundant food supply, and an available source of lime and calcium.

Land snails are one of the exceptionally diverse groups in the Smokies. Researchers have already documented 130 species of snail and slug as living in Great Smoky Mountains National Park. Expectations are there could be almost as many species still unknown from the park, including some species unknown to science. Unlike slugs, a land snail leaves a shell behind when it dies and most species can be identified using the shell alone. Land snails range in size from over 40 mm in diameter to only one millimeter in diameter, therefore it is important to look closely for the tiniest species. Most snails, unlike slugs, require a source of calcium in their diet in order to build their shells. This is significant in the context of the park for several reasons.

There are only three areas in the park with significant limestone-





based surface geology (Cades Cove, White Oak Sinks, and Finley Cane) and these are the areas with the greatest land snail diversity. These are also the only known locations in the park for some species that can only live on limestone substrates.

Dogwoods are significant in the forest for bringing calcium to the soils (via their roots and leaves), making the forest floor less acidic and more accessible for calcium-loving species. Dogwoods are declining in the park because of an introduced fungus pathogen called Dogwood Anthracnose. The species that is replacing the dogwood in the forest understory is Eastern Hemlock, which has the reverse effect on the soils.

Acid deposition in high elevations is leaching calcium out of the soils. There are several dozen species of snail found only in high elevations in the southern Appalachians. The loss of calcium from the mountaintop ecosystem may be having an adverse effect on these species and could possibly lead to their extinction. Additionally, research in Europe has provided convincing evidence that lack of calcium in some environments reduces reproduction in some groups of birds. Dutch researchers associated the bird declines on years of acid precipitation, which appear to have reduced land snail numbers. Snail shells are a prime source of calcium for wild birds that need to boost calcium for egg laying. The Dutch scientists were able to manipulate reproductive success in their study by increasing calcium with supplemental feedings. Dr. Ted Simons' study in the Smokies will investigate

this same issue starting in 2004. The Smokies get some of the highest depositions of sulfate and nitrate in North America. Because of these significant issues effecting land snails in the park, it is important that we learn as much as possible about the present distribution of snail species in the park so we can recognize when species start to become rare, or rarer than they are now as these issues have been in effect for several decades already. Knowing their present range can also help managers identify populations that may be especially at risk from future acid deposition or loss of dogwoods, allowing protection activities to begin sooner. This project will produce the following three results:

- Locate and identify new park record species of land snails
- Increase our knowledge of the current range of land snail species
- Provide students with both an educational experience and a legitimate sense of contribution to the protection of the park's incredible diversity

On your field trip to the Smokies, your students will be participating in an inventory of land snails. It will be important to be able to focus on what makes one snail species different from another. Using the snail identification worksheet your students will gain several ways to determine shell differences. Have the students look at the vocabulary to become familiar with the terms associated with snails. Using the snail information sheet, complete the snail identification worksheet.

One reason we are studying snails is because they are an important part

of the soil's food chain. In Great Smoky Mountains National Park, rangers are concerned about snail populations. This is why we are helping in this biological monitoring program. During the field trip, your students will learn more about why we monitor snail populations.

Procedure:

Have students review over snail definitions and describe physical characteristics that make one snail shell different from another using the Snail Information worksheet. Use the Snail Identification worksheet activity as a review.

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.

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 view the Linking Geology and Life podcast video go to

<http://www.thegreatsmoky-mountains.org/eft/10modules.html> Turn the microscope knob that appears on the computer screen to Section 3, Why So Diverse Here? Click "Watch Video" and view video.

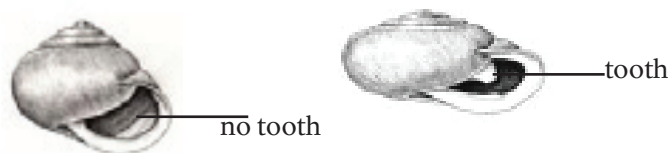


SNAIL INFORMATION SHEET

***Snails differ in the shape of their shell opening. Some ways to describe the opening might be as round, oval or crescent shaped.

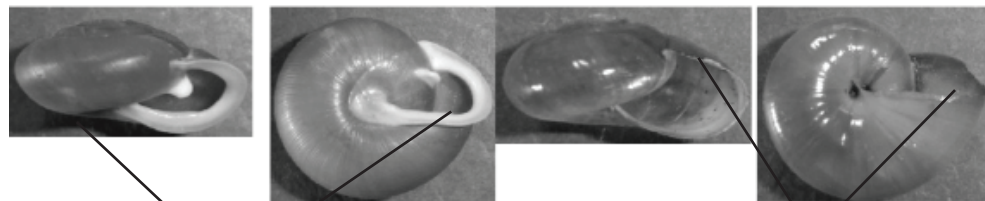
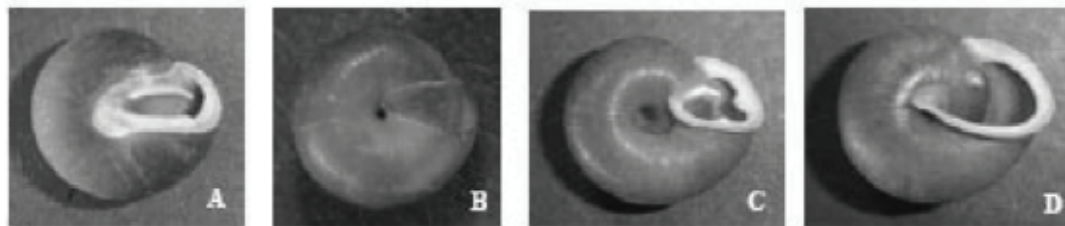


***Snails differ in the location and size of the opening. Sometimes you will notice “teeth” in the opening.

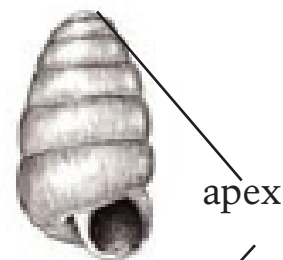


***Snails differ in the appearance of the umbilicus (this is the center of the bottom side of the shell, side opposite of the apex).

A. Imperforate (with closed umbilicus); B. Perforate (with very small umbilical opening); C. Umbilicate (with noticeable umbilical opening); and D. Rimate (with umbilical opening partially closed by apertural lip).



***Snails differ in the shape of their shell.



Pupa Shape



Beehive Shape



Heliciform Shape



Depressed Heliciform

SNAIL IDENTIFICATION WORKSHEET

Describe the snail shells below. Use the snail information sheet to help you.



1. _____
2. _____
3. _____



1. _____
2. _____
3. _____



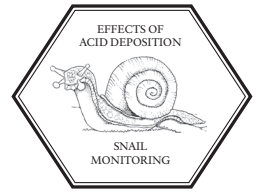
1. _____
2. _____
3. _____



1. _____
2. _____
3. _____

SNAIL IDENTIFICATION WORKSHEET

ANSWER KEY



Some possible answers, not inclusive.



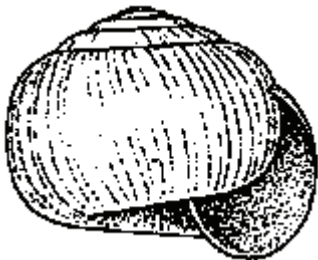
1. lip present _____
2. teeth present _____
3. small opening and/or crescent shaped _____



1. no lip _____
2. spiny _____
3. no apex _____



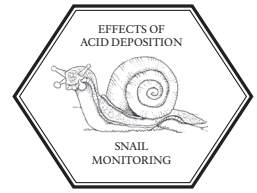
1. tall apex, no umbilicus _____
2. no visible opening _____
3. large tooth _____



1. no lip, no teeth _____
2. indented umbilicus _____
3. tall apex _____

ON-SITE ACTIVITY

SNAIL STUDY



Grade Level: High School

Subject Area: Science

Activity time: 75 minutes

Setting: Classroom

Skills: Categorizing, Classifying, Collecting information, Communicating, Connecting, Gathering information, Identifying cause and effect, Interpreting, Proposing solutions, Recording data, Sorting

Vocabulary:

- **Aspirator:** a piece of scientific equipment that uses suction to collect specimens that are too small to pick up with hands or tweezers.
- **Biological Monitoring:** a technique used by scientists to check the condition of a particular species or ecosystem over time.
- **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.

Materials:

- Plastic bags
- GPS unit
- 3D Snail Key
- Identification keys

Objectives:

- 1) explain why scientists are concerned about snail populations
- 2) explain the role snails play in the soil food chain
- 3) search for and identify the types of snails found

Background:

During the field trip the students are going to look on the soil surface for a particular animal, snails, because they are of special concern to park biologists.

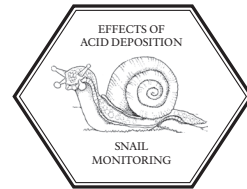
Our soils in the park, especially at high elevations such as Purchase Knob, are exposed to high levels of acid rain (or rain with low pH). Park managers are very concerned about how this affects soils and the availability of nutrients to plants and animals. Soils with a pH of 5.5 or lower have a low availability of calcium and other nutrients but an overabundance of aluminum and iron. How would a loss of calcium affect an animal like a snail (needed for shell production)? How does that affect the rest of the food chain (calcium in snails is important to other animals such as birds who need it for egg shell production)?

Procedure:

Your students are going to participate in an on-going study to inventory (identify) and monitor snail species. After we have collected and noted the locations throughout the park of snails for a few years, we will get an idea of what is considered a normal distribution and population size. During the field trip we will try to identify the type of snail using the snail's physical characteristics. The students are participating in an on-going monitoring program that won't show any definite information for a few years.

POST-SITE ACTIVITY

MAKING CALCIUM CONNECTIONS



Grade Level: High School

Subject Area: Science

Activity time: 30 minutes

Setting: Classroom

Skills: Categorizing, Collecting information, Communicating, Comparing, Contrasting, Connecting, Gathering information, Interpreting

Materials:

- Computer with internet connections
- "Making Calcium Connections" concept map (page 14)
- "Making Calcium Connections" concept map answer key (page 15)

Objectives:

- 1) learn about calcium's importance to both humans and snails
- 2) make connections between snail and human's calcium needs

Background:

Calcium is a very important element to both the snail and the human body. During this lesson students will list connections between their own need for calcium and a snail's need for calcium.

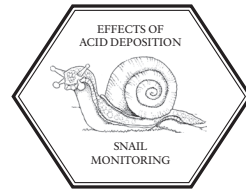
Calcium is the fifth element and the third most abundant metal in the earth's crust. The calcium compounds account for 3.64% of the earth's crust. The distribution of calcium is very wide; it is found in almost every terrestrial area in the world. This element is essential for the life of plants and animals, for it is present in the animal's skeleton, in tooth, in the egg's shell, in the coral and in many soils. Seawater contains 0.15% of calcium chloride. Calcium cannot be found alone in nature.

Procedure:

Students are to use the computers to research the similarities between snails and humans in relation to the need for calcium. The students will use the researched information to complete the "Making Calcium Connections" concept map.

Reference:

- <http://www.lenntech.com/periodic/elements/ca.htm>



MAKING CALCIUM CONNECTIONS

Sources of calcium for Snails in the environment:

- 1.
- 2.

Sources of calcium for Humans in the environment:

- 1.
- 2.

Calcium's function for the Snail:

- 1.
- 2.

Calcium's function for the Human:

- 1.
- 2.

Calcium

Effect of calcium deficiency on a Snail:

- 1.
- 2.

Effect of calcium deficiency on a Human:

- 1.
- 2.

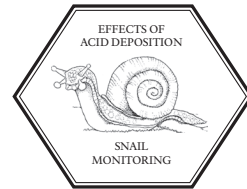
Location where Calcium is found in the Snail's body:

- 1.

Locations where calcium is found in the Human's body:

- 1.
- 2.





MAKING CALCIUM CONNECTIONS TEACHER KEY

Sources of calcium for Snails in the environment:

1. Calcium is found mostly as limestone, gypsum and fluoride. Stalagmites and stalactites contain calcium carbonate.
2. Calcium is always present in every plant, as it is essential for its growth. It is contained in the soft tissue, in fluids within the tissue and in the structure of every animal's skeleton.
3. Dogwood trees and their calcium-rich leaves
4. Other snail shells

Sources of calcium for Humans in the environment:

1. Dairy products
2. Nuts, some green vegetables like spinach, and cauliflower, beans, lentils...

Importance of calcium for the Snail:

1. The shell of a snail is made up of calcium carbonate. The growth of the shell in the young animal.
2. Maintenance of the shell and repair in the adult snail.

Importance of calcium for the Human:

1. Essential component for the preservation of the human skeleton and teeth
2. Assists the functions of muscle contraction, central nervous function and hormone secretion.

Calcium

Effect of calcium deficiency on a Snail:

1. Death of snail
2. Thinning of snail shell

Effect of calcium deficiency on a Human:

1. Chronic calcium deficiency contributes to poor mineralization of bones: Osteoporosis and Soft bones (osteomalacia)
2. Hypocalcemia (low level of calcium) and Tetany
3. Hypercalcemia
4. In children, rickets and impaired growth.

Location where Calcium is found in the Snail's body:

1. Shell

Locations where calcium is found in the Human's body:

1. 99% of Calcium is the bones, teeth, and cartilage.
2. 1% is used in nervous impulses

