Stream Scientist

Ranger Led Program

Theme: Water Quality, Macroinvertebrates, Biodiversity
Grade Level: 6th-8th grade
Best Time to Plan Trip: Spring or Fall

Unit Rationale

Students will learn how researchers and park scientists use scientific methods to study streams and explore relationships of streams to other influences. Your park visit will allow the students to become active participants in learning about stream management including water quality testing, stream flow measuring, and sampling of stream life using waders and nets. To prepare for your trip, please view the video "Downstream" and use the included pre-site classroom activities. The on-site instruction is conducted by park rangers with your assistance with discussion and discipline. Please feel free to contact the park if you have further questions.

State Curriculum Standards - Tennessee

Sixth Grade

Science
Embedded Inquiry
- SPI 0607 Inq. 1
- SPI 0607 Inq. 2
- SPI 0607 Inq. 3
- SPI 0607 Inq. 4
- SPI 0607 Inq. 5

Independence
- SPI 0607 2.1
- SPI 0607 2.2

English/Language Arts
Communication
- SPI 0601.2.4
- SPI 0601.2.5

Seventh Grade

Science
Embedded Inquiry
- SPI 0707 Inq. 1
- SPI 0707 Inq. 2
- SPI 0707 Inq. 3
- SPI 0707 Inq. 4
- SPI 0707 Inq. 5

English/Language Arts
Communication
- SPI 0701.2.7
- SPI 0701.2.8

Eighth Grade

Science
Embedded Inquiry
- SPI 0807 Inq. 1
- SPI 0807 Inq. 2
- SPI 0807 Inq. 3
- SPI 0807 Inq. 4
- SPI 0807 Inq. 5

Biodiversity and Change
- SPI 0807.5.1
- SPI 0807.5.2
- SPI 0807.5.3
- SPI 0807.5.4

English/Language Arts
Communication
- SPI 0801.2.7
- SPI 0801.2.8

Sixth Grade

Science

Embedded Inquiry

- SPI 0607 Inq. 1 Design a simple experimental procedure with an identified control and appropriate variables.
- SPI 0607 Inq. 2 Select tools and procedures needed to conduct a moderately complex experiment.
- SPI 0607 Inq. 3 Interpret and translate data into a table, graph, or diagram.
- SPI 0607 Inq. 4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.
- SPI 0607 Inq. 5 Identify a faulty interpretation of data that is due to bias or experimental error.

Interdependence

- SPI 0607.2.1 Classify organisms as producers, consumers, scavengers, or decomposers according to their role in a food chain or web.
- SPI 0607.2.2 Interpret how materials and energy are transferred through an ecosystem.

English/Language Arts

Communication

- SPI 0601.2.4 Select the most appropriate behaviors for participating productively in a team (e.g., contribute appropriate and useful information and ideas, understand the purpose for working as a team, understand the responsibilities of various roles within the team).
- SPI 0601.2.5 Identify the functions and responsibilities of individual roles within an organized group (i.e., reporter, recorder, information gatherer, leader, timekeeper).

Seventh Grade

Science

Embedded Inquiry

- SPI 0707 Inq. 1 Design a simple experimental procedure with an identified control and appropriate variables.
- SPI 0707 Inq. 2 Select tools and procedures needed to conduct a moderately complex experiment.
- SPI 0707 Inq. 3 Interpret and translate data into a table, graph, or diagram.
- SPI 0707 Inq. 4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.
- SPI 0707 Inq. 5 Identify a faulty interpretation of data that is due to bias or experimental error.

English/Language Arts

Communication

- SPI 0701.2.7 Select the most appropriate behaviors for participating productively in a team (e.g., ask primarily relevant questions that move the team toward its goal and contribute to the topic of discussion, articulate the goals that have been provided for the team work and ask clarifying questions, come to agreement by seeking consensus or following the majority).
- SPI 0701.2.8 Identify the functions and responsibilities of individual roles within an organized group (i.e., reporter, recorder, information gatherer, leader, timekeeper).

Eighth Grade

Science

Embedded Inquiry

- SPI 0807 Inq. 1 Design a simple experimental procedure with an identified control and appropriate variables.
- SPI 0807 Inq. 2 Select tools and procedures needed to conduct a moderately complex experiment.
- SPI 0807 Inq. 3 Interpret and translate data into a table, graph, or diagram.
- SPI 0807 Inq. 4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.
- SPI 0807 Inq. 5 Identify a faulty interpretation of data that is due to bias or experimental error.

Biodiversity and Change

- SPI 0807.5.1 Use a simple classification key to identify an unknown organism.
- SPI 0807.5.2 Analyze structural, behavioral, and physiological adaptations to predict which populations are likely to survive in a particular environment.
- SPI 0807.5.3 Analyze data on levels of variation within a population to make predictions about survival under particular environmental conditions.
- SPI 0807.5.4 Identify several reasons for the importance of maintaining the earth's biodiversity.

English/Language Arts

Communication

- SPI 0801.2.7 Select the most appropriate strategies for participating productively in a team (e.g., gain the floor in orderly ways, meet or set deadlines for completing each task, come to agreement by seeking consensus or following the majority).
- SPI 0801.2.8 Identify the functions and responsibilities of individuals within an organized group (i.e., reporter, recorder, information gatherer, leader, timekeeper).

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Planning a Successful Trip
Stream Scientist

Schedule for a day of activities in Great Smoky Mountains National Park

• Arrive at Sugarlands Visitor Center for restrooms and to meet rangers
• On-site activities with lunch in between activities
• Reload bus and return to school

Planning a Successful Trip

• The location for this trip is at the Sugarlands Visitor Center located near Gatlinburg. Park rangers will direct your bus driver where to park.

• All students, teachers, and chaperons will meet the park rangers at Sugarlands Visitor Center. The rangers will introduce themselves, state the theme of the program, and explain where and how the program will be conducted. The program includes several activity stations in and around the stream. Students will be wearing wading boots in the stream; however, have the students bring a towel and extra shoes in case they get wet.

• There is no cost to use this site.

• Arrange to have a teacher or chaperone available for every 10 students.

Safety Considerations and Other Important Information

• Great Smoky Mountains National Park is a federally protected public use area. Please help the rangers keep all of the plants and animals protected in the park by not picking the plants or taking anything from the park.

• Please remind your students to wear appropriate footwear and clothing for this extended outdoor experience. Flip flops, slip-on shoes, or sandals are not appropriate for the program.

• Temperatures in some parts of the park can be 10-15 degrees colder than at your school. Long pants and layers are suggested for the program. Pants are the best precaution against cool temperatures, bee stings, ticks, and poison ivy.

• Within the park, cell phones are not always reliable. Rangers will follow the on-site agenda. If an unexpected problem occurs, rangers do carry park radios to make contact with the park dispatch office. For non-emergencies, call the Park Ranger dispatch at 865-436-1230 or contact a park employee.

Animals and Plants of Concern in the park

• All animals in the park are wild and their behaviors are unpredictable. Treat all animals with caution.

• Venomous snakes - Two species of venomous snakes live in the Smokies, the copperhead and timber rattlesnake. Students should be cautious where they place their hands and feet.

• Insects - Yellow jacket wasps are the insects of greatest concern. They build nests in the ground along trails and streams and are aggressive when disturbed. Stings cause local swelling and can lead to severe allergic reactions in sensitive individuals. Such persons should carry epinephrine kits.

• Poison Ivy - Poison ivy is a three-leaved plant which can grow on the ground as well as on "hairy" vines up trees. To avoid chances of an allergic reaction wear long pants, stay on trails, and avoid direct contact with vegetation. If contact occurs or is a concern, wash affected parts in cold soapy water immediately.

• It is extremely helpful to rangers leading the program for students to wear clearly labeled name tags with first names only.

• Pets are not allowed on most park trails. Please do not bring them on the field trip.

• For more information about the park (Things to Know Before You Come) please visit the park's website: http://www.nps.gov/grsm/planyourvisit/things2know.htm

Background Information

Park Description:

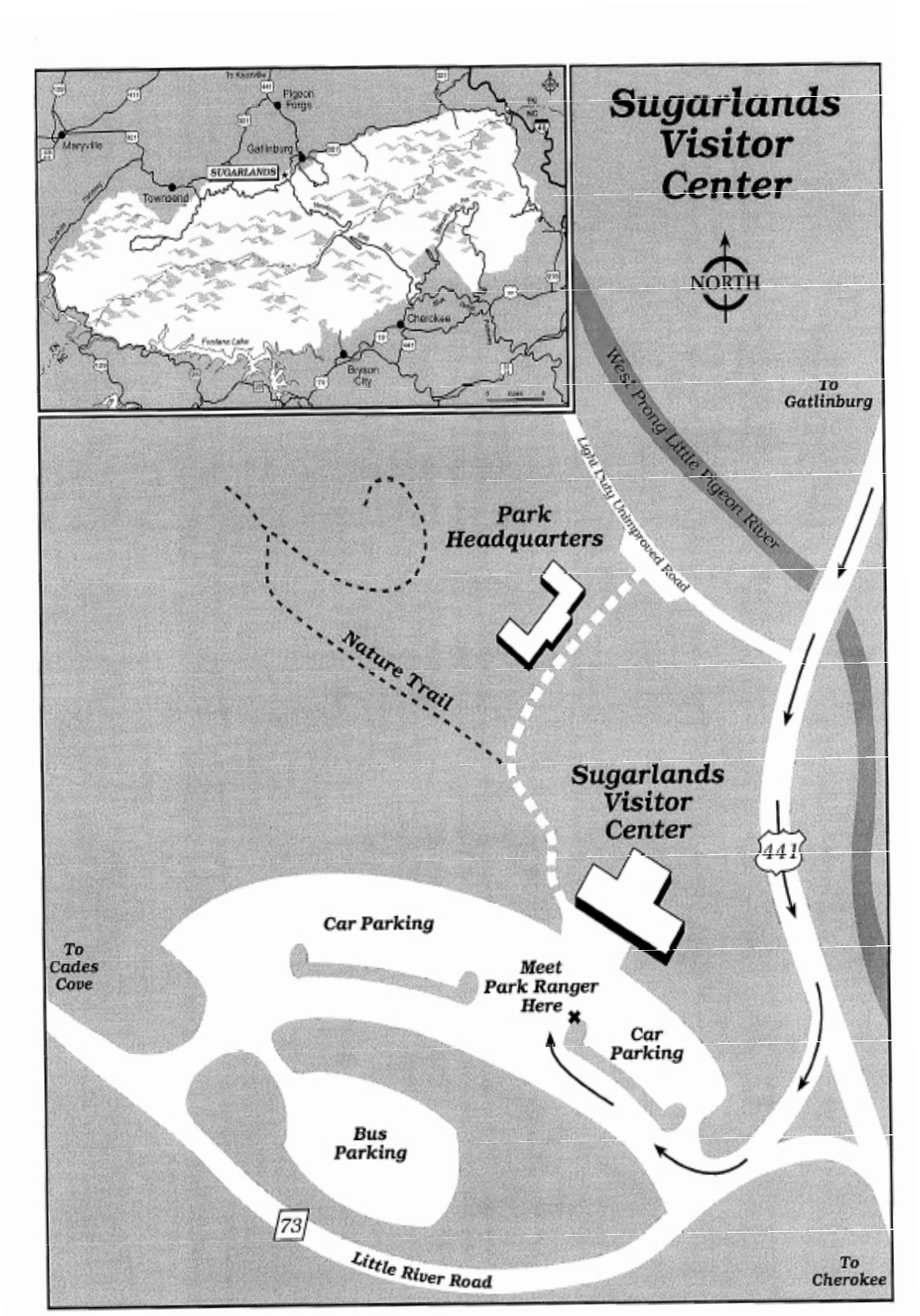
The National Park Service is charged with the management and preservation of the nation's most precious natural and cultural resources. These resources are woven into our natural heritage, and they provide opportunities for recreation, appreciation of beauty, historical reflection, cultural enrichment,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

Map to Sugarlands Visitor Center



Pre-Site Activity
Water Quality Information

Grade Level: 6th-8th

Subject Area: Science

Activity time: 60 minutes

Setting: Classroom

Skills: Analyzing, Categorizing, Communicating, Comparing, Describing, Listening

Vocabulary:

•Acidic: a solution that has more hydrogen ions than it does.

•Alkalinity: a measure of the ability of a water sample to resist a decrease in pH and thus protects humans, wildlife, and aquatic life from the effects of acidification; determined on a filtered sample.

•Basic: a solution that has more hydroxide ions than hydrogen ions.

•Benthic: bottom dwelling organisms living below the water surface on the substrate.

•Biomass: the collective total mass of an organism, population, community or ecosystem.

•Conductivity: measure of how well a water sample conducts electricity and an estimate of the total dissolved solids in a sample .

•Dissolved oxygen (DO): the concentration of free molecular oxygen (a gas) dissolved in water.

•Ecosystem: a hypothetical 'system' used to describe patterns in the various ways that living and non-living things interact.

•Eutrophication: a process by which water rich in mineral and organic nutrients promotes a proliferation of plant life which overproduces, dies, and eventually reduces water's oxygen level as bacteria decompose it (using more oxygen in the process).

•Headwaters: the most upstream segments of streams. In this area streams are just beginning to form and may be very small.

•Macroinvertebrate: an invertebrate that is large enough to be seen without the use of a microscope.

•Nitrogen fixation: the conversion of elemental nitrogen in the atmosphere to a form that can be used as a nitrogen source by organisms.

•Parameters: measurable characteristics that may be used to explain biological systems (for example, acid rain deposition in a forest soil is a measurable parameter).

•pH: the hydrogen ion concentration of hydroxide ions when they are dissolved in water.

•Predator: an organism which primarily obtains energy from consuming other living non-plant organisms.

•Species richness: the total number of species collected in a sample or community.

•Specific heat: the amount of heat per unit mass required to raise the temperature of a material by one degree Celsius.

•Tolerance: generally used to refer to the ability of organisms to withstand pollution.

Objectives:

1) become familiar with the vocabulary associated with water quality monitoring
2) become familiar with the types of water quality tests within water quality monitoring
3) determine the differences between monitoring and inventory
4) understand the biodiversity of the Great Smoky Mountains National Park
5) recognize that many plants and animals in the park are endemic species meaning they are known to live only in the park
6) become familiar with the current threats to the water systems within the Park

Materials:

•Water Quality Vocabulary worksheet (page 7)
•Water quality parameters worksheet (pages 9)
•Computer with internet connection.

Vocabulary and Definitions for Water Quality Study

Background:

When students visit the Smokies on their field trip they will be collecting data as part of the Water Quality monitoring study. This lesson will introduce key vocabulary terms and information regarding the different water quality tests that will be performed. Relate to the students that during their field trip to the National Park they will be assisting in a research project by collecting data on the water quality of a National Park stream. To do this, they will need to be knowledgeable of the vocabulary used during the trip.

Procedure:

Students should work in pairs or by themselves in reviewing the different Test Parameters, Stream Ecology Basics, and Vocabulary.

To view the Biodiversity podcast video go to
http://www.thegreatsmokymountains.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.thegreatsmokymountains.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.thegreatsmokymountains.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.

To view the Hellbenders podcast video go to
http://www.thegreatsmokymountains.org/eft/10modules.html Turn the microscope knob that appears on the computer screen to Section 4, Studying Biodiversity. Click "Watch Video" and view video.

Resources:

"Stream Ecology Basics Sampling Training Guide" http://www.dlia.org/dlia/education/activities_stream_ecology.pdf
"Healthy Water Healthy People" Testing Kit Manual

Water Quality Parameters

Alkalinity = total measure of the substances in water that have "acid-neutralizing" ability, the power to keep its pH from changing.

Importance and Explanation? Important for fish and aquatic life because it protects or buffers against pH changes, keeping the pH fairly constant, and makes water less vulnerable to acid rain. The main source of natural alkalinity is rocks(limestone).

Conductivity = measure of how well a water sample conducts electricity and an estimate of the total dissolved solids in a sample.

Importance? Presence of ions in water makes it a good conductor of electricity. Ions that are often found in natural waters include: calcium, aluminum, magnesium, sodium, potassium, carbonate, bicarbonate, phosphate, chloride, nitrate, and sulfate.

Dissolved Oxygen (DO) = amount of oxygen that is dissolved in water.

Importance and Explanation? Measuring DO in water indicates how much DO is present but not how much oxygen the water is capable of dissolving. The dissolved oxygen gets into the water by diffusion from the surrounding air; aeration of water that has tumbled over falls and rapids; and as a waste product of photosynthesis.

Nitrate = measures the organic or fertilizer matter in water.

Importance and Explanation? Nitrite and Nitrate are forms of the element Nitrogen, which makes up about 80 percent of the air we breathe. As an essential component of life, nitrogen is recycled continually by plants and animals, and is found in the cells of all living things. Nitrogen is unavailable for plant use in its most common form, atmospheric nitrogen (N_2); therefore, nitrate often becomes a limiting nutrient for plant growth.

pH = measures the hydrogen ion concentration or activity on a logarithmic scale.

Importance and Explanation? The hydrogen ion concentration determines the pH of a solution. pH is referred to as hydrogen ion concentration or activity. An acid is a solution with more hydrogen ions than hydroxide ions. The pH test measures the hydrogen ion concentration and allows us to infer how acidic or basic a substance is.

Phosphate = measures the organic or fertilizer matter in water.

Importance and Explanation? Phosphorus is an essential nutrient for all forms of terrestrial life and is known to be required for plant growth, storage, and transmission. Phosphates are found in several types of rocks; however, more than half of the phosphates found in lakes, streams, and rivers are the result of human activity.

Temperature = measures the average amount of heat in the water.

Importance and Explanation? Temperature determines processes necessary for life, reproductive timing and duration of the life cycle of aquatic organisms. Air temperature may change by 20°C in a 24 hour period; however, water temperature will change insignificantly in a 24 hour period. The concept of specific heat is critical to understanding water temperature measurement. Water has a high specific heat because it takes a large amount of heat to break hydrogen bonds, the attraction of one water molecule to another water molecule.

Turbidity= cloudy appearance of water caused by light scattering suspended particles.
Transparency (Clarity) = measures the clearness of water and is an indicator of how well light passes through it.

Importance and Explanation? Any substance that makes water cloudy will cause turbidity. Turbidity affects fish and aquatic life by interfering with sunlight penetration. Water plants need light for photosynthesis. If suspended particles block out light, photosynthesis—and the production of oxygen for fish and aquatic life—will be reduced.

Pre-Site Activity: Aquatic Adaptation

Grade Level: 6th-8th

Subject Area: Science

Activity Time: 60 minutes over two class periods

Setting: Indoors

Skills: **Classifying;** Comparing; Contrasting; Describing

Vocabulary: invertebrate; insects; larvae; nymph

Objectives: **To introduce students to the defining characteristics of aquatic macroinvertebrates.**

Materials: Insect identification Cards, "adoption" certificates (see following pages)

Procedure for Teacher:

Generate overhead transparencies of each macroinvertebrate in this packet (pages A-C). Cut the overheads into 18 individual overhead cards for the following activity.

Remind students that insects can be born from the land or the water. Divide students into groups of 2 or 3, share information about aquatic macroinvertebrates they will most likely find on their park trip. Allow each group to pick an insect (or teacher may assign them one).

Explain to each group that they will need to be able to identify "their" invertebrate while on the field trip. Give each student one evening to learn their creature by sight and study facts about their creature.

Procedure for Students:

The following day, students must be able to identify their creature. Students may participate in a challenge to identify their insect in front of the class. Teacher can randomly show the insect cards on the overhead. Students must quickly "claim" their creature if it was the one assigned to them. Each group earns points for each fact they can recall about their creature. Pass out an "adoption certificate" to each student upon successful identification of their macro-invertebrate. Participation and their total score earned during the quiz.

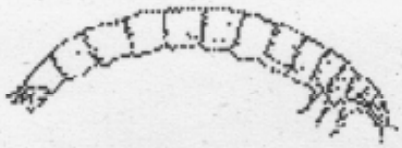
Extension:

Visit an area around your school where these macroinvertebrates may have hatched out of the water. See how many creatures in their adult stage can be found flying or crawling in the area. Students may have to research what their larvae changes into in its adult stage

Overhead Quiz Cards for Aquatic Adoptions- Page A

A

B



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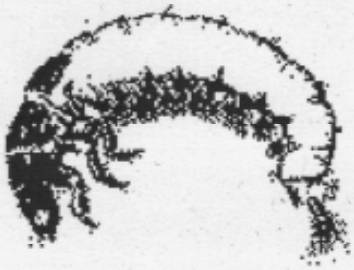

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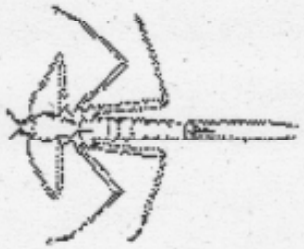

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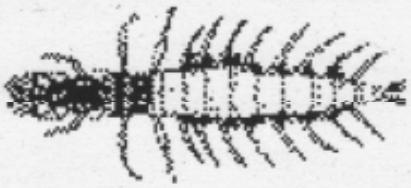

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Overhead Quiz Cards for Aquatic Adoptions- Page B

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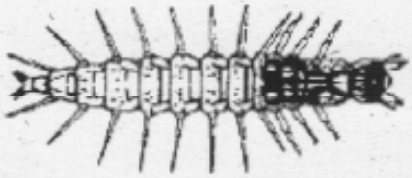

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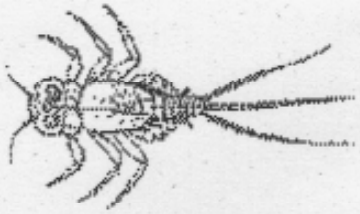

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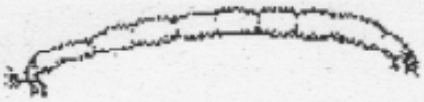

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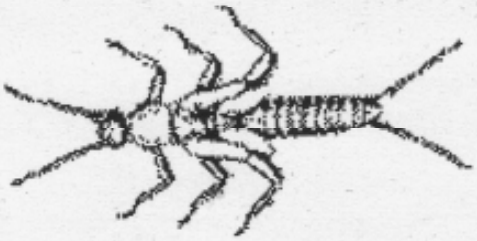

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Overhead Quiz Cards for Aquatic Adoptions- Page C

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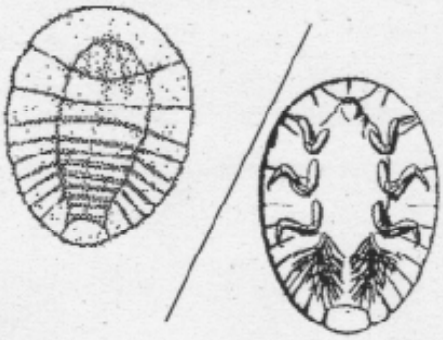

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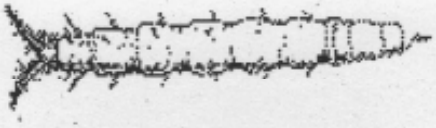

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Aquatic Adoption Cards

A. Alderfly Facts

- Carnivorous and may bite
- Develop over period of one to three years
- Mouth has large, chewing pinchers
- Smooth underside without gill tufts
- Abdomen has strand-like appendages extending from each side
- Three pairs of segmented legs on middle section of body with tiny pinchers at the end of each
- Straight, single feathery tail
- 3/4 to 4 inches long
- **Somewhat sensitive to water pollution**

B. Aquatic Worm Facts

- May be found in large numbers in organically polluted streams
- Moves by stretching and pulling its body along in a worm-like fashion
- May be red, tan, black or brown
- Can look like an earthworm or be much narrower and thread-like
- Segmented body
- Up to five inches long
- May have short bristles or hairs that help with movement, but are not usually visible
- **Tolerant of water pollution**

C. Riffle Beetle Larva Facts

- Up to 3/4 long
- Body is long, hard, still, segmented
- Six long segmented legs on upper middle section of body
- Back end has two tiny hooks and short hairs
- **Somewhat sensitive to water pollution**

D. Black Fly Larva Facts

- Move by drifting downstream on silken threads that extend from the tip of the abdomen
- Often stuck by their attachment disks to the surface of rocks, sticks or other debris in the streams
- Up to 1/3 inches long
- The head is usually black, but sometimes brown, tan or green
- One very tiny leg-like appendage directly under the head
- Attachment disks (small suckers) on the end of the abdomen
- Back end of the body widens and is bulbous
- No legs
- Tiny gills by head filter food from water
- **Tolerant of water pollution**

E. Caddisfly Facts

- Some make houses or cases for themselves out of different materials such as rocks, sand, gravel, twigs or leaves using a glue-like substance secreted from their back end
- Some spin webs to trap food from the flowing water
- Up to 1 1/2 inches long
- Very small or no antennae
- Six segmented legs on upper middle section of body
- Filamentous gills may be on the end of the body or on the underside
- Two small, thick extensions at the end of the body and each has a single hook at the end
- **Although most species are very sensitive to pollution, some are pollution tolerant**

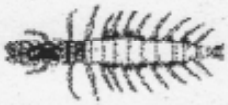
F. Cranefly Facts

- Develop over a period of six weeks to five years
- Close to 300 species in North America
- Up to four inches long
- Head is usually retracted so the front end appears round
- Fleshy, plump, rounded segmented body
- Its digestive track (internal organs) can be seen moving back and forth as it crawls
- No legs
- Back end usually has several extentions or finger-like lobes
- Milky, light-brown, gray or greenish in color
- **Somewhat sensitive to water pollution**

G. Damselfly Facts

- Develop over one to four years
- Large eyes
- Large scoop-like lower lip
- No gills on the sides or underneath the abdomen
- Six long segmented legs on the upper middle section of the body
- 1/2 - 1 inch long
- Long spindly legs
- **Somewhat sensitive to water pollution**

H. Hellgramite Facts (also called Dobsonfly)

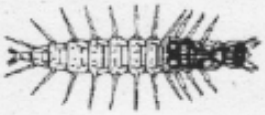


- Carnivorous and may bite
- One to four inches long
- Mouth has large, chewing pinchers
- Six segmented legs on middle section of body with tiny pinchers at the end of each
- Many fleshy, filamentous appendages on each side of the abdomen
- Back end is forked with two short tails and two hooks on each tail
- Gill tufts on the underside of the tail that look like "hairy armpits"
- Dark brown to black in color
- Often confused with fishfly but fishfly is smooth on underside with no gill tufts
- **Very sensitive to water pollution**

I. Dragonfly Larva Facts

- Develop over one to four year period
- Large eyes
- Large scoop-like lower lip
- Wide oval or round abdomen that may end in three wedge-shaped extensions
- No gills on the sides or underneath
- 3/4 - 2 inches long
- Six long segmented legs on upper middle section of body
- **Somewhat sensitive to water pollution**

J. Fish Fly Facts

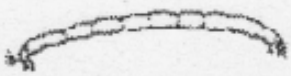


- Carnivorous and may bite
- Develop during period of one to three years
- Mouth has large, chewing pinchers
- Up to 1 and 1/2 inches long
- Three pairs of legs on middle section of body with tiny pinchers at the end of each
  Back end is forked with two short tails and two hooks on each tail
- Often confused with hellgramite (dobson fly larva) but does not have fluffy gills on underside
- **Somewhat sensitive to water pollution**

K. Mayfly Facts

- About 700 species in North America
- Develop in streams during a period of two weeks to two years
- Live on exposed rock surfaces in fast current or buried in soft stream beds
- Large numbers of flying adults may emerge from stream at the same time
- Plate- like or feathery gills along the sides of the abdomen
- Two or three long hair-like tails
- Six segmented legs on middle section of body
- Up to one inch long
- The body can be up to one inch long
- Body is usually flat
- **Very sensitive to water pollution**

L. Midgefly Facts



- Almost 2000 species in North America
- Are found in all but the most polluted aquatic conditions
- Up to 1/2 inch long
- One pair of tiny, fleshy legs below the head and one pair on the back end
- The back end sometimes has a tiny pair of extensions that look like brushes
- A thin dark line (digestive tract) can be seen inside the body
- **Fairly tolerant of polluted water**

M. Sowbug Larva Facts

- Also called the pillbug (adult stage)
- Up to ¾ inches long
- Seven pairs of legs
- Dark brown to grey in color
- Two pairs of antennae (one pair is much longer than the other)
- Much wider than they are high and rather flat
- **Somewhat sensitive to water pollution**

N. Whirligig Beetle Larva Description

- Pincher-like mouth parts
- Six segmented legs on middle section of the body
- The legs end in tiny claws
- Four hooks at the end of the body
- No tail
- **Somewhat sensitive to water pollution**

O. Scud Larva Facts

- They swim rapidly on their sides and are nicknamed "side swimmers"
- Usually found where there are plants in the water
- Seven pairs of tiny segmented legs
- Two pairs of antennae
- Color is white to clear
- 1/4 to one inch long
- Resembles a freshwater shrimp
- Hard, plate-like shell except over the head and upper body
- **Somewhat sensitive to water pollution**

P. Stonefly Larva Facts

- Are found in cool, clean streams with high levels of dissolved oxygen
- Develop in the stream for period of three months to three years
- Are either predators or feed on fungi and bacteria from rotting leaves
- Two long antennae
- Two hair-like tails
- Six segmented legs on middle section of body
- 1/4 - 2 inches long
- **Very sensitive to water pollution**

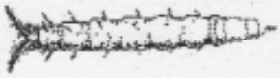
Q. Description of Riffle Beetle Adult

- Length is up to ¾ inch long
- Body is long, hard, stiff and segmented
- Six long segmented legs on upper middle section of body
- Back end has two tiny hooks and short hairs (may be hard to see)
- **Very sensitive to water pollution**

R. Water Penny Facts

- Segmented plate-like covering
- Six tiny segmented legs beneath the round body
- Color is brown, black or tan
- The water penny is the aquatic larva of a beetle; the adult of the species is not aquatic
- The body is often stuck flat to surfaces and looks like a tiny round leaf
- Measures 1/4" diameter
- **Very sensitive to water pollution**

S. Watersnipe fly Facts



- Body is tapered at the head end
- Up to two inches long
- Carnivorous/ they can bite
- Body has two feathery-like horns at the back end
- Many pairs of caterpillar-like legs on the underside
- Pale to green in color
- **Somewhat sensitive to water pollution**

Certificate of Adoption

This document certifies that _____ has chosen to be
(student name)

temporary caretaker of a _____ named _____
(type of macroinvertebrate) (name your creature)

while on a visit to Great Smoky Mountains National Park. The student promises to carefully collect macroinvertebrates while not causing any harm to the resources of the National Park. All creatures collected for observation will be safely returned to the waters from which they were born.

I agree to the care and responsibilities listed above

_____
(student signature)

Park Official _____ Date _____

(photocopy and cut on dotted line)

Certificate of Adoption

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_____
(student signature)

Park Official _____ Date _____

On-Site Activity
Park Ranger Directed Lessons

Grade Level: 6th-8th

Subject Area: Science

Activity Time: 3 hours

Class Size: Maximum 50 students

Setting: Outdoors

Skills: Classifying; Discussing; Evaluating; Experimenting; Hypothesizing; Listening; Observing; Proposing solutions; Recording data

Vocabulary: dissolved oxygen; ecosystem; erosion; groundwater; hydrology; invertebrate; insects; kick-net; larvae; nymph; nitrates; non-point source pollution; pH; point source pollution; streamflow

Objectives: Students will explore an aquatic ecosystem within Great Smoky Mountains National Park.

Materials: Study equipment provided by park rangers

Background:
The following is a brief description of your on-site activities. These activities will be led by park staff, but please be familiar with them, as the classroom teacher may be asked to assist on-site.

Water Quality Testing (45 minutes)
Students will use different scientific methods and tools to test the water quality of a stream.

Pass the Ball (15 minutes)
This activity is designed to teach students about the water cycle, watersheds, and groundwater.

Who Polluted Our River (30 minutes)
Even though mountain springs are considerably clean, there are some unseen pollutants in the water. Students will learn about the various pollutants that can be found in the water and their source.

Aquatic Creatures (1.5 hours)
Students will generate and test a hypothesis about stream health based on what types of aquatic macroinvertebrates are found in the water.

Post-Site Activity
Graphing Elevation Trends and Stewardship

Grade Level: 6th-8th

Subject Area: Science

Activity time: 60 minutes

Setting: Classroom

Skills: Analyzing, Applying, Assessing, Calculating, Charting, Communicating, Connecting, Contrasting, Discussing, Evaluating, Generalizing, Graphing, Inferring, Predicting, Summarizing

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

Objectives:
1) demonstrate the ability to graph provided data
2) describe the trends seen from the graph
3) communicate the park-wide trends of water quality within the park
4) understand the term "Stewardship"
5) learn how each student can become a steward to their own school and community

Materials:
•"Great Smoky Mountains Watershed Elevation Trends" worksheet (pages 23-24)
•Teacher Answer Key (page 25)
•Computer with internet connection

Background:
Great Smoky Mountain watersheds show distinct differences in geology and morphology (land shape) with elevation (example: steeper slopes at higher elevations). Differing elevations show differing levels of the various parameters. Ask students to hypothesize some reasons why elevation would affect the pH, nitrates, and sulfates.

Procedure:
Have the students individually study the table of provided information of elevation versus several parameters. The students will then construct a graph of elevation versus pH, elevation versus nitrate, and elevation versus sulfate. Remind the students to label their axes. After graphing, the students should be able to use the graph to summarize in words what trends are seen within the graph. Regroup the students upon completion of the graphs and summary. Compare answers as a group.

To view the Stewardship podcast video go to **http://www.thegreatsmokymountains.org/eft/10modules.html** and 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.

Great Smoky Mountains Watershed Elevation Trends

Great Smoky Mountain watersheds show distinct differences in geology and morphology with elevation (example: steeper slopes at higher elevations). Different fish species are more common in different elevation ranges.

Comparison of Different Parameters in regards to Elevation

	Current Conditions		
Elevation (feet)	pH	Nitrate (kg/ha)	Sulfate (μeq/l/yr)
1,000-1500	6.66	10.5	44.2
1,500-2,000	6.57	11.5	35.6
2,000-2,500	6.34	12.8	32.8
2,500-3,000	6.30	18.8	36.8
3,000-3,500	6.12	23.9	42.9
3,500-4,000	6.18	35.2	71.2
4,000-4,500	5.85	34.7	74.8
4,500-5,000	5.74	34.6	72.8
5,000-5,500	5.66	49.9	37.7
>5,500	5.11	64.3	38.0

Construct a graph of elevation versus pH, nitrate, and sulfate. Remember to label your axes.

A. Elevation versus current pH

B. Elevation versus nitrate

C. Elevation versus sulfate

Summary of Graphs

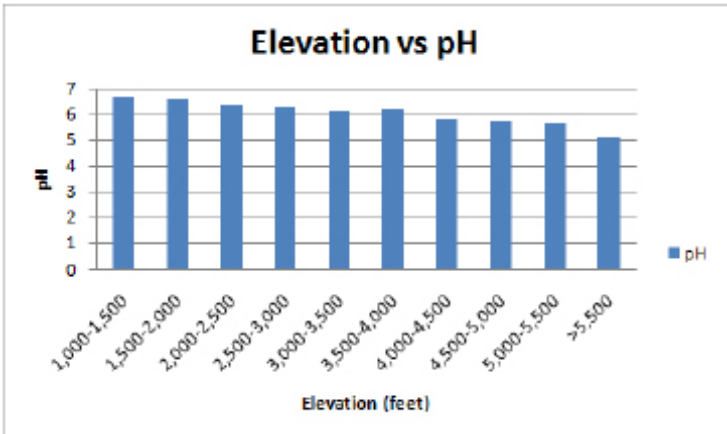
A. By viewing your graph, what is the overall trend of elevation versus pH?

B. By viewing your graph, what is the overall trend of elevation versus nitrate?

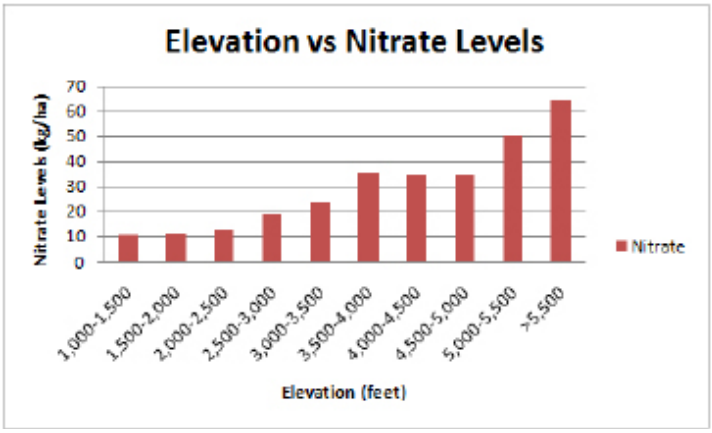
C. By viewing your graph, what is the overall trend of elevation versus sulfate?

Great Smoky Mountains Watershed Elevation Trends Teacher Answer Key

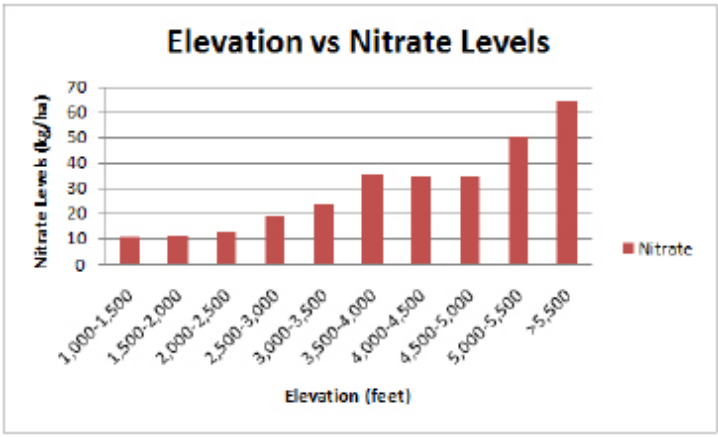
A.



B.



C.



Summary of Graphs

A. By viewing your graph, what is the overall trend of elevation versus pH?

pH decreases as elevation increases.

Teacher Information: pH is declining at 0.2 units/yr at elevations 1,000-3,500 feet but no change above 3,500 feet. If current trends continue, median pH of Little River at Elkmont (elev. 2,146feet) will be 6.0 in 34 years, many others <25 years (Robinson et al. 2007)

B. By viewing your graph, what is the overall trend of elevation versus nitrate?

Nitrate concentrations increase as elevation increases.

Teacher Information: Nitrate concentrations and total N deposition (kg/ha) show no change, although ammonia and nitrate in precipitation has been declining (Robinson et al. 2007). There was elevated nitrogen and cations leaching in soils following hemlock decline and mortality (Yorks et al. 1999)

C. By viewing your graph, what is the overall trend of elevation versus sulfate?

Sulfate concentrations decrease from 1,000-2,000 feet and increase from 2,000 feet until 5,000 feet and then decrease.

Teacher Information: Sulfate concentrations have been declining at a rate of -0.83 to -1.3 eq/l/yr at elevations less than 3,500ft consistent with decreasing atmospheric sulfate deposition; similar to rates seen at Hubbard Brook (Gbondo-Tugbawa and Driscoll 2002) from low to high elevation (-1.2 to -2.5 eq/l/yr) (Robinson et al. 2007)

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 rain gear.

- 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).

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 rain gear.

-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