

# WATER QUALITY



**THEME:** Water Quality

**GRADE LEVEL:** Eighth

**BEST TIME TO PLAN TRIP:** Fall or Spring

## UNIT RATIONALE

The Smokies has over 2,100 miles of rushing mountain streams and rivers that flow through the park. In each mile lives a diverse community of native fish, amphibians, insects, and larvae, some of which are found only in the Southern Appalachians. Park fisheries managers and university researchers monitor water quality, fish populations, and watersheds to better understand the dynamics of water running through diverse ecosystems. During the study the students will assist the park in collecting data from the stream and identify the quality of the stream using water quality test parameters and macroinvertebrate findings.

## 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.

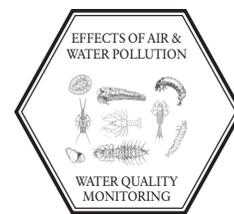
Competency Goal 1: The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

- 1.01 Identify and create questions and hypotheses that can be answered through scientific investigations.
- 1.03 Apply safety procedures in field studies.
- 1.04 Analyze variables in scientific investigations.
- 1.05 Analyze evidence.
- 1.06 Use mathematics to gather, organize, and present quantitative data resulting from scientific investigations.

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

- 3.01 Analyze the unique properties of water.
- 3.02 Explain the structure of the hydrosphere.
- 3.03 Evaluate evidence that Earth's oceans are a reservoir of nutrients, minerals, dissolved gases, and life form.
- 3.04 Describe how terrestrial and aquatic food webs are interconnected.
- 3.05 Analyze hydrospheric data over time to predict the health of a water system.





3.06 Evaluate technologies and information systems used to monitor the hydrosphere.

3.07 Describe how humans affect the quality of water.

3.08 Recognize that the good health of environments and organisms requires.

Competency Goal 4: The learner will conduct investigations and utilize technology and information systems to build an understanding of chemistry.

4.01 Understand that both naturally occurring and synthetic substances are chemicals.

4.02 Evaluate evidence that elements combine in a multitude of ways to produce compounds that account for all living and nonliving substances.

4.04 Describe the suitability of materials for use in technological design.

4.06 Describe and measure quantities related to chemical/physical changes within a system.

4.08 Identify evidence that some chemicals may contribute to human health conditions.

4.09 Describe factors that determine the effects a chemical has on a living organism.

4.10 Describe risks and benefits of chemicals.

Competency Goal 5: The learner will conduct investigations and utilize appropriate technologies and information systems to build an understanding of evidence of evolution in organisms and landforms.

5.03 Examine evidence that the geologic evolution has had significant global impact.

## 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.

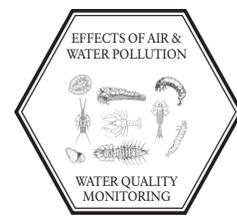
Competency Goal 4: The learner will understand and use graphs and data analysis.

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.





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## 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

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Activity	Page
Unit Rationale/State Learning Standards .....	1-3
Table of Contents .....	4
Planning your Trip .....	5
Safety Considerations .....	6
Background Information.....	7
Maps to Purchase Knob and Deep Creek.....	8
Pre-Site Activities	
Vocabulary .....	9-10
Water quality test parameters worksheet.....	11
Aquatic Adoptions .....	12
Aquatic Adoption Cards .....	13-17
Overhead Quiz Cards.....	18-20
Adoption Certificate.....	21
On-Site Activities	
Park Ranger Directed Lessons: Water Quality Study at Purchase Knob .....	22
Park Ranger Directed Lessons: Water Quality Study at Deep Creek.....	23
Post-Site Activities	
Graphing Elevation Trends and Stewardship.....	24-26
Graphing Elevation Trends Teacher Answer Key .....	27
Appendix	
Parent/Chaperone Letter .....	28





# PLANNING A SUCCESSFUL TRIP

## AT PURCHASE KNOB

### 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 8

• 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.

#### • Restrooms and Water

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

## AT DEEP CREEK

### SCHEDULE FOR A DAY OF ACTIVITIES IN GREAT SMOKY MOUNTAINS NATIONAL PARK AT DEEP CREEK

- Meet park ranger at Deep Creek Pavilion
- 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 Deep Creek can be found on page 8

• The maximum number of students for this trip is 50. 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.

#### • Restrooms and Water

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



# SAFETY CONSIDERATIONS AND OTHER IMPORTANT INFORMATION

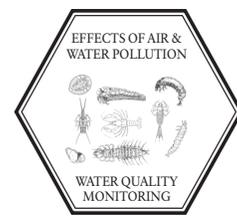


- Great Smoky Mountains National Park is a federally protected public use area. Please help the rangers keep all of the plants and animals protected in the park by not picking the plants or taking anything from the park.
- Please remind your students to wear appropriate footwear and clothing for this 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

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## **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.

## **Deep Creek Description:**

Deep Creek is located three miles outside of the town of Bryson City, NC . Situated at an elevation of 1,800 feet, the area contains cove hardwood forests. Deep Creek is appropriately named by the swift flowing stream that serves as a watershed for Clingmans Dome between the Noland and Thomas Divide. It is where "Kituhwa" was located, one of the first Cherokee town sites that botanist Williams Bartram visited in the early 1800s. Later it was settled by families who planted crops, fished and worked on the railroad and sawmills. The forests along the Deep Creek watershed remained largely old growth forest at the time of acquisition by the park in the late 1920s. Today, Deep Creek is popular with tubers, fisherman, campers and hikers.





# PRE-SITE ACTIVITY

## WATER QUALITY INFORMATION



**Grade Level:** Eighth Grade

**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 9)
- Water quality parameters worksheet (pages 11-12)
- 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 Purchase Knob they will be assisting in a research project by collecting data on the water quality of the Purchase Knob 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.

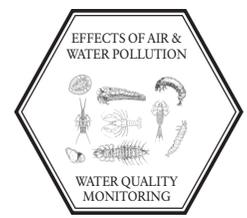
To view the Hellbenders podcast video go to

<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](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  $20^{\circ}\text{C}$  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 ADOPTION



**Grade Level:** Eighth Grade

**Subject Area:** Science

**Activity time:** 60 minutes,  
divided over 2 days

**Setting:** Classroom

**Skills:** Categorizing, Clas-  
sifying, Collecting information,  
Communicating, Connecting,  
Gathering information

### Objectives:

- 1) use the following *Aquatic Adoption* cards to pick one aquatic creature to “adopt” for study
- 2) study the life history of “their” insect
- 3) attempt to identify the terrestrial stage of the insect

### Materials:

- Insect I.D. cards (listed on following page 13-17)
- “Adoption” certificates (listed on following page 21)
- Overhead quiz cards (listed on following pages 18-20)

### Procedure:

Generate overhead transparencies of each macroinvertebrate in this packet (pages 18-20). Cut the overheads into 18 individual 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 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 macroinvertebrate.

### 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.

### Resources:

Terrestrial Invertebrates Clip Art: <http://clean-water.uwex.edu/pubs/clipart/index.htm> and <http://people.virginia.edu/~sos-iwla/Stream-Study/StreamStudyHomePage/StreamStudy.HTML>



# 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, ran, 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 to water pollution



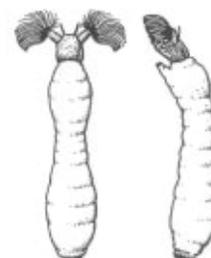
## C. Rifle Beetle Larva Facts

- Up to 3/4 inches 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 leaf-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 to water pollution



# AQUATIC ADOPTION CARDS CONTINUED

## 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**



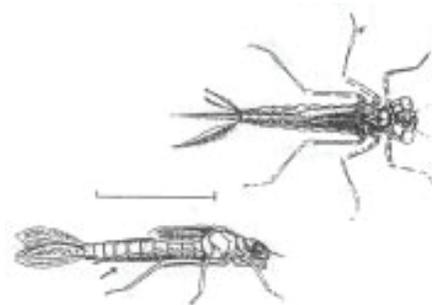
## F. Cranefly Facts

- 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
- Black end usually has several extensions or finger-like holes
- Milky, light-brown, gray, or greenish in color
- Somewhat sensitive to water pollution**



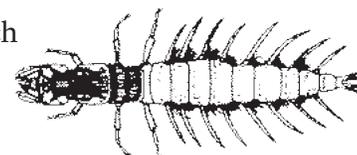
## G. Damselfly Facts

- 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 (or Dobsonfly) Facts

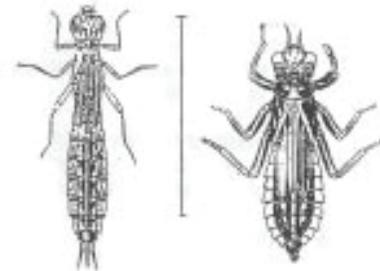
- Carnivorous and may bite
- One to four inches long
- Mouth has large, chewing pinchers
- Six segmented legs on middle section of body with tiny pinchers at the end of each
- Many fleshy, filamentous appendages on each side of the abdomen
- Back end is forked with two short tails and two hooks on each 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**



# AQUATIC ADOPTION CARDS CONTINUED

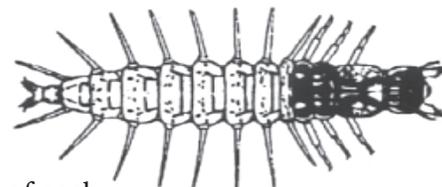
## I. Dragonfly Larva Facts

- 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. Fishfly Facts

- Carnivorous and may bite
- Develop over 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 hellgrammite (dobson fly larva) but does not have fluffy gills on underside
- Somewhat sensitive to water pollution



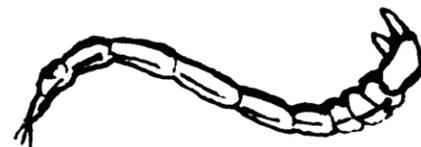
## K. Mayfly Facts

- 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
- The body can be up to one inch long
- Body is usually flat
- Very sensitive to water pollution



## L. Midgefly Facts

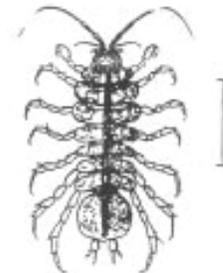
- Almost 200 species in North America
- Are found in all but the most polluted aquatic conditions
- Up to 1/2 inch long
- One pair of tiny, fleshy legs below the head and one pair on the back end
- The back end sometimes has a tiny pair of extensions that look like brushes
- A thin dark line (digestive tract) can be seen inside the body
- Fairly tolerant to water pollution



# AQUATIC ADOPTION CARDS CONTINUED

## M. Sowbug Larva Facts

- Also called the pillbug (adult stage)
- Up to 3/4 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



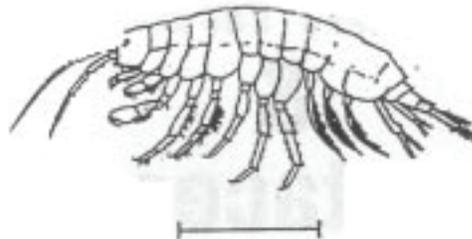
## N. Whirligig Beetle Larva Facts

- 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



# AQUATIC ADOPTION CARDS CONTINUED

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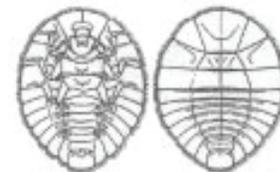
## Q. Riffle Beetle Facts

- Length is up to 3/4 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 and may 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

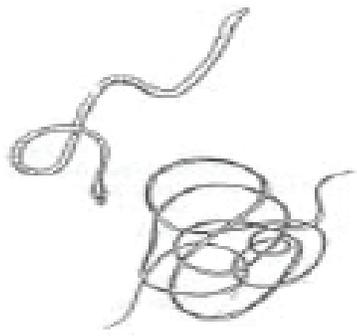


# OVERHEAD QUIZ CARDS FOR AQUATIC ADOPTIONS

A.



B.



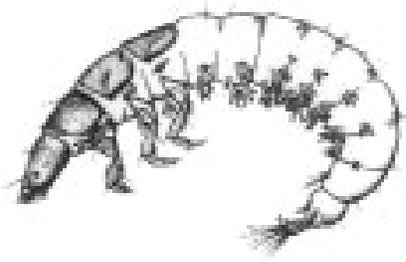
C.



D.



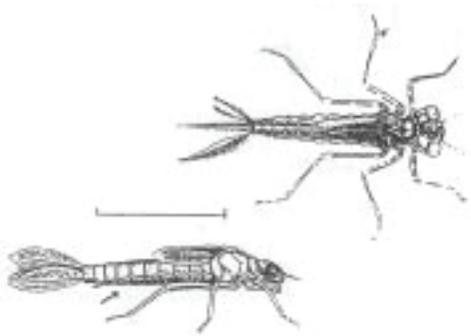
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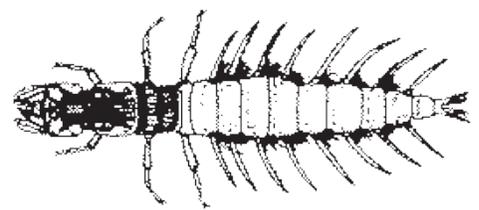
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G.



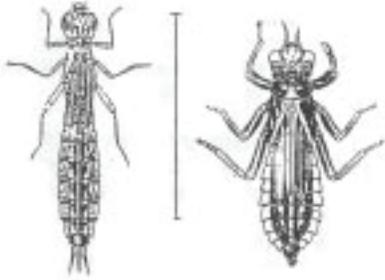
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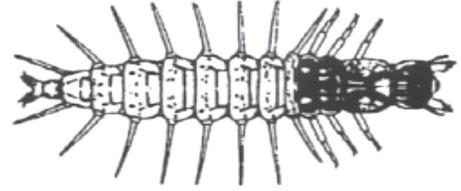
# OVERHEAD QUIZ CARDS FOR AQUATIC ADOPTIONS



I.



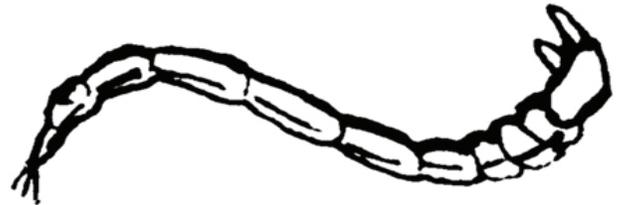
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K.



L.



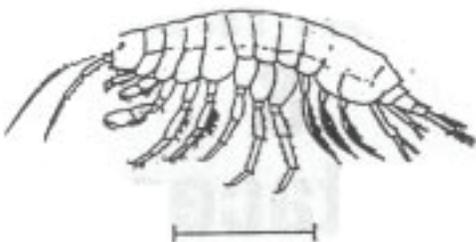
M.



N.



O.



P.



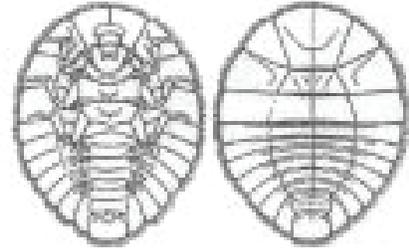
# OVERHEAD QUIZ CARDS FOR AQUATIC ADOPTIONS



Q.



R.



S.



# CERTIFICATES OF ADOPTION



## *Certificate of Adoption*

This document certifies that \_\_\_\_\_ has chosen to be temporary caretaker of a  
(student name)

\_\_\_\_\_ named \_\_\_\_\_ while on a visit to Great Smoky  
(type of macroinvertebrate) (name your creature)

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)

Teacher Signature \_\_\_\_\_

Date \_\_\_\_\_

(photocopy and cut on dotted line)

## *Certificate of Adoption*

This document certifies that \_\_\_\_\_ has chosen to be temporary caretaker of a  
(student name)

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(type of macroinvertebrate) (name your creature)

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I agree to the care and responsibilities listed above

\_\_\_\_\_

(student signature)

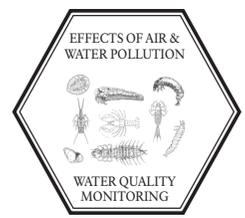
Teacher Signature \_\_\_\_\_

Date \_\_\_\_\_



# ON-SITE ACTIVITY

## WATER QUALITY STUDY AT PURCHASE KNOB



**Grade Level:** Eighth Grade

**Subject Area:** Science

**Activity time:** 75 minutes

**Setting:** Outside in the park

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

### Objectives:

- 1) demonstrate the ability to collect and record data
- 2) search for and identify benthic macroinvertebrates in the stream
- 3) describe the threats on streams and macroinvertebrate life in the streams
- 4) explain why it is important to study water quality and its benthic macroinvertebrates

### Materials:

- Transparency tube;
- Nitrite/nitrate test strip
- pH test strip; •phosphate strip test
- Alkalinity test strip;
- Thermometer for soil, water, and air;
- If available conductivity probe and dissolved oxygen probe
- Net
- Macroinvertebrate key
- Plastic containers to view macroinvertebrates

### Background:

The ranger will explain to the students that the Smokies has over 2,100 miles of rushing mountain streams and rivers that flow through the park. In each mile lives a diverse community of native fish, amphibians, insects, and larvae, some of which are found only in the Southern Appalachians. Besides things we hope to find in our water, however, there are also many things that threaten Smokies' streams: chemical contaminants, metals leached from rocks and soil, diseases, and non-native plants and animals. To tackle these issues, park fisheries managers and university researchers monitor water quality, fish populations, and watersheds to better understand the dynamics of water running through diverse ecosystems. The park uses this science information to make rules about fishing, restore populations of native and endangered fish, and even influence national pollution laws. The park also uses this information to educate the public and visitors about how they can help keep Smokies streams healthy. This particular stream at Purchase Knob has been tested and monitored for several years. During the study the students will assist the ranger(s) in collecting the data from the stream.

# ON-SITE ACTIVITY

## WATER QUALITY STUDY AT DEEP CREEK



**Grade Level:** Eighth Grade

**Subject Area:** Science

**Activity time:** 3 hours

**Setting:** Outside in the park

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

### Objectives:

- 1) demonstrate the ability to collect and record data
- 2) search for and identify benthic macroinvertebrates in the stream
- 3) describe the threats on streams and macroinvertebrate life in the streams
- 4) explain why it is important to study water quality and its benthic macroinvertebrates
- 5) gain a deeper appreciation of human impacts to the hydrosphere and the role of individual stewardship protecting this resource

### Materials:

- Net
- Macroinvertebrate key
- Plastic containers to view macroinvertebrates
- Magnifying lenses, magniscopes
- Shower curtain, watering can, sponge
- Inflatable globe
- “Who polluted the River” activity materials

### Background:

The ranger will explain to the students that the Smokies has over 2,100 miles of rushing mountain streams and rivers that flow through the park. In each mile lives a diverse community of native fish, amphibians, insects, and larvae, some of which are found only in the Southern Appalachians. Besides things we hope to find in our water, however, there are also many things that threaten Smokies’ streams: chemical contaminants, metals leached from rocks and soil, diseases, and non-native plants and animals. To tackle these issues, park fisheries managers and university researchers monitor water quality, fish populations, and watersheds to better understand the dynamics of water running through diverse ecosystems. The park uses this science information to make rules about fishing, restore populations of native and endangered fish, and even influence national pollution laws. The park also uses this information to educate the public, and visitors about how they can help keep Smokies streams healthy. This particular stream at Deep Creek has been tested and monitored for several years. Due to the pristine qualities of the creek, this watershed was selected in 1994 to receive several reintroduced river otters. Thanks to improved water quality, these shy and elusive top predators are now thriving in many of the park’s restored waterway. During the study the students will assist the ranger(s) collect data from the stream.

# POST-SITE ACTIVITY

## GRAPHING ELEVATION TRENDS AND STEWARDSHIP



**Grade Level:** Eighth Grade

**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 25-26)
- 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

<u>Elevation (feet)</u>	<u>pH</u>	<u>Nitrate (kg/ha)</u>	<u>Sulfate (<math>\mu\text{eq/l/yr}</math>)</u>
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

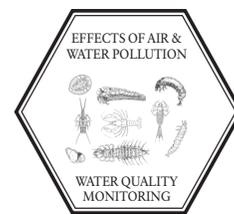


C. Elevation versus sulfate

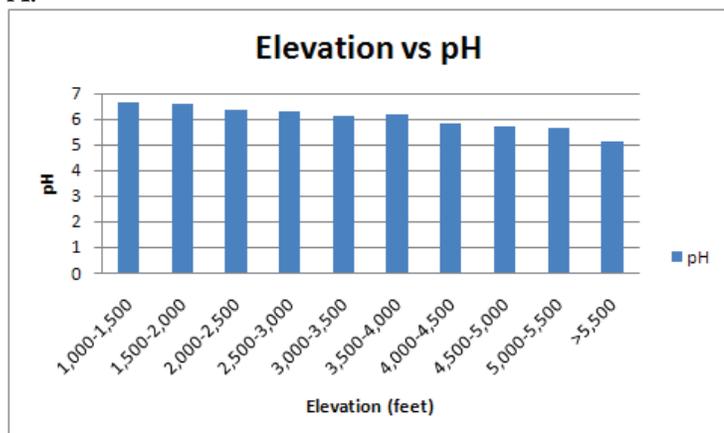




# GREAT SMOKY MOUNTAINS WATERSHED ELEVATION TRENDS TEACHER ANSWER KEY



A.



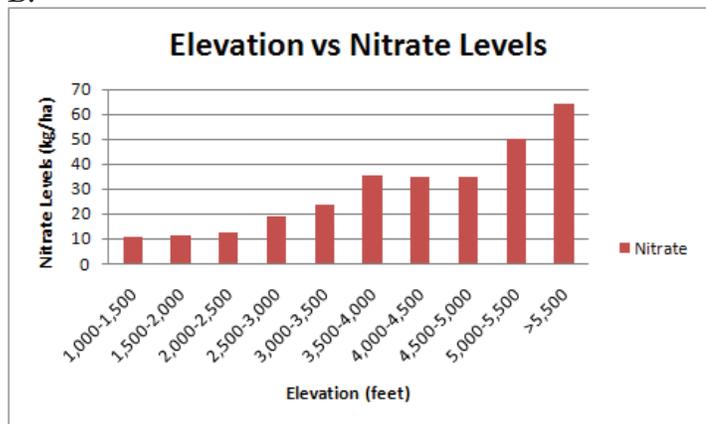
## Summary of Graphs

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.

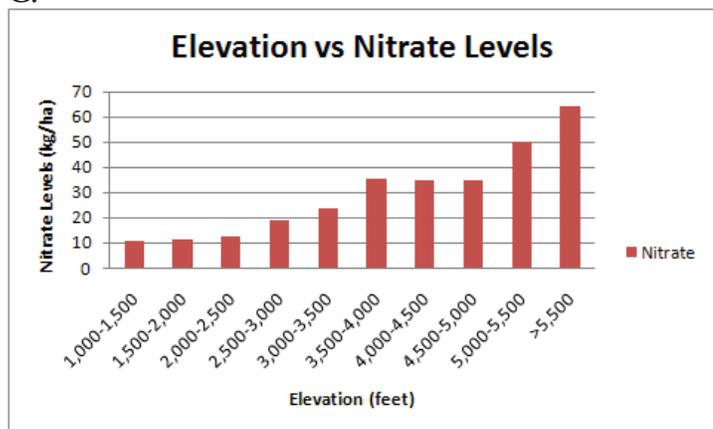


B. By viewing your graph, what is the overall trend of elevation versus nitrate?

*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.



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 (Gbondotugbawa 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

