"To spend childhood days along creek banks is to be drawn into the wider world. A creek reaches upward into the hills and mountains... It reaches down to the lowlands and the fat old rivers... Above all, a creek offers the mind a chance to penetrate the alien world of water and think like a tadpole or a trout. What drifts in creek water is the possibility of other worlds inside and above our own."

- Peter Steinhart

Stream Ecology

time

Three Hours

objective

To enhance understanding of the Great Smoky Mountains stream ecosystems and some of the problems they are facing

concepts

- Streams are communities made up of living and non-living parts.
- Streams affect and are affected by their surroundings.
- Streams ecosystems serve as indicators of environmental health in watersheds.

methods

In addition to capturing and observing stream animals, the students will participate in activities which will enhance their understanding of aquatic ecosystems and human impact upon them.

subject areas

Science, social studies

Habitat cards, crayons, hand lenses, collecting jars, field guides, study sheets, aquatic creature cards, string, old shoes, old pants, notebook, pencil or pen

INTRODUCTORY ACTIVITIES

ADAPTATIONS

time

Ten Minutes

lead-in

Begin the class by asking the students, "What is ecology?" (the study of the interrelationships of living and non-living things) Explain to the students that they will be studying a specific environment: the stream, which has some very specialized creatures living in it.

procedures

Ask students, "What are things that every creature needs to survive?" (food, water, shelter, oxygen)

Tell students, "All creatures have the tools they need to get these things from their specific environment. Such tools are called *adaptations*."

Show the students some of the animal pictures and ask them for some adaptations of those animals. (examples: camouflage, bats' sonar, eagles' eyesight, rattlesnake venom, etc.)

Tell students that creatures which live in water are called *aquatic*. Ask students, "What kind of adaptations do aquatic creatures need to survive?" (gills, fins, webbed feet, streamlined bodies, etc.)

wrap-up

Ask students if all animals have adaptations of some sort. (yes) Will adaptations that work well in one environment necessarily work in another? (No; a fish will not live long on land, because it is adapted for water.)

Can they think of any adaptations which have helped humans survive and become dominant species? (opposable thumb, power to reason, ability to change their environment, binocular color vision, and upright posture)

CENTRAL ACTIVITIES

CREATE A CREATURE

time

Thirty Minutes

lead-in

Give each student one of the habitat cards provided in the materials bag. Explain that they must draw a creature using their imagination. (There are a variety of habitats: on the bottom of a stream, in white water, on a rock, beneath rocks, in a pool, etc.)

procedures

Each student is to create their own creature and adapt it for the specified habitat. They should also name their creature. Ask the students to keep a few questions in mind as they design their creatures:

- What kind of food does the creature eat, and how is it adapted for gathering and eating that food?
- How does the creature move around?
- How does the creature defend itself and avoid predators?
- Is the creature an herbivore, carnivore, or a decomposer/ scavenger?

Pass out drawing paper (If you prefer that they keep their drawings, have them use their notebooks instead.) and crayons. Give students fifteen minutes to complete their drawings.

wrap-up

Call students back together and ask each to share his or her creature. Encourage and support every student. Every adaptation is valid, as long as it helps the creature in some way.

STREAM RELATIONSHIPS

time

Ten Minutes

lead-in

Explain to the children that a stream has many ecological relationships. Have children think of several such relationships.

procedures

Have the students walk around the stream and find a relationship between the stream and anything surrounding the stream, living or non-living. Example: crayfish need rocks for shelter and rocks trap food in flowing stream for the crayfish to eat.

wrap-up

Talk about the relationships within the small section of the stream. Include the idea that there are probably a lot more which were not found. These relationships are often in association with or dependent upon other relationships.

STREAM SEARCH

time

One Hour or More

lead-in

Tell the group that they are going to observe creatures and their habitats. Explain to the students that with each rock they move, they will be exposing a particular creature's habitat. They should be careful to move everything back to the way it was originally found. Remember that many of the creatures are in their immature, or *larval*, form. These tiny creatures must be handled *very gently*, and remember that salamanders must only be handled with *wet* hands! Release salamanders and crayfish next to (*not* under) the rock where they were found.

This particular activity can be potentially dangerous, so they should proceed with caution. Since the rocks are very slippery, tell them that it is extremely important that they take their time when near the rocks. If the group is near the river, tell the students that they are not to wander out into the middle, but rather *stay at the edge*. If the group is working in one of the smaller streams it is all right for them to go in farther.

procedures

Divide into teams of two or three. Pass out hand lenses, collecting jars, worksheets, field guides, and pans.

Explain to the teams that after they have collected several creatures they should try to complete the worksheet.

Explain that the hand lenses are to be used for examining small objects. If the hand lens is held close to the object and then gently pulled away, the maximum magnification will eventually be reached.

If time allows, explore two different types of habitats, such as a deep pool and a shallow riffle, and compare them.

wrap-up

Discuss the creatures found. Did they have special features which would enable them to survive better in their environments? (For example, some animals are very flat and cling to the bottoms of rocks very well. Thus, they are well-adapted to living on the rocks on the bottom of the stream.)

Ask the students the following questions:
- What does the stream provide for the forest? The field?
- In what ways does the forest affect the stream? (Trees keep stream cooler, help absorb run-off, and hold sediments in place.)
- How do larger animals use the stream? (to drink, bathe, cool off, as a food source)
- What are some factors which affect the lives of animals in water? (pollution, silt, floods, drought, temperature, depth, speed)
- Are there physical differences between animals living in the water and those living in mud?
- If they were a water animal, what would they need to live? (food, water, shelter, oxygen, space, and a means of reproduction)
- Can they determine what an animal eats by observing the mouth parts? Can they give some examples? (beaver, trout, caddis fly, hog sucker, crayfish, human, etc.)
- Can they think of an aquatic food chain using some of the plants and animals found?

PEOPLE AND WATER

time

Twenty Minutes

lead-in

The Smokies receive approximately sixty-four inches of rainfall per year, which is equal to eight hundred ninety billion gallons of water. Of this water, three hundred ninety billion gallons is used by plants or is evaporated. The other five hundred billion flows into streams, lakes, and the water table. People use water in many ways; can the students name some? Ask the students how many gallons of water they think they use in a day. The average U.S. citizen uses about one hundred twenty gallons per day.

procedures

What did the students use water for today, or what did they use that required water to make it usable in that form? Show them the following chart:

• Drink	.5 gallons/day
• Toilet	5 gallons/flush
• Shower	5 gallons/minute
• Bath	25 gallons
• Wash dishes	10 gallons
• Wash clothes	30 gallons per load
• One Sunday newspaper	150 gallons/paper

FOOD:

• Vegetables	200-300 gallons/one day's supply/person
• Meat (9 1/4 oz.)	1400 gallons/one day's supply/person

- One loaf of bread 300 gallons to grow grain
- One pound of beef 4000 gallons

LIFE:

- Body 65%
- Blood 80-90%
- Muscles 75%
- Bones 20%

OTHER USES:
Electricity - from hydro-electric plants (dams)
Clothing - from plants or animals or factory processing
Industries - steel and paper mills, chemical plants, plastics

Teachers' Note: The water available today is basically the same amount the earth had three billion years ago. It is all there will ever be. We may be drinking the same water a dinosaur drank.

wrap-up

Ask the students to figure up the average amount of water they use each day, using what they have learned about water consumption. What are some things each person can do to conserve some of this water?

Why is water important for human life? If the students had only five gallons of water to use each day, how would they use it?

Where does the water they drink come from, and where does it go when they are finished using it? (For example, Tremont gets its water from a well. After use, it goes down the drain to our treatment station, then eventually to the lagoons where it filters naturally through the ground, then to the river. While filtering, it is cleansed of any impurities.)

What other animals depend on water? Why? Animals depend on water as much as human beings do. They have the need to drink water, and some animals require it as a place to live. Fish and other aquatic animals need rivers, lakes, and oceans; ducks and geese need wetlands to nest, find food, molt and breed. Many animals such as beavers, dragon flies, frogs, otters, and muskrats require water habitats; the American bald eagle depends on a water habitat for the fish it eats.

How is the human race negatively affecting our water supply? (pollution, strip-mining, sewage, fertilizers, insecticides, poor forestry and farming practices, paper production and simply wasting water)

What can be done to preserve clean water? (recycle, use recycled products, use non-toxic products, use less water, use less electricity)

What are people doing to protect water resources? (low-flow shower heads, turn water off when brushing teeth, low phosphate detergent, sewage treatment, native plant gardens that do not require as much watering as exotics)

CONCLUDING ACTIVITIES

CREATE A RIVER

time

Thirty Minutes

lead-in

Tell students that they are each to draw a river on a sheet of paper. The only requirement is that there be at least two human-made structures and at least one natural feature on the river or on the banks. Tell them also to orient their river so that it flows across the page horizontally. The area around their rivers will represent the *watershed*, which is the land area drained by a river.

procedures

After they have completed their drawings, collect them and then tell the students that what they have done is create a river by each drawing a section. Place all of the drawings end to end so that the water "flows" down the river. Discuss what happens to the quality of the water as the river progresses. Ask individual students what human-made structure they have placed on or near the river. There are negative side effects to virtually all types of development on or near a river.

- Houses, stores, shopping centers, roads: run-off from urban areas includes gasoline, oil, synthetic chemicals, and sewage
- Factories, power plants: dumping of legal and illegal chemicals, thermal pollution in dumping of waste water
- Farms and rural areas: run-off of pesticides and fertilizers, illegal dumping of garbage in river, animal wastes

wrap-up

By watching the "river" get polluted, the students will see that water pollution is a complex process which involves many people. End the activity by mentioning that the adaptations of stream inhabitants generally will not help them survive if human-caused changes occur within the environment. The adaptations of stream animals have taken millions of years to develop, and the rapid changes that people bring to stream habitats are negatively affecting the diversity of aquatic life.

Ask students for some ideas of ways they can protect streams and rivers. Emphasize that all life depends on water, and that it is up to us, as individuals and as members of society, to ensure that we have an adequate supply of water for ourselves and our fellow earth dwellers.

FOOD WEB PRIORITIES

time

Twenty Minutes

lead-in

Explain to students that they will each be playing the role of an animal or plant in order to better understand how these things fit into the environment.

procedures

Gather the students in a circle and give each one an aquatic creature card. Tell the students that they will now assume the role of the creature on their card. Explain to students that they will each have three minutes to tell the group why they are important to the aquatic habitat.

Ask for a volunteer to go first, and give him or her one end of the string. Ask which students from the rest of the group have an animal that is related to the first animal. Pass the string to one of them and listen to the explanation of relatedness. Continue to pass the string in this manner.

When everyone has spoken and each person is holding part of the string, it will form a criss-crossed web. Ask everyone to pull the string tight.

Ask one student to tug on her or his part of the string, and ask anyone who feels a tug to also give a tug. Everyone should eventually feel the tugging.

Tell the students that this is an example of a food web, and it shows how things living in a specific environment are connected to and are dependent upon one another.

Ask students if there is any creature they would like to eliminate from the web. If so, give the creature being eliminated the chance to defend himself or herself. Some organisms have become extinct or will become extinct before we have the time or opportunity to study them and learn about their importance.

Take a vote among the other students on the matter. A majority is needed for elimination. If a creature is voted out, have him or her drop their part of the string. He or she is extinct.

What happens now when someone tugs? What happens if two creatures become extinct?

Teachers' Note: This activity is similar to one in the Little Creatures lesson, but is effective even when repeated.

wrap-up

Gather the string and have everyone sit down. Ask students if they know what an ecosystem is. Explain to the students that an ecosystem is made up of all the living and non-living (biotic and abiotic) parts of an environment, fitting together like a puzzle to make a single, working unit.

Ask students, "What does it mean when something is extinct?" (The last of a species is dead and there is no way for the species to make a comeback.)

Ask students, "How can the extinction of one thing affect other things?" (Others may have fed on that organism, it may have kept other populations in check, or it may have created or supplied necessary habitat, etc.)

Tell the students that the web they created is an example of an ecosystem, and just like the web, if any one member is removed from the system, there can be drastic effects.

lesson wrap-up

End the lesson by reviewing the concepts found at the beginning of the lesson. What are the living and non-living parts of the stream ecosystem the students investigated? How is the stream affected by its surroundings? What effect does the stream have on its surroundings? Did the stream appear to be a clean, healthy ecosystem? Remind the students that the area around Tremont was logged in the 1930s. How might the stream have looked then? How has it changed? Do the students think other streams can also become cleaner if pollution is reduced?

STREAM ECOLOGY HABITAT CARDS

The land is muddy and lies mostly under shallow water. There are lots of reeds, cattails and other plants. Many aquatic worms and insects, small fish, tadpoles, muskrats, and waterfowl inhabit the area. The climate is warm and moist.

This ocean shoreline has a sandy beach and backs up to dunes. Tides bring in seaweed, kelp, and driftwood. The beach is inhabited by seagulls, pelicans, and other shore birds, along with many insects, worms, and animals that live in shells. The climate is hot in the summer with frequent storms, and cool and rainy in the winter.

The habitat is a swift, moving river. A rock-covered bottom causes many ripples and cascades. Fish, such as brook trout and red-bellied shiners, are commonly found among the boulders and pools. Insect larvae find shelter along the rocky bottom.

The land is very cold. Snow covers the ground for nine months during the year. It is a very windy place. The ocean is inhabited by seals, whales, walrus, fish, and many smaller creatures. Polar bears hunt along the shore. The ocean is ice-covered most of the year.

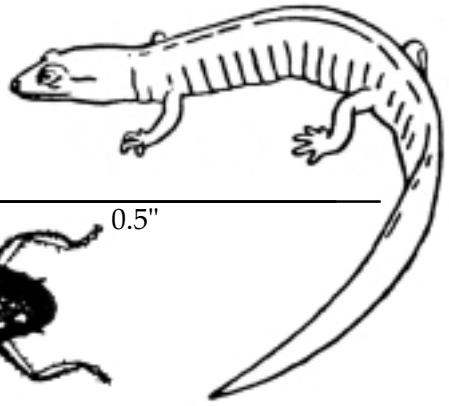
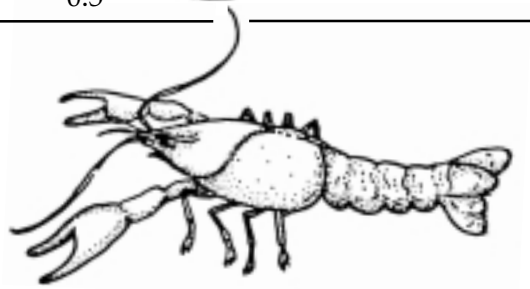
The habitat is a trickling creek. Mud covers the few rocks found on the bottom. Salamanders, crayfish, and minnows find shelter in the shallow water. Insects, spiders, snakes, frogs, and turtles move about among the grasses and the larger rocks lining the bank.

The habitat is a large, deep, cold lake. What little plant life exists is found along the narrow strip of shallow water near the shoreline. The water is usually fairly clear, but rain storms can quickly turn the lake water a muddy brown. Areas of mud or sand cover most of the bottom. Catfish, bass, carp, and bluegill live in the lake.

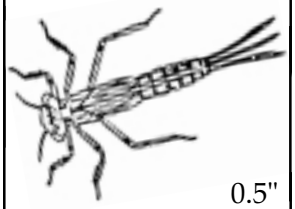
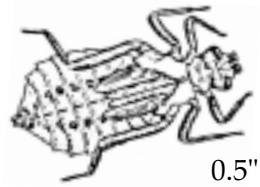
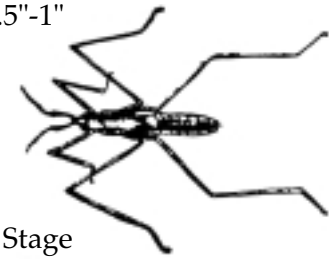
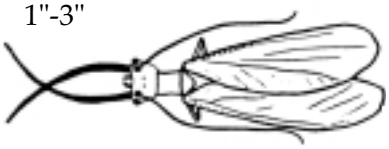
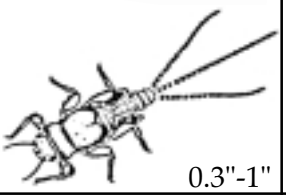
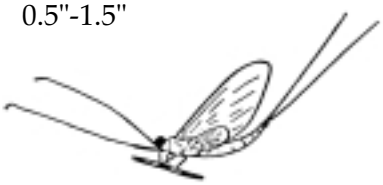
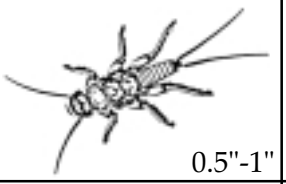
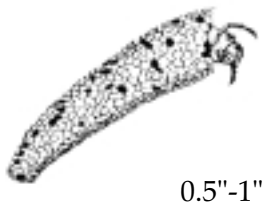
	The habitat is a small farm pond. Cows and other livestock use the pond as a source of drinking water and as a place to cool off. The water becomes very warm in the summer, but it freezes over in the winter. The deepest point is only four feet, and the water remains mud-colored all year. Low-growing grasses and a few cattails are all that grow along the bank. Frogs, turtles, insects, and catfish live here.
	A slow winding river dominates this area. The bottom is mucky ooze. The banks overflow with springtime snowmelt floods. Wide areas of lush green marshland border the murky river. Many species of fish inhabit the river. Muskrats, otters, mink, and deer can also be found here. The river and marshlands offer food, shelter, and nesting sites to many types of ducks, geese, and other migratory birds.
	The land is very hot and dry. Rain, when it comes, quickly forms gushing streams that dry out again in a few minutes or hours. Many types of cacti are common to this area. The ground is sandy and rock-covered. Some of the animals that live here are insects, spiders, scorpions, snakes, lizards, hawks, owls, song birds, bats, rabbits, and foxes.
	A spring bubbles gently into a small rocky pool. In this shady spot a thick carpet of mosses, lichens, and small flowering plants covers the rocks and ground. The water from the spring is crystal-clear and very cold. Even during the heat of the summer, this spot remains cool. The spring and its pool usually freeze during the winter. Salamanders, snails, insects, and an occasional frog can be found living near the spring. Other forest animals use the pool as a source of drinking water.

STREAM CREATURE FINDER

*sizes are approximate; expect variation

Larvae/Nymph	Adult	Description
 1.5"	1.5" 	**Cranefly** - Craneflies look like large mosquitoes. They are long and slender, with long legs. Larva appear to be transparent.
 .25"	0.5" 	**Mosquito** - Larva of mosquitoes angle downward from the surface and breathe through gills and an air tube. Female adults are the only ones to suck blood.
 Adult Stage	0.5" 	**Water-Boatmen** - Swim on their stomachs, while backwimmers swim on their backs. Their backs are shaped like the bottom of a boat, and they use their long hind legs to propel them through the water.
		**Salamander** - Eggs are laid in the water. Larvae are completely aquatic and they have gills. As the larvae get older, they move to land. Salamanders have wet skin and no claws.
	0.5"	**Whirligig Beetle** - These beetles are easily recognized for their whirling, circling motion on the water surface. Their eyes are split in two spots, to see above and below the water's surface.
 0.5"		**Riffle Beetle** - This beetle is best known for its larval stage, where it is called a water penny. These flat, copper-colored larva cling to the underside of rocks.
		**Crayfish** - Crayfish have five pairs of legs. The first pair is armed with claws. If a leg is lost, another will grow in its place. If threatened, a crayfish will often flip its fan-like tail down to propel it backwards to safety.

Stream Ecology

Larvae/Nymph	Adult	Description
 0.5"	2"-3" 	**Damselfly** - Damselflies look like matchsticks with wings. They hold their four wings up and together while resting. Nymphs stay only a few months under water before turning into adults. The nymphs are often found in the slower-moving water.
 0.5"	2"-4" 	**Dragonfly** - Dragonflies look like short crayons with four large wings. They hold their wings straight out while resting. Nymphs may spend up to a year underwater before turning into adults.
 Adult Stage	.5"-1" 	**Water Strider** - Water striders are named for their ability to skim or skate with their long legs over the surface of the water. They prefer quiet and gentle areas of the stream. The broad-shouldered water strider is similar except for its size. They feed on tiny insects.
 1"-2"	1"-3" 	**Dobsonfly** - Dobsonflies spend up to three years as larva before turning into adults. Larva live under stones in the swiftest parts of the stream.
 0.3"-1"	0.5"-1.5" 	**Mayfly** - As adults, mayflies live only a few hours or days, living only long enough to mate and lay eggs. The nymphs live under water up to two years, move to land, and molt into adults.
 0.5"-1"	1"-2" 	**Stonefly** - As a nymph, the stonefly lives under the water for one or more years. Nymphs live under rocks in the fast moving water. Adults live only a short time, then die.
 0.5"-1"	1"-2" 	**Caddisfly** - The unusual larva build cases of sand or plant debris, cemented together by silk. Cases built by different species are distinctive. Larva feed on small water plants and animals, and in turn are food for many fish.
	0.5" 	**Diving Beetle** - There are many kinds of diving beetles found in the stream. Most prefer the slow-moving part of the stream.

STREAM STUDY SHEET

DATE:
TIME:
WEATHER CONDITIONS:

LOCATION:

DESCRIBE THE HABITAT:

DESCRIBE THE CREATURE OR PLANT: Keep in mind the following list of questions as you describe your discovery. Is it a plant or an animal? Where was it found? What color is it? What is its basic shape? Does it have any of the following: leaves, stem(s), flowers, seeds, bark, roots, fins, tail, hard shell, legs, wings, scales?

Name three of its adaptations.

Does it move? How does it move?

How does it get the food it needs to survive?

How is it protected?

What would you name your discovery?

Draw a picture of your discovery in the margin or on the back.

AQUATIC CREATURE CARDS

ALGAE
Found in or near water; Needs sunlight for photo-synthesis; Eaten by insects, birds, rodents

WATER STRIDER
'Skates' on water; Eats insects, small fish; Eaten by fish, other insects

KINGFISHER
Lives near water; Eats fish, amphibians, insects, mice

SALAMANDER
Found under rocks in moist areas; Eats insects, worms, small invertebrates; Eaten by fish, snakes, small mammals

TROUT
Found in water; Eats insects, other fish; Eaten by birds, otters, fish, people

WATER PENNY
Found under rocks; Eats algae, moss, other plants; Eaten by other insects

FROG
Lives near water; Eats insects, worms, small animals; Eaten by fish, birds, snakes, some mammals

CRANEFLY LARVAE
Lives in/near water; Some eat animals, some plants; Eaten by birds, fish, insects

RIVER OTTER
Lives near water; Eats fish, crayfish

MAYFLY LARVAE
Found under rocks; Eats small animals, plants and organic debris; Eaten by insects, fish

CADDISFLY LARVAE
Found on stream bed; Eats tiny plants/animals; Eaten by fish, especially trout

STONEFLY LARVAE
Found under rocks; Eats small plants/animals; Eaten by insects, fish, crayfish

SNAIL Lives in/near water; Eats plants, dead animals; Eaten by fish, birds	HELLGRAMMITE Found under rocks; Eats small animals, insects; Eaten by fish
DUCKWEED Tiny floating plant; photo-synthesizes; eaten by waterfowl	MOSQUITO Lives in/near water; Males eat nectar, females eat blood; Eaten by bats, birds, flying insects
CRAYFISH Lives on stream bottom; Eats small insects, worms, plants; Eaten by humans, fish, raccoon	DRAGONFLY Found under rocks; Eats insect larvae, worms, small fish; Eaten by fish