FUN and LEARNING in the WATER

TEACHER'S GUIDE

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WATER FLOWS
What's a Watershed?

STREAM LIFE I
What Can You Learn From a Water Bug?

STREAM LIFE II
A Scientist's Look at a Stream

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Livermore Area Recreation & Park District
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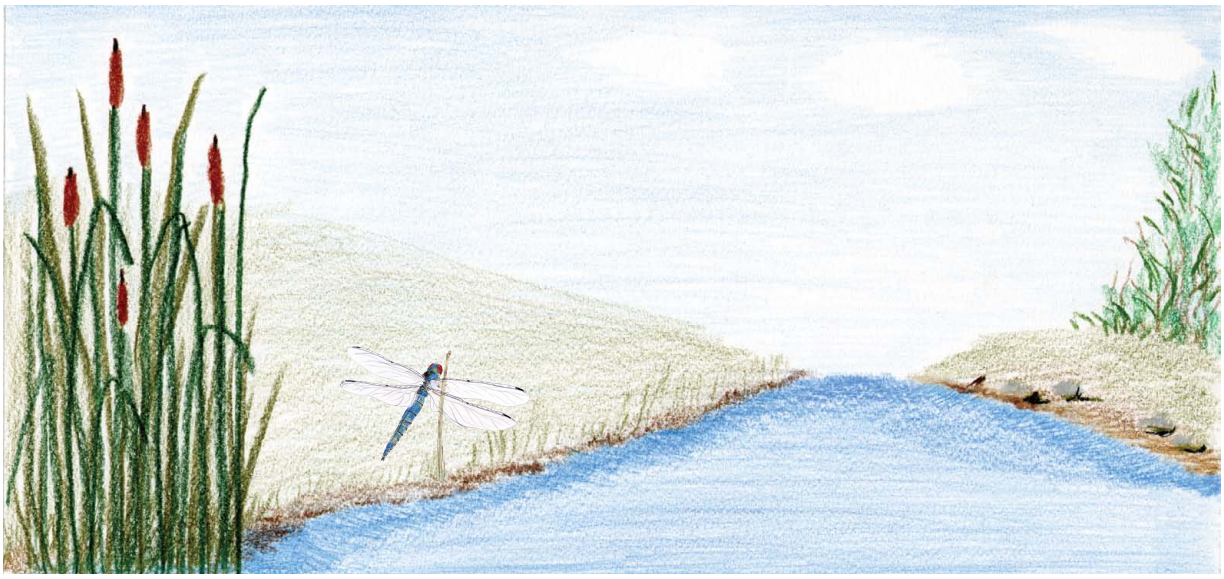
What's INSIDE...

Things to do Before your Program

- Key Ideas and Concepts
- Expand Your Vocabulary
- Wrap up Worksheets for Students
- Answers to Wrap-up Worksheets
- Meeting Next Generation Science Standards
- Additional Sources of Information on Water Issues

This series of water education programs is provided free of charge by the Livermore Area Recreation and Park District, made possible by a grant from the Alameda Countywide Clean Water Program.



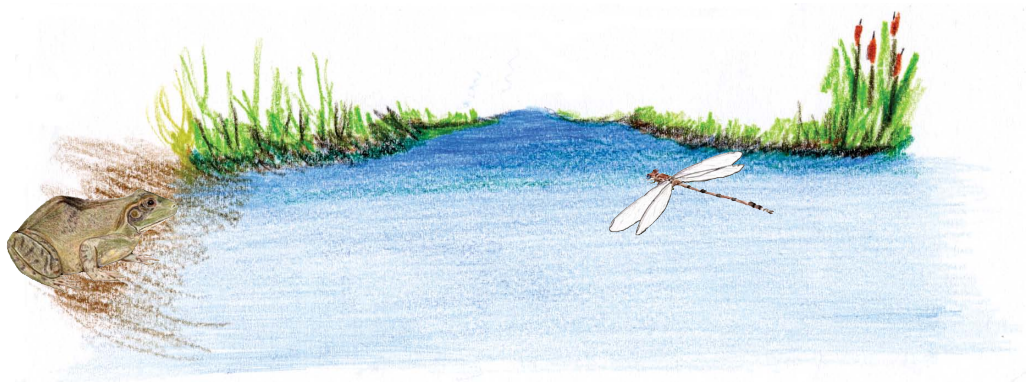
Water Flows
What's a Watershed?

Before the Ranger Arrives

- Ensure that students are familiar with the water cycle. (See key concepts below.)
- Prompt students to brainstorm ways in which people use water.
- Encourage students to think about why clean water is important.
- Have students think about ways water can become polluted and how pollution can be prevented.

Key Concepts the Ranger Will Discuss

- Water from the ocean becomes fresh water through the hydrologic (water) cycle of evaporation, condensation, and precipitation. Only a very small percentage of the water on earth is fresh water.
- A watershed is all the land and waterways that water flows through and over to reach a specific area or body of water, such as a lake, river or bay.
- Pollution that occurs anywhere in a watershed can affect everything downstream.
- Pollution can occur in our own neighborhoods. There are steps students can take to prevent pollution.
- Humans have changed the way water naturally flows to allow us to prevent flooding, create dry land on which to build houses, irrigate farmland and control our water supply. This has altered our landscape and has had some negative effects on our environment.



Water Flows
What's a Watershed?

VOCABULARY

AQUIFER – An underground area with large amounts of groundwater.

FERTILIZER – A chemical or natural substance added to soil to help plants grow. When it gets into a stream it can cause algae to grow very fast.

GROUNDWATER – Water held underground in the soil or in spaces and crevices in underground layers of rock.

"H_2O" – The molecular formula for water (Two Hydrogen atoms bonded to one Oxygen atom).

HERBICIDES – Chemicals used to kill weeds and unwanted plants**.**

HYDROLOGIC CYCLE – The cycle of processes by which water circulates between the earth's oceans, atmosphere, and land.

PESTICIDES – Chemicals used to kill insects or other "pests" that can harm crops.

POLLUTION – Introduction into the environment of a material or thing that can have harmful or poisonous effects.

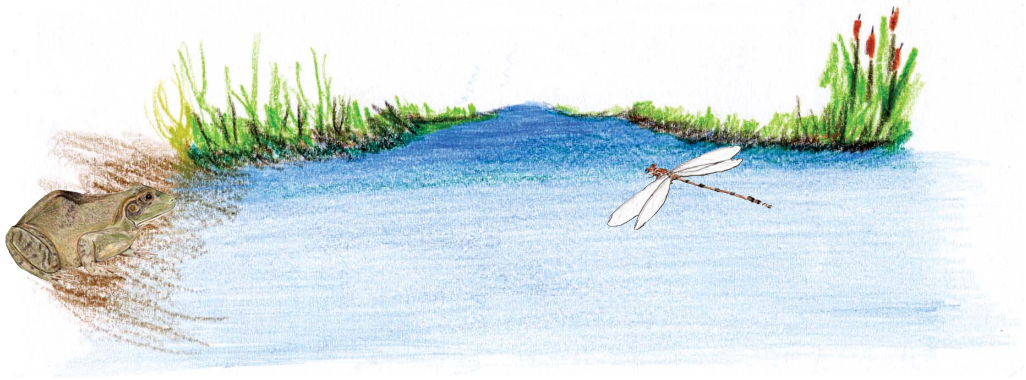
SEDIMENT – Dirt, sand or other particles in the water. This can make breathing difficult for fish and other organisms with gills.

STORM DRAIN – The drains and openings in street gutters, parking lots, and other paved areas that water flows into. Water that flows into most of these storm drains goes to local creeks and eventually, the bay and ocean.

TRIBUTARY – A smaller creek or stream that contributes water or flows into a larger creek, stream or river.

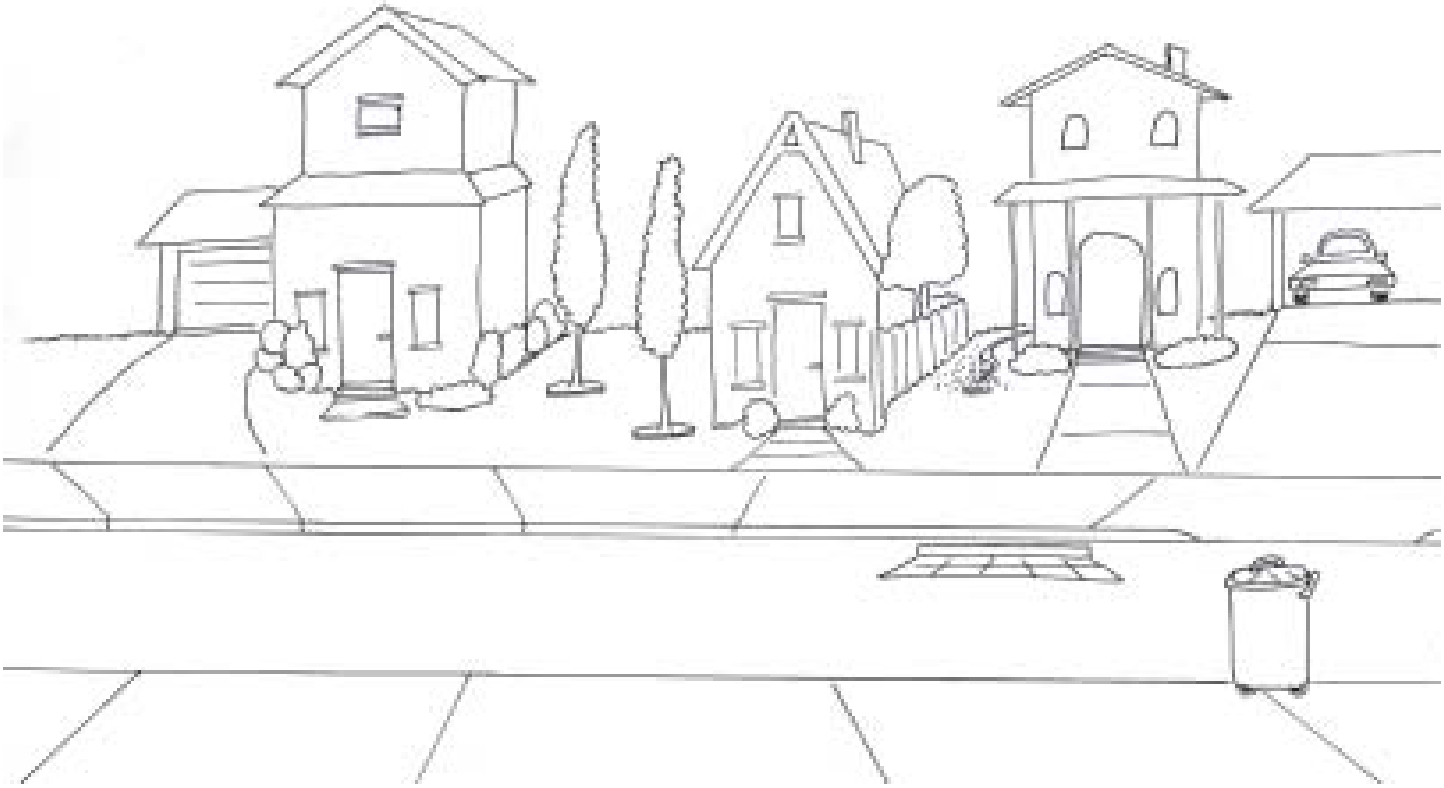
WATER VAPOR – The gas phase of water, like clouds or fog before it condenses.

WATERSHED – All the land and waterways that water flows over and through when going to a specific body of water.



Water Flows
Wrap up

1) Draw and list at least 3 ways pollution can occur in a neighborhood.



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_____

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2) Label the parts of the water cycle on the dashed lines above.

3) What was something interesting or surprising that you learned?

STREAM I

What can you learn from a water bug?

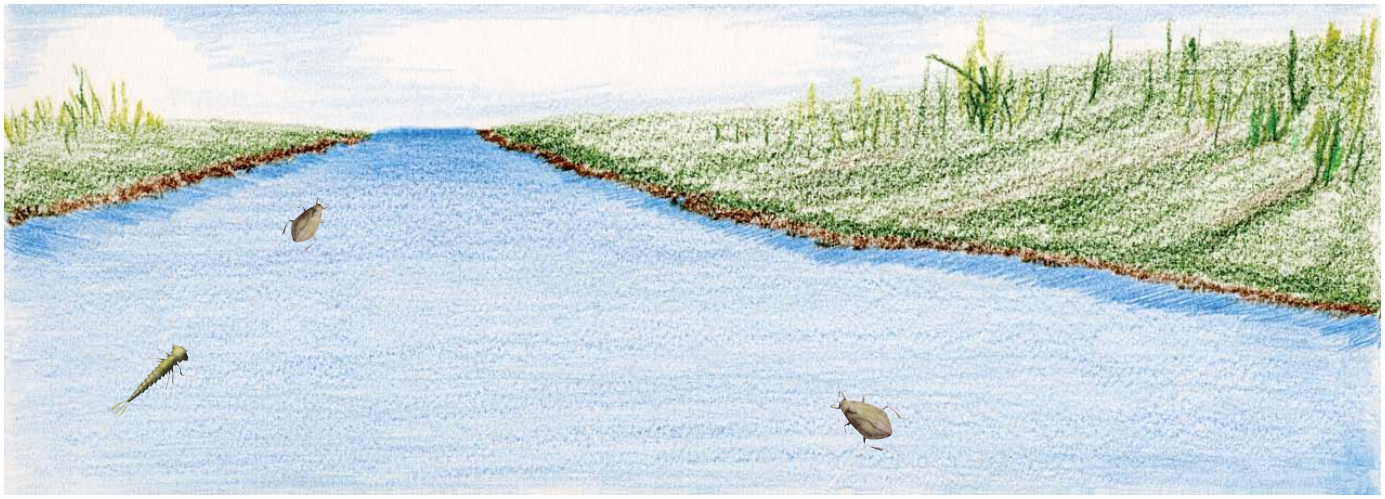
Before the Ranger Arrives

- Have your students make a list of animals they think they might find in a local stream.
- Have students brainstorm ways they might be able to tell if a stream is healthy.
- Introduce the concept of pH. (See "Key Concepts" below.)
- Introduce or review the concept of a "Food Web." (See "Key Concepts" below.)

Key Concepts the Ranger Will Discuss

- Stream health can be evaluated by using various methods.
- Scientists can tell a lot about the health of the stream by surveying for aquatic insects (benthic macroinvertebrates) and other aquatic organisms such as fish and snails.
- Aquatic organisms have anatomical adaptations that allow them to live in fresh water aquatic environments. Sediment, water temperature, and other factors can affect the ability of organisms to get the oxygen they need.
- Pollution sensitive organisms like the mayfly are considered to be "indicator species" for a healthy stream.
- The stream supports a complex web of life made up of predators and prey, producers, consumers, and decomposers. A disruption to any part of the food web can have far-reaching effects.
- Potential of hydrogen, better known as pH, is a measure of how acidic or basic/alkali something is. The pH scale runs from 0 - 14 with low numbers indicating acids (such as soda and vinegar), high numbers indicating bases (such as bleach and other cleansers) and neutral (6-8) being the healthiest for most aquatic organisms.
- pH is an important measure of one aspect of stream health.
- Dissolved oxygen (the amount of oxygen in the water) is also an important measure of stream health. Cold water holds more oxygen than warm water. After an algae bloom, sometimes caused by fertilizer run-off, as the algae decomposes it can use up much of the oxygen in the water, causing a problem for organisms that need to get their oxygen from the water.

During the Stream II field trip, students will be scientists, and apply what they have learned when they visit a stream for the 3rd part of this series.



STREAM I

What can you learn from a water bug?

VOCABULARY

ORGANISM – An individual plant or animal.

ADAPTATION – A behavior or anatomical feature that allows an organism to better survive in its environment.

BENTHIC MACROINVERTEBRATE – An invertebrate (organism that does not have a backbone) large enough to be visible to the naked eye that lives in a stream or creek.

DATA – Information collected by scientists that can be used to test a hypothesis or to monitor conditions, such as the health of a stream.

DISSOLVED OXYGEN – The amount of oxygen in the water.

FOOD WEB – The flow of energy within an ecosystem from one organism to another.

PRODUCER – Plants that convert sunlight to energy by photosynthesis.

FIRST ORDER CONSUMER – Organisms that get their energy by eating producers (plants).

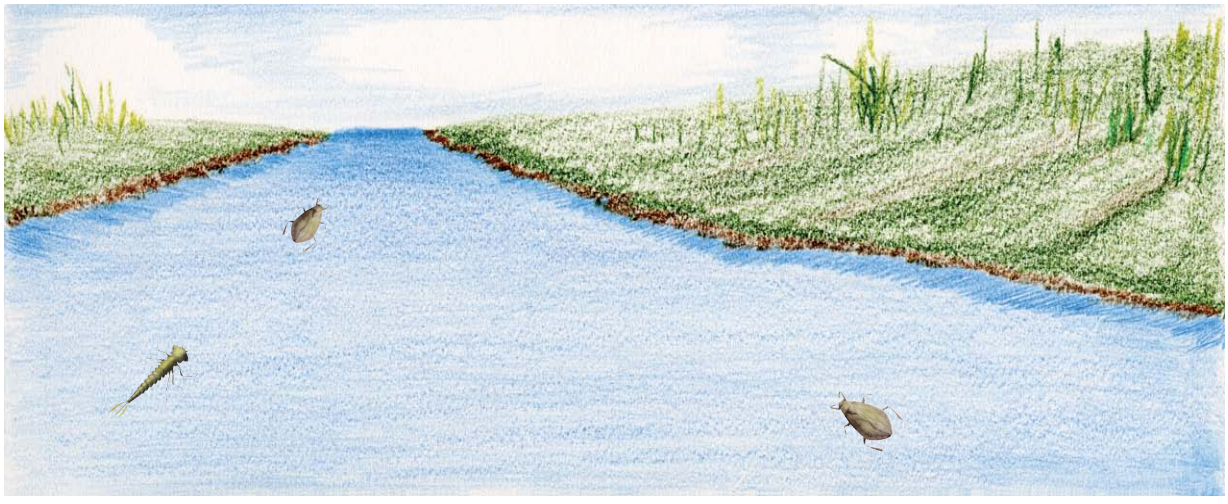
SECOND ORDER CONSUMER – Organisms that get their energy by eating other consumers.

DECOMPOSER – Organisms that get their energy by eating decomposing (dead or rotting) materials.

INDICATOR SPECIES – An organism so sensitive to pollution that finding it in significant numbers is a good indication that the area is healthy.

LARVA / NYMPH – The immature (or juvenile) form of an insect.

pH SCALE (ACIDIC, BASIC, NEUTRAL) – A measure of how acidic or basic/alkali something is.



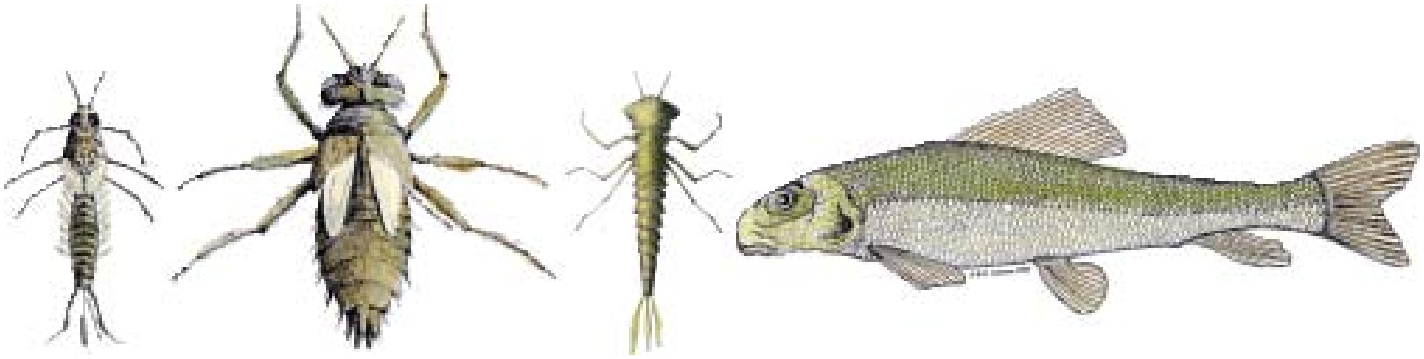
STREAM I

Wrap up

1) Can you come up with at least three ways to determine whether a stream is healthy or not healthy?

2) What is a “benthic macroinvertebrate survey”?

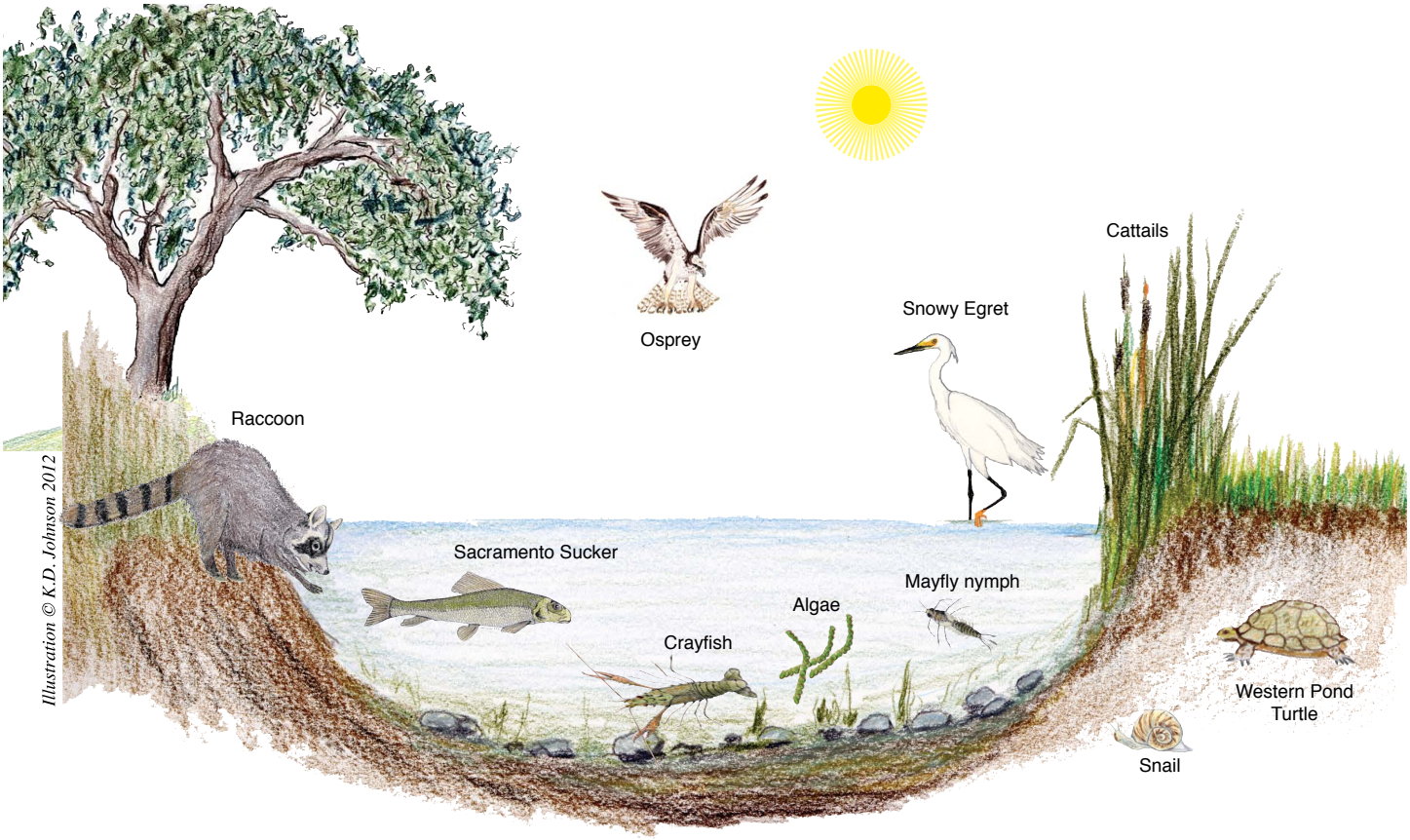
3) Circle the location of the gills on these aquatic organisms



mayfly larva dragonfly larva damselfly larva fish

4) Would they be happier in cold water or warm water? Why?

5) Food Web



Label each animal as a producer, first order consumer, second order consumer or decomposer. Draw arrows showing how energy can pass through the food web. (Hint: start with the sun!)

6) What is an indicator species? What is an example of an indicator species we might find in a healthy local stream?

7) Place the labels “acidic” “basic” and “neutral” on the pH scale. Circle the pH range that water in a healthy creek should be.

_____ _____ _____

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

STREAM II

A Scientist's Look at the Stream

Before the Ranger Arrives

- Look at maps to locate the site you will be visiting.
- Ask students to track where the water comes from and where it goes.
- Ask students what organisms they think they might find in the creek.
- Have students discuss if they think the stream will be healthy or not.
- Have them review ways to measure stream health.

Key Concepts the Ranger Will Discuss

- Scientists gather and carefully record data to analyze stream health.
- Visual observations can tell you a lot about stream health.
- Students should be sure to look at the surroundings, such as the plants growing on the bank and nearby man-made structures, not just the water.
- Canopy cover and water temperature can affect the amount of oxygen available to aquatic organisms.
- It is important to look not only at visible signs of pollution but also potential sources of pollution.

In Preparation for the Field Trip

- Divide your class into 2 scientific teams of equal size.
- Instruct students to bring a change of clothes and shoes.
- Students are required to wear close-toed shoes in the stream because of hazards like sharp rocks. No open-toed sandals, flip-flops or bare feet.
- Rain boots / galoshes not recommended; they fill with water, making it hard to walk. Old tennis shoes / sneakers are perfect.

STREAM II
Wrap up

1) What are three of the methods you used to measure stream health?

2) Summarize your results.
   What did you discover?

3) Average the pH and temperatures your groups found. DO YOUR MATH HERE

GROUP	pH	TEMPERATURE
1		
2		
3		
4		
AVERAGE		

4) Did all groups have the same results? If not, why might they be different?

5) Did you find any signs of pollution?
   What possible sources of pollution did you identify?

6) What do your findings lead you to think about the health of the stream
   and the health of the watershed?

7) Why is ongoing or long-term monitoring important?
   Even if the stream is clean now, could it become polluted?
   How would we know?

ANSWERS TO WRAP UP WORKSHEETS

Water Flows

1) Answers will vary. Students may draw people littering, cars leaking oil, fertilizer coming off lawn, dog pooping in gutter etc.
2) Bottom to top: evaporation, condensation, precipitation
3) Answers will vary.

Stream I

1) Answers may include looking for life in or around the creek, looking for trash or pollution, measuring temperature and/or pH, smelling the water, etc.
2) A benthic macroinvertrebate survey is when scientists catch small organisms (usually insects) they find living in a pond or stream and record data about them (usually the species and number found of each).
3) Mayfly gills are on sides of abdomen; dragonfly gills are within the abdomen; damselfly gills are the three appendages on the end of the abdomen; fish gills are located inside the fish's body approximately where the neck would be (if fish had necks).
4) Organisms that use gills to breathe generally prefer cold water as it holds more oxygen for them to breathe.
5) Producers – algae, cattails
   First order consumers – snail, mayfly
   Second order consumers – Sacramento Sucker (fish), turtle, raccoon, osprey, snowy egret
   Decomposer – crayfish
6) An indicator species is an organism that is so sensitive to pollution, that finding it is a good indication of a healthy ecosystem.
   Mayflies and caddisflies are two indicator species we might find in local streams.
7) Left to right: Acidic, basic, neutral. A healthy creek should have a pH between 6 and 8.

Stream II

1) Students surveyed benthic macroinvertebrates, made visual observations (looking for signs of pollution etc.), smelled the water, measured temperature, pH and some groups may have measured dissolved oxygen.
2) Answers will vary
3) Answers will vary
4) Groups may have measured at different locations and/or different times.
   The actions of students in the previous group may have altered what later groups found.
   There may have been error in measurements or data may have been recorded incorrectly.
5) Answers will vary. Some sources of pollution may be roads, people, nearby agriculture….
6) Answers will vary.
7) Long-term monitoring is important to detect changes in stream health and alert scientists to problems that may be occurring. We won't know if a stream has become polluted unless we continue to monitor it.

MEETING NEXT GENERATION SCIENCE STANDARDS

The study of water, storm water pollution and creek ecology ties into many areas of the curriculum. Many of the Next Generation Standards are addressed in this series of programs:

4-ESS2-1.SEP: Planning and Carrying Out Investigations - Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. [This standard is covered in the Stream II field trip]

4-ESS2-2: Analyzing and Interpreting Data - Analyze and interpret data to make sense of phenomena using logical reasoning. [This standard is covered in the Stream II field trip]

4-ESS2.A: Earth Materials and Systems - Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. [Water Flows addresses this standard]

4-ESS2.CC: Cause and Effect- Cause and effect relationships are routinely identified, tested, and used to explain change. [All programs in our series touch on this standard]

4-ESS3-2.SEP: Constructing Explanations and Designing Solutions - Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. [Students do this during the Stream II field trip]

4-LS1.A: Structure and Function - Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. [Stream I in-class program]

4-PS3-2.SEP: Planning and Carrying Out Investigations - Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. [This standard is covered in the Stream II field trip]

4-PS3-3.SEP: Asking Questions and Defining Problems - Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships. [Stream I and Stream II]

5-ESS2-2: Earth's Systems - Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth. [Water Flows]

5-ESS2.A: Earth Materials and Systems - Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather. [Water Flows]

5-ESS2.C: The Roles of Water in Earth's Surface Processes - Nearly all of Earth's available water is in the ocean. Most fresh water is in glaciers or underground; only a tiny fraction is in streams, lakes, wetlands, and the atmosphere.[Water Flows]

5-ESS3.C: Human Impacts on Earth Systems - Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space. But individuals and communities are doing things to help protect Earth's resources and environments. [Entire Series]

5-LS2.A: Interdependent Relationships in Ecosystems - The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life. Newly introduced species can damage the balance of an ecosystem. [Stream I and Stream II]

5-LS2.B: Cycles of Matter and Energy Transfer in Ecosystems - Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. [Stream I and Stream II]

5-PS1.CC: Scale, Proportion, and Quantity - Standard units are used to measure and describe physical quantities such as weight, time, temperature, and volume. [Stream II]

5-PS1.SEP: Planning and Carrying Out Investigations - Make observations to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. [Stream II]

5-PS3.D: Energy in Chemical Processes and Everyday Life - The energy released [from] food was once energy from the sun that was captured by plants in the chemical process that forms plant matter (from air and water). [Stream I touches on this]

ADDITIONAL RESOURCES

WEBSITES

There are many wonderful resources you can use to further explore watersheds, aquatic ecosystems and water quality monitoring. Listed here are a few you may want to check out.

- Fun interactive site for kids: http://www.discoverwater.org
- The Water Education Foundation - Has lesson materials relating to the history, geography and science of water: http://www.watereducation.org
- Global Learning and Observations to Benefit the Environment (GLOBE) has "storybooks", activities and a Teacher's Implementation guide: http://globe.gov/k-4
- The Department of Water Resources has links to a variety of educational resources: http://www.water.ca.gov/education/
- Calwater's website includes information about water conservation as well as educational materials: http://www.calwater.com/conservation/index.php
- The Arbor Day Foundation has an interactive activity that shows how trees help tame stormwater: http://www.arborday.org/trees/stormwater.cfm
- USGS has some great information: http://water.usgs.gov/wsc/watersheds.html

LOCAL WATER AGENCIES AND ORGANIZATIONS

- Zone 7 Water Agency's site has educational materials about where our drinking water comes from: http://www.zone7water.com/links/kids-zone
- Alameda Countywide Clean Water Program: http://www.cleanwaterprogram.org/index.php Provides funding for this program and others as part of its effort to protect creeks, wetlands and the San Francisco Bay. They also offer community stewardship grants and informational materials.
- Alameda Creek Alliance is a citizen group working to restore steelhead trout to Alameda Creek: http://www.alamedacreek.org/
- City of Livermore has activity booklets: http://www.cityoflivermore.net/citygov/pw/wrd/resources/teachers.asp

CURRICULA AND WORKSHOPS FOR TEACHERS

- Project Wild Aquatic has a wonderful, in-depth K-12 curriculum which can be obtained by attending a Project Wild Workshop. More information: http://www.projectwild.org/ProjectWILDK-12AquaticcurriculumandActivityGuide.htm
- Project Wet workshops www.projectwet.org/