

CALIFORNIA STATE PARKS



Watershed Education Program Docent Manual

Developed by Stewards of the Coast and Redwoods
Russian River Sector State Park Interpretive Association

California State Parks/Russian River Sector

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original funding for this program was provided by Proposition 13/State of California, Russian River Watershed Council, ChevronTexaco, California State Parks Foundation and the City of Santa Rosa.

In-Kind Matching Funds were contributed by Adopt-A-Watershed.

Acknowledgements

Partnerships

This program was developed in partnership with many public and private entities.

Stewards of the Coast and Redwoods would like to thank all our partners who have contributed to making this program such a great success. Working with *California State Parks* is a gratifying experience and we are proud to produce this program in partnership with them.

The original funding was received from the *State of California from Proposition 13 funds*. This education program is one component of a large grant that was received to restore the Willow Creek Watershed. Additional funds were provided by the *Russian River Watershed Council, Chevron, the City of Santa Rosa, and the Medtronic Foundation*.

We would like to thank *Harold Johnson, El Molino High School, and Barbara Gegan, Monte Rio Elementary School* for working with us as pilot schools during our first year. Their expertise as teachers enabled us to produce a quality program. In addition, we thank their students for their input and suggestions.

We also received valuable advice and input from the staff of *Prunuske Chatham, Occidental*.

Acknowledgements/Credits

Special thanks to *Donna Chinlund* for her inspiration and efforts to develop an engaging program and to *Chris Lods* for providing his artistic ability to design the beautiful cover and wonderful design elements.

Permission was granted to use photocopied materials in the manual. We express our thanks to the City of Santa Rosa, the California Aquatic Science Education Consortium at UCSB, Project Wild, and the Oregon Department of Fish and Wildlife: Watershed Education Project.

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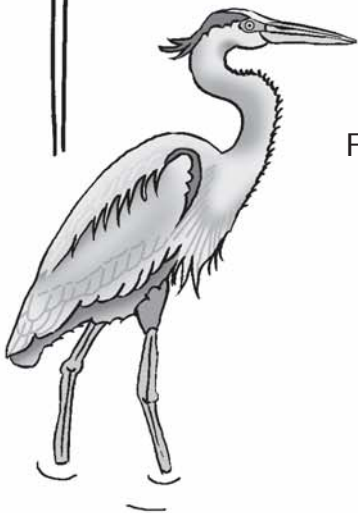


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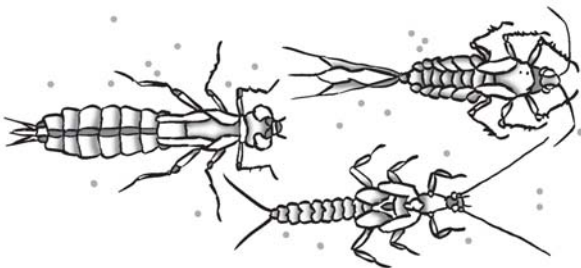
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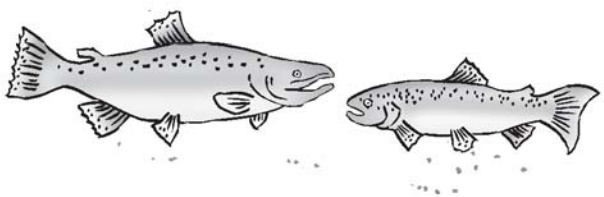
THE CALIFORNIA STATE PARK SYSTEM
AND
VOLUNTEERS





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CLASSROOM VISIT MATERIALS SENT TO THE TEACHERS CLASSROOM KIT AND LESSON PLANS



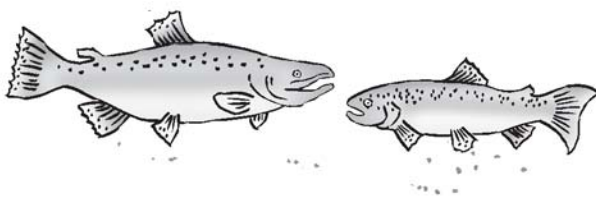
WELCOME TO THE WILLOW CREEK WATERSHED PROJECT

Salmon were last seen in Willow Creek in 1995. The salmon spawned for hundreds of years in Willow Creek. What changed in this habitat? Why are salmon not returning to this creek in large numbers to spawn today?

We can explore the answers to these questions together to see if it is possible to restore this watershed to a healthy state so salmon will return and spawn again.

Your participation in this project, and engaging students in a hands on learning process, is a wonderful contribution to our community and the environment.

Middle School and High School individuals will have an opportunity to develop an understanding of the watershed process through participation. Together we can experience working with nature and mentors to assess and restore this site. As a result, we can learn more about what it will take to nurture this watershed back to health so that salmon may return someday. Thank you for bringing your enthusiasm and perspective to this exciting and worthwhile endeavor.

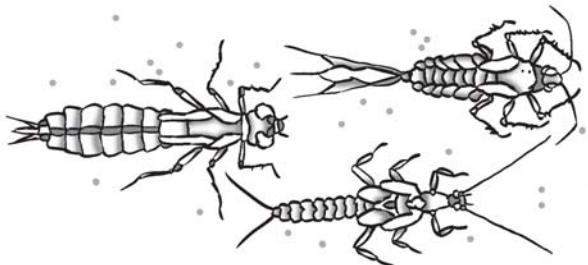


Dear Volunteer,

The activities in this section have been sent to the classroom teachers. We have asked them to complete these activities with their students prior to visiting Willow Creek.

Please review the material in this section and watch the videos, "Return of the Salmon" and "Life Cycle of the Salmon".

Imagine how you can incorporate the information in this section into the activities you facilitate at Willow Creek.



"RETURN OF THE SALMON" VIDEO QUESTIONS

LEVELS: High School

OBJECTIVES: The students will be able to

1. Describe what a watershed is and how salmon relate to it.
2. Describe the impacts on watersheds and the ways we can minimize those impacts.

MATERIALS: Video "Return of the Salmon"
Video Questions (attached)
Flip chart and colored pens

TIME: Preparation: 10 minutes
Activity: 45-60 minutes

DIRECTIONS:

1. **Divide** the class into teams of 4. Distribute a copy of the questions to each person.
2. **Explain** that the video contains the answers to the questions.
3. **Stop the video** after approximately 12 minutes. Give the teams about 7 minutes to review the answers they have learned to this point, repeat the process at the end of the viewing.
4. **Teams report their answers** in a class dialogue.

"Return of the Salmon"

Find the answers to the following questions in the video.

How do watersheds function?

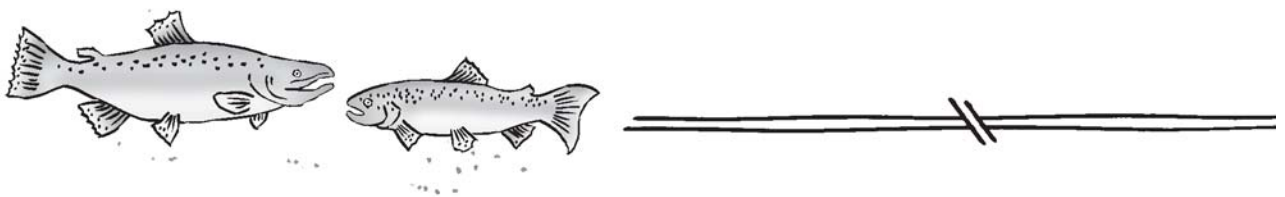
Where do salmon spawn?

What do salmon eat?

How does woody debris contribute to salmon habitat?

How do citizens get involved in watershed restoration?

What is stewardship?



"Return of the Salmon"

Answers to the questions from the video.

How do watersheds function?

Rain and snow collect in a watershed, which is a basin of land defined by its ridgelines. Headwater streams form in the high elevations flowing into larger streams, which gather together into a river before emptying into the ocean.

Where do salmon spawn?

Salmon spawn in fresh water tributaries in a watershed.

What do salmon eat?

Salmon eat insects that live in the water.

How does woody debris contribute to Salmon habitat?

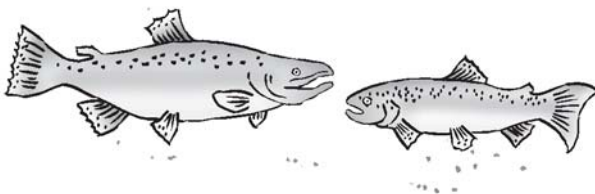
The woody debris in streams creates pools and places for the salmon to live it's like fish condos.

How do citizens get involved in watershed restoration?

There are many ways people can get involved in restoration of watersheds, some form watershed associations public and private, some people participate in restoration projects, and others help spread the word and develop understanding for restoration efforts.

What is stewardship?

Stewardship is the protection of the land for future human populations as well as for the animals.



Willow Creek Watershed Pre Site Visit Activity
"LIFE CYCLE OF THE SALMON" VIDEO QUESTIONS

LEVELS: Middle School and High School

OBJECTIVE: The students will be able to:

1. Verbalize the basic habitat requirements of Coho Salmon
2. Verbalize the life cycle of the salmon

MATERIALS:

1. Video "Life Cycle of the Salmon" (in classroom visit kit)
2. Video questions (in classroom visit kit)
3. Laminated copies of the questions

TIME: Preparation: 5 minutes

Activity: 25 minutes

DIRECTIONS:

1. **Hold** up the video questions.
2. **Divide** the class into teams of 4 and give each team a copy of the questions. Explain the answers to the questions in the video, and that it's only 5 minutes long, so listen carefully.
3. **Read** each question.
4. **Explain** that each team will have 10 minutes to answer all the questions after the video is over.
5. **Explain** that teams will report their answers to one or two of the questions listed; however, teams do not know which question they will be asked to answer, so do your best to learn all the answers.

"Life Cycle of the Salmon" Questions from the Video

What do salmon do when they spawn?

What do salmon need to spawn?

What is a sack fry?

What is a fingerling?

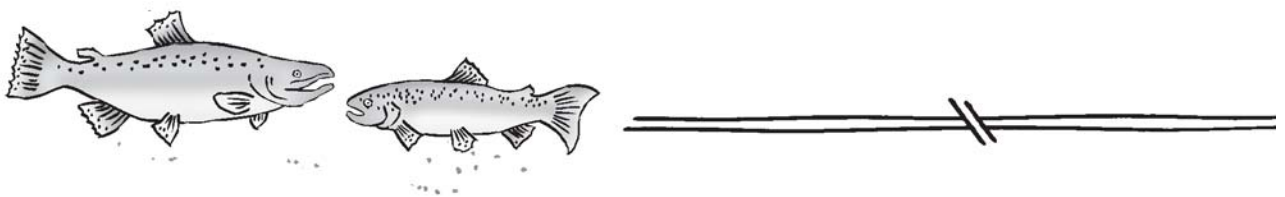
What do fingerlings need to survive?

What is smolting?

How long do salmon live in the ocean?

What do salmon do when they return to the stream they were hatched in?

What happens to the salmon after they spawn?



"Life Cycle of the Salmon" Answer Sheet for Video Questions

What do salmon do when they spawn?

Salmon create new life (more salmon). They create redds (nests) in the gravel for the eggs. The female lays thousands of eggs in a few days and the male fertilizes them.

What do salmon need to spawn?

Salmon need clean gravel, cold clean water, and water flowing through the gravel to bring oxygen to the eggs, or the eggs will suffocate.

What is a sack fry?

A young salmon that lives on its rich yolk sack and hides in the gravel away from predators.

What is a fingerling?

A fingerling is a salmon that has grown to 1 inch in length.

What do fingerlings need to survive?

Fingerlings need deep pools in which the current is not too strong; and they need shade, hiding places, and insects to eat.

What is smolting?

Smolting is the body changes a salmon develops to make the change from living in fresh water to living and surviving in the ocean.

How long do salmon live in the ocean?

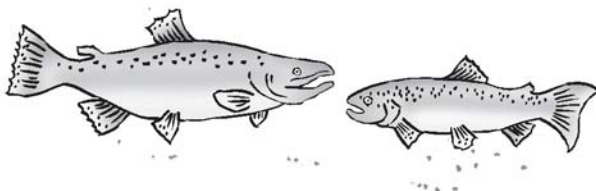
Salmon live in the ocean 2 to 5 years.

What do salmon do when they return to the stream they were hatched in?

Salmon swim hard and jump high to get back to where they were born.

What happens to the salmon after they spawn?

The female protects the eggs for about two weeks, and then she dies, and her body decays and gives nutrients back to the environment.



The Water Cycle and Watersheds

LEVELS: Middle School to Adult

OBJECTIVES: Students will be able to:

1. Describe what the water cycle is and draw a picture or diagram of how the water cycle works, including rain, runoff (overland flow), stream, river, evaporation, and clouds.
2. Describe what a watershed is and include in the drawing how the watershed and the water cycle interact (see the diagram included in the following pages).

MATERIALS:

1. Attached reading on the water cycle and watersheds, Xerox enough copies for your class teams
2. Art paper, magic markers, or crayons, or colored pencils and pens

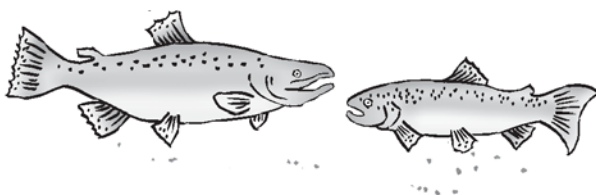
TIME: Preparation: 10 minutes

Activity: 45-60 minutes

The Water Cycle and Watersheds

DIRECTIONS:

1. **Divide the class into groups of four each and distribute** the attached reading and diagram of the water cycle and watershed.
2. **Explain** each team of four has been given information describing the water cycle and what a watershed is. It is the task of each team to read, understand, and explain the reading to each team member so they can draw an example of the water cycle and a watershed interacting.
3. **Refer** to the diagram in the reading material. It is an example of what we are asking them to do and have fun with.
4. **Circulate** around the teams **listening** for their understanding of the water cycle and the meaning of a watershed. Offer assistance when clarification is needed.



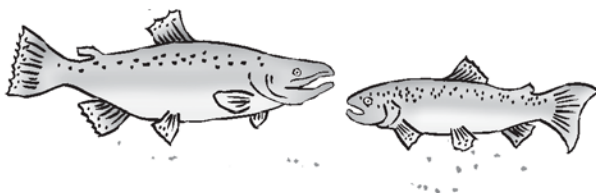
The Water Cycle and Watersheds

The pathway water takes as it moves through air, soil, streams, rivers, oceans, and ice is called the **water cycle**.

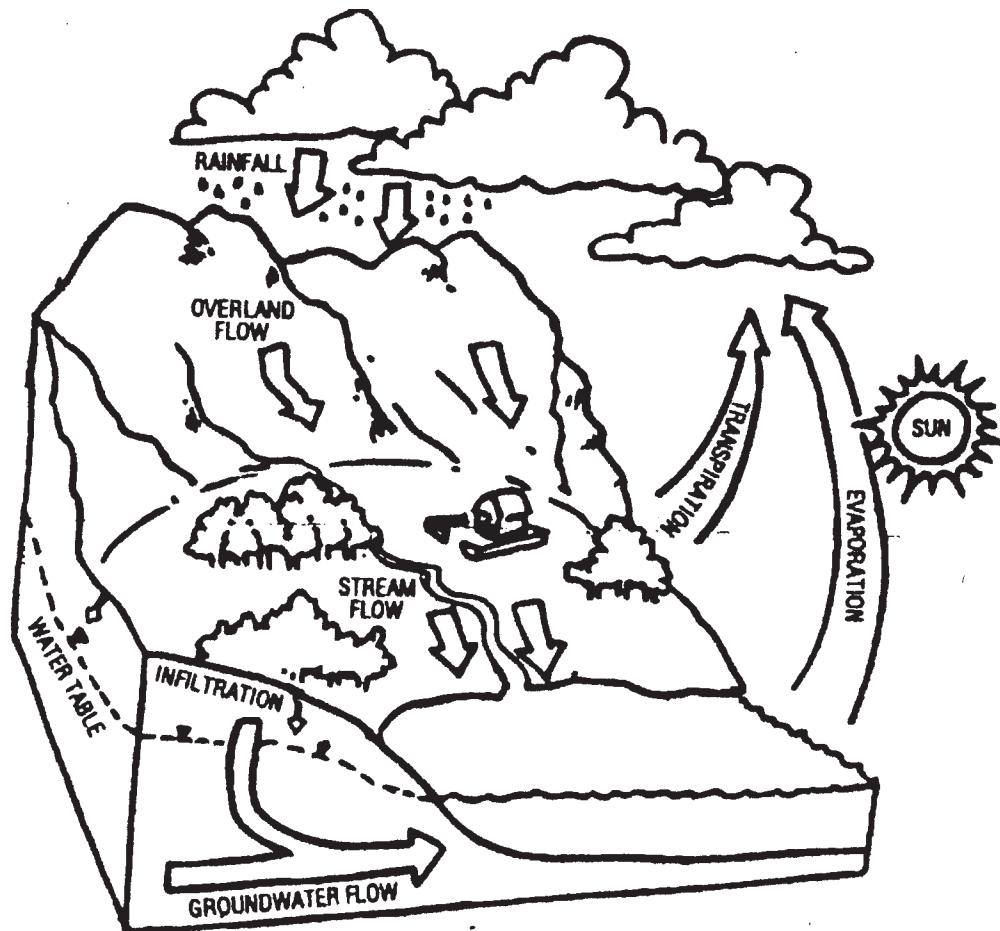
1. Rain falls on the land and begins to puddle or run off.
2. Small streams join larger streams and then become big rivers.
3. Rivers flow into oceans.
4. Water evaporates and turns into water vapor, which forms clouds.
5. Plant roots also take up and release water through their leaves and stems, which then is released into the atmosphere.
6. Water also reaches rivers or streams when raindrops soak into the soil and become part of the groundwater (water which flows underground).
7. The groundwater sometimes comes to the surface as springs, or seeps and flows into streams and rivers.

The first step in learning about a stream is to learn about its watershed. A **watershed** is an area of land that drains into a particular stream, river, or lake. Water flows downhill, so when raindrops fall on the land, they flow down to the lowest elevation - usually a river or stream. A small stream that runs through your town might receive rainfall runoff from only a few acres of land, but it is still an important part of a larger watershed.

Knowing a stream's watershed area is very important. Everything that happens in a stream's watershed - good and bad- affects the stream no matter how far away. If someone pours a quart of oil onto the ground a mile from a stream in its watershed, eventually that pollution may reach the stream. Because of this, all people need to be careful and not cause pollution, even if they do not live on a stream or lake.



Hydrological Cycle Diagram



Here is What the Salmon Need

Salmon Need

Cold Water 42 - 55 degrees

Clean Water

Dissolved Oxygen in the water

Protection from predators

pH range of 6.5 - 7.5

Food

Gravel

In a Healthy Stream

Shade from trees, cold run-off from mountains and springs

Bacteria breaks down decaying matter and scavengers eat it. Plants take up nitrates. (Pollutants from people can hurt rivers.)

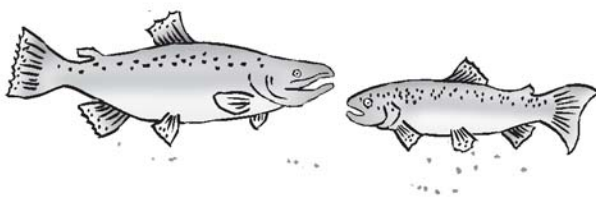
Water is cold and tumbles over rocks downhill, picking up oxygen from the air. Plants add oxygen.

Eggs are buried in the gravel. Buried eggs are safe from birds and amphibians. Fingerlings hide under boulders, logs, root wads, and undercut banks.

Rock types, amount of plants and decaying matter in the water and animal wastes all affect pH.

Aquatic insects living in the gravel, other insects that fall into the water, any small animals fish can find, including other fish provide food.

Rocks erode from the watershed, get washed into streams, and are tumbled smooth. Salmon need good sized gravel, not silt and sand.



Willow Creek Watershed Classroom Visit Activity
Introduction to Willow Creek Watershed Project

LEVELS: Middle and High school

OBJECTIVES: The students will:

1. Be introduced to you and the other volunteers and learn why you are enthusiastic about salmon and the Willow Creek Project;
2. Understand that salmon were last seen in Willow Creek in 1995 and that their numbers have declined dramatically along the North West Coast in the last 50 to 100 years;
3. Understand that there may be salmon in the ocean now that remember the scent of Willow Creek and have the instinct to return to spawn there;
4. Understand that the goal of the Willow Creek project is to monitor and restore the Willow Creek watershed with the hope that salmon will return in the future.

MATERIALS: None

TIME: 5 minutes

DIRECTIONS:

1. **Relax** and **communicate** the above objectives.
2. **Develop** a feeling of rapport among the learners, a feeling of connection that says, "We're all in this together."
3. **Provide** a safe learning environment. Communicate through your thoughts, actions, and words that the students' thoughts, feelings, beliefs and ideas have value.

Willow Creek Watershed Classroom Visit Activity

Salmon Life Cycle and Habitat Review

LEVELS: Middle and High School

OBJECTIVES: The students will:

1. Review the life cycle of the salmon.
2. Understand the meaning of a watershed.
3. Understand how activities that occur in watersheds, from the ridge tops to the streams, affect the quality of the water in the stream and consequently the salmon's habitat or home.
4. Understand the location of the Willow Creek watershed and where they will be going on their field studies trip.
5. Communicate to a partner what they remember about the life cycle of a salmon.

MATERIALS:

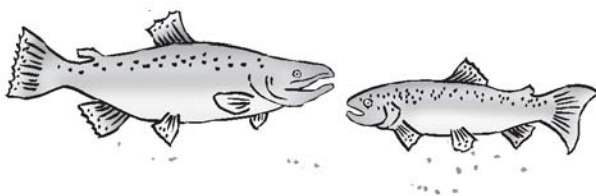
1. 8 laminated posters of "Pacific Salmon Life Cycle"
2. 8 laminated Willow Creek Site Location Maps
3. Bell to signal time to transition to next step in activity

TIME: 15 minutes

Salmon Life Cycle and Habitat Review *continued*

DIRECTIONS:

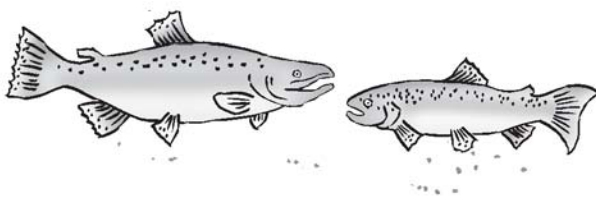
1. Have students find a partner to work with that is next to them in the room and tell them that they will each have 3 minutes to tell their partner everything they remember about the life cycle of the salmon, after three minutes you will ring a bell and the other partner will have their opportunity to tell everything they remember about the life cycle of the salmon.
2. Have two sets of partner pair up (so there are groups of four), and distribute 1 poster, "Pacific Salmon Life Cycle", to each group.
3. Refer the students to the photo on the upper left corner of the poster of the salmon in upstream spawning migration and explain that it is possible that there are salmon in the ocean that have the instinct to return to Willow Creek and spawn.
4. Direct the student's attention to the photo of the salmon eggs and review the habitat needs for spawning; e.g. gravel that cool, oxygenated water can move through, in order for the eggs to remain alive.
5. Direct attention to the enlarged photo of salmon eggs and potential obstacles for the eggs.
6. Direct attention to the picture of fry and their yolk sacs and mention what they eat.
7. Direct attention to two photos at the bottom of the poster depicting young salmon and explain that their habitat needs are to survive in fresh water; e.g. food, pools, cover is needed to hide and escape predators.



Salmon Life Cycle and Habitat Review continued

DIRECTIONS:

8. **Direct** attention to the ocean migration and life at sea information in the adjacent photo.
9. **Explain** that the quality of the water in a stream determines whether salmon can live there or not; and that the water quality is affected by what is happening in the watershed.
10. **Distribute** to each group of four a Willow Creek Site Location Map, ask them to locate and view with each person in their group: Jenner, the Russian River, Willow Creek, and the 3rd Bridge (on Willow Creek). Explain that the Field Studies site is upstream about three miles from the 3rd Bridge.
11. **Ask** students to locate on the map the red line around Willow Creek that, is labeled in red Watershed Boundary.
12. **Direct** students to work with their original partner. Ask partner A to put their hands together side by side slightly cupped. Ask everyone to imagine that the line that is created where the two hands meet is Willow Creek. Ask them to also imagine that the rim of their cupped hands is the ridge top of the watershed. Ask partner B to run their finger along the rim of the cupped hands of their partner to indicate the watershed boundary and correlate this to the watershed boundary marked in red on the map. Imagine the lines on the palms and fingers are the tributaries to Willow Creek. Show how this is a model of a watershed.
13. **Explain** that next they are going to test some water samples to see if they would be suitable for salmon to live in.



Willow Creek Watershed Classroom Visit Activity
Erosion Station

LEVELS: Middle School to Adult

OBJECTIVES: The students will:

1. Demonstrate what a watershed is using the analogy of how cupped hands are similar to a basin of land, with tributaries and streams .
2. Understand how erosion in a watershed can affect the health of a stream.
3. Understand how different land use practices can affect the health of a watershed and a stream.

MATERIALS:

1. 8x11 paper for each student and volunteer
2. 12 red permanent markers to represent ridge line
3. 12 blue permanent markers to represent streams
4. 12 green water-soluble markers to represent housing
5. 12 brown water-soluble markers to represent dirt roads
6. 12 orange water-soluble markers to represent land practices that leave exposed soil with little or no plant life to hold the earth in place when it rains
7. 1 spray bottle with water in it
8. 1 towel
9. 11 container for excess water
10. 1 contour map
11. topographical maps
12. 1 chart of stream cross-section and the surrounding area up to the ridgeline

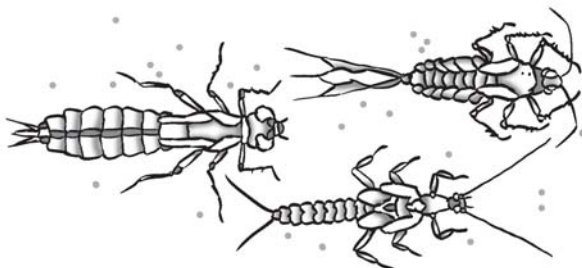
TIME: 12 minutes

Willow Creek Classroom Visit Activity

Erosion Station continued

DIRECTIONS:

1. **Model** for participants how to cup your hands to simulate a watershed and invite them to do the same. Point out the analogies between the cupped hands and watershed ridge lines, tributaries, streams and rivers
2. **Ask** participants to explain what a watershed is using the cupped hand analogy.
3. **Explain** another way of demonstrating how a watershed works. Invite each participant to take a piece of paper and crumple it into a ball. Unfold the crumbled paper gradually and form it into a contour map with ridges, canyons, tributaries, streams, etc. You may point out the contour map in the kit to support the concept.
4. **Invite** participants to use a red permanent marker to indicate the ridge lines, and a blue permanent marker to indicate the stream bottoms.
5. **Instruct** participants to:
 - Use an orange water-soluble marker to represent land use practices that leave exposed soil with little or no plant life to hold the earth in place when it rains; e.g. construction, various plowing practices, over grazing.
 - Use a green water-soluble marker to represent housing and various things we do around our homes that may be washed away when it rains.
 - Use a brown water-soluble marker to represent dirt roads.
6. **Show** the participants the spray bottle with the water in it. Explain how this is a simulation of rain, and how water and gravity combined, can carry what is occurring in a watershed into the stream.
7. **Spray** the participant's watershed contour maps with the water and see what happens.
8. **Ask** participants what they see and what they think regarding erosion in watersheds. How does erosion affect the stream, the salmon, and people?
9. If you have time, **look** at the Topo map of Willow Creek, let 2 people share a map. Tell them the red line on the map indicates the tallest ridgelines in Willow Creek watershed. Ask them if they can find the creek. Can they find where the creek enters the Russian River?



Willow Creek Classroom Visit Activity

Sedimentation and Stream Quality Station

LEVELS: Middle and High Schools

OBJECTIVES: The students will:

1. Understand the importance of the stream bottom to salmon.
2. Measure and identify the different substrate size categories of sediment (see "Streamkeeper's" page 102).
3. Understand stream qualities such as turbidity, temperature, and embeddedness and how they impact salmon survival.
4. Dialogue regarding our lifestyles and what we can do to prevent unnecessary amounts of sediment from entering a stream.

MATERIALS:

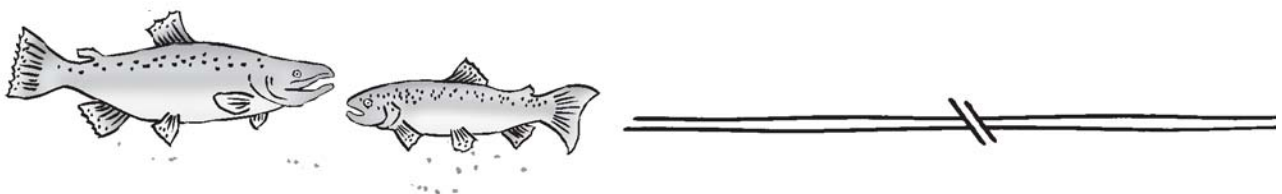
1. 6 laminated Topo maps of Willow Creek Watershed
2. 6 laminated posters of the "Pacific Salmon Life Cycle"
3. 12 rulers to measure substrate
4. Data sheets to record substrate size
5. 4 boxes each containing one example of different substrate size found on stream bottoms e.g. silt, sand, gravel, cobble (see "Streamkeeper's" page 102)

TIME: 12 minutes

Willow Creek Watershed Classroom Visit Activity
Sedimentation and Stream Quality Station
continued

DIRECTIONS:

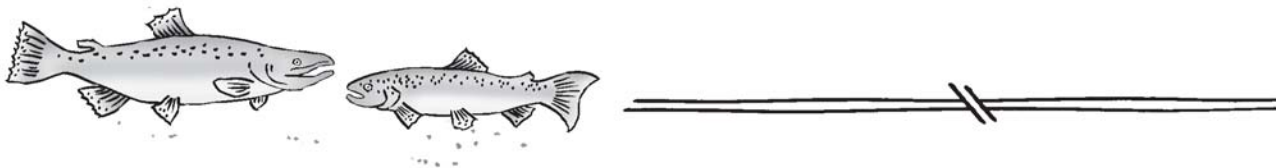
1. **Explain** how the stream bottom is crucial for salmon survival.
2. **Demonstrate** how to achieve "random" sampling of substrate and how to measure pebble size in cm. Include hands-on participation by students.
3. **Define embeddedness** (the extent to which cobbles are surrounded or covered by fine sediment). Use the sample and pictures to illustrate.
4. **Discuss** with participants what salmon need in order to lay their eggs in the stream. Acknowledge all responses and show appreciation for their willingness to join you in exploring this subject.
5. **Ask** participants to share, in teams of two, the poster you are distributing of the "Pacific Salmon Life Cycle". **Draw attention** to the photo of the salmon eggs at the top of the poster.
6. **Explain** that salmon cover their eggs in 8 to 14 inches of gravel. If there is too much silt (a very fine sediment) present, it can smother the salmon eggs, causing the sack fry to be trapped in the gravel after spawning. Refer to the "Pacific Salmon Life Cycle" poster and draw their attention to the photo of the fry.
7. **Ask** participants to explain erosion and what are some ways that large amounts of sediment might enter a stream. Appreciate responses and draw out from their answers the concept that watersheds need plants and tree canopy to help hold the soil, and prevent gravity from carrying the soil into the creeks. The amount of sediment in a creek may also be related to how we build roads, plow fields, plan for drainage when it rains, remembering that water and gravity carry things to the stream. How we behave in nature along our creeks also impacts the amount of sediment in a stream. We need to be aware of stream banks and remember not to push them into the creeks with our feet or bikes.
8. **Explain** that water and gravity are powerful forces and can carry loose soil to streams or cause erosion.



Willow Creek Watershed Classroom Visit Activity
Sedimentation and Stream Quality Station
continued

DIRECTIONS:

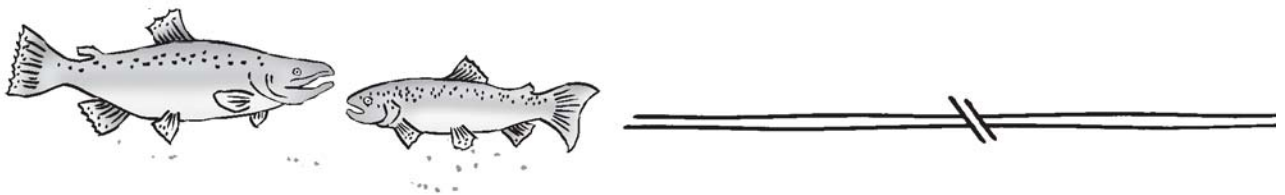
9. **Ask** students if how we behave in nature along creeks also impacts the amount of sediment in a stream.
10. **Define turbidity** (cloudiness of water due to suspended clay and silt). **Explain** that fine sediment can prevent water from circulating through the gravel where the eggs are, which results in preventing a continuous supply of oxygen for the developing fish. It can also decrease water clarity and light transmission through the water, affecting the food source for macroinvertebrates and thus salmon.
11. **Tell** them that at high levels, the fine sediment can clog the gills of the fish and other critters, and make it difficult for them to breathe.
12. **Discuss** the importance of temperature (salmon like it cool) and how stream restoration can reduce water temperature. Willows, alders, etc. can be planted in cleared areas.
13. **Explain** why pH is important (salmon can't live in highly acidic or strongly basic water). Show how to use "Lethal pH limits for Aquatic organisms." Lead a hands-on activity using pH paper or a pH measuring device on buffered water solutions.
14. **Explain** the importance of stream flow and how it is measured. How does it affect substrate size? Where in the watershed are the largest and smallest sediments? (Largest sediments are found nearer the upper edges and the finest sediments are found near the mouth of the watershed).
15. **Conclude** from the responses that salmon need gravel they can move with their tails in to form nests or redds, plus clean, cool, well oxygenated water, protection from predators, and a pH range of 6.5 - 7.5.



What is Important About the Stream Bottom?

The stream bottom is extremely important to the organisms that live there. Some crucial activities that happen there are:

1. Fish reproduction and egg development;
2. Growth and development of bottom-dwelling macroinvertebrates that feed fish and invertebrates;
3. Rearing of juvenile fish, frogs, and salamanders;
4. Growth of bacteria, fungi and algae that feed macroinvertebrates.



Willow Creek Watershed Classroom Visit Activity
Macroinvertebrate Station

LEVELS: Middle and High School

OBJECTIVES: The students will:

1. Understand the definition of a Benthic Macroinvertebrate.
2. Understand that we collect and identify these spineless critters because they are indicators of the quality of the water in the creek.
3. Understand the field techniques we will use at the field site.
4. Look at the BMI preserved samples.
5. Understand where the spineless ones live and why.

MATERIALS:

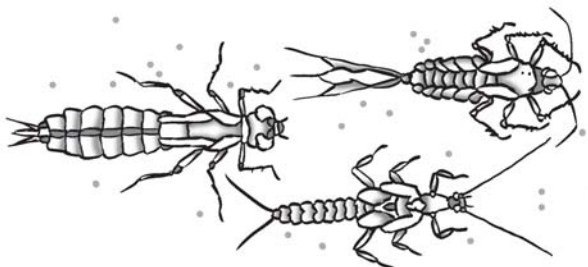
1. BMI sampling equipment
2. BMI preserved samples
3. BMI poster/laminated dichotomus charts
4. Journals

TIME: 12 Minutes

Willow Creek Watershed Classroom Visit Activity
Macroinvertebrate Station continued

DIRECTIONS:

1. **Ask** participants what they think salmon eat
2. **Explain** what Benthic Macroinvertebrates are; Benthic means bottom of lake, sea, or ocean, macro means large enough to see with the naked eye, and invertebrate means spineless.
3. **Explain** to participants the reason for collecting macroinvertebrates and the technique you will use (Read "Streamkeeper's Field Guide", pages 129 to 139).
4. **Demonstrate** how you will use the kick net and other sampling equipment such as sieve bucket, brushes trays, pipets, magnifiers ice cube trays.
5. **Ask** participants where they think the macro invertebrates live in the stream, what they think they eat, and how they catch their food.
6. **Invite** participants to look at the BMI preserved samples. Ask them to guess how the invertebrate breathes.
7. **Identify** preserved samples.
8. **Ask** participants what they think the BMI eat; shredders chew, scrapers take algae from rocks, collectors eat fine particles, and predators eat others.
9. **Explain** how to use the Dichotomous charts and drawings.
10. **Mention** you'll see them in the field.



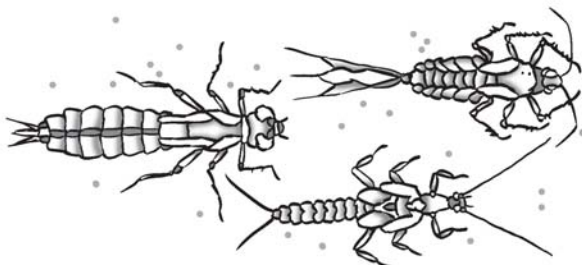
Macroinvertebrates

What are they?

1. Macroinvertebrates are animals that do not have backbones, and are visible to the naked eye. Many of these organisms live on the stream bottom.
2. Many of these spineless ones are insects, but many others are represented by freshwater aquatic worms, snails, clams, or **crustaceans** like (crayfish, crabs, shrimp, etc.)

Why are they important?

1. Macroinvertebrates tell us about the health of a stream. Because they are relatively sedentary residents of the stream bottom, they often become a pollutant's captive audience. Fish can (hopefully) swim away from some pollution problems. However, even regular chemical tests of the water can fail to detect transitory events. Because macroinvertebrates cannot swim away from pollution, they can be affected by even subtle levels of degradation which makes them good indicators of stream health.
2. Some macroinvertebrates are intolerant of pollution. Their presence in the stream, like a canary in a mineshaft, suggests healthy conditions. However, some macroinvertebrates are quite tolerant of pollution. Taken together, the presence or absence of tolerant and intolerant types, can indicate the overall stream health.
3. Macroinvertebrates are food for fish and important links in the food chain as recyclers of nutrients.



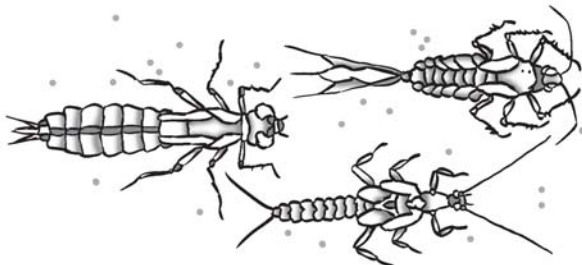
Macroinvertebrates

How Do Macroinvertebrates Breathe?

The art of breathing in an aquatic environment poses a great challenge to macroinvertebrates because oxygen in water exists as **dissolved oxygen**, which is less abundant than the atmospheric oxygen available to beings like humans.

To utilize dissolved oxygen in their underwater home, stream macroinvertebrates have developed countless ways to breathe:

1. Most have soft or membranous areas of the body wall through which oxygen diffuses.
2. Many have external **gills**, or membranous outgrowths of the body wall, which increase the surface area for oxygen uptake. These gills can be platelike, filamentous, tubelike or fleshy.
3. Some ventilate parts of their bodies to increase their available oxygen supply. Certain mayfly larvae beat their abdominal gills. Some caddisfly larvae are known for their undulating abdominal movements.



Willow Creek Watershed Classroom Activity

Macroinvertebrates -Creek Creatures

LEVELS: Middle and High School

OBJECTIVES: The students will:

1. Understand what a Benthic Macroinvertebrate is.
2. Understand where the spineless ones live and why.
3. Understand how and why we collect them to help us determine water quality in the stream.
4. Learn the field techniques for collecting and identifying BMIs.
5. Learn to use dichotomous charts and become familiar with some of the common creek macroinvertebrates.
6. Verbalize 3 adaptive characteristics of one macroinvertebrate.

MATERIALS:

1. BMI sampling equipment
2. BMI preserved samples
3. Laminated dichotomous charts/ BMI poster
4. Journals

TIME: 12 minutes

Macroinvertebrates -Creek Creatures

DIRECTIONS:

1. Ask participants what they think salmon eat.
2. Ask what Benthic Macroinvertebrates are; Benthic means bottom of the lake, sea or ocean, macro means large enough to see with the naked eye, and invertebrate means spineless.
3. Ask participants where they think BMIs live in the stream and why. Riffles are shallow areas of fast moving white water, cobbles/gravel bottoms and well-oxygenated water of riffles provide optimal conditions for many underwater insects and spawning salmonids.
4. Ask students why we should study them. Explain that MBIs are a good indicator of stream health and water quality. They are also a food source for fish.
5. What do they look like? (Insects, worms, snails, clams, crayfish, & spiders) Invite participants to look at the BMI preserved samples. Ask them to guess how the invertebrate breathes.
6. Ask participants what they think the BMI eat; shredders chew, scrapers take algae from rocks, collectors eat fine particles, and predators eat others. How do they catch their food?
7. Explain how to use the Dichotomous charts and drawings. Identify the preserved samples by looking at their legs, tails, bills, wings, thorax and abdomens.
8. Demonstrate collection techniques such as how to use the kick net and other sampling equipment ("Streamkeeper's Field Guide", pages 129 to 139).



Closing Remarks and Preparation for Field Visit

LEVELS: Middle School to High School

OBJECTIVES: The students will:

1. Understand that professionals, volunteers and students are monitoring Willow Creek Watershed to learn if it is possible to restore it to a healthy state so that salmon will return to Willow Creek.
2. Understand where Willow Creek Watershed is and where they will be going on their field studies trip.
3. Understand and dialogue about how they can make changes in their own life style to help decrease the amount of erosion and sedimentation in streams.
4. Understand what they will be doing during their field studies day. Clarify what to bring and review safety guidelines.

MATERIALS:

1. Handout list of things to bring to fieldsite visit.

TIME: 6 minutes

DIRECTIONS:

1. Be creative, have fun, and engage the students in understanding the above objectives
2. Be sure the teacher has the handout that lists the above, and that the teacher has a plan of when this handout will be given to the participants reviewed and taken home

WHAT TO BRING TO FIELD SITE

-Dress warm and in layers, in case the weather changes. Wear clothes you don't mind getting dirty. Long pants are advisable.

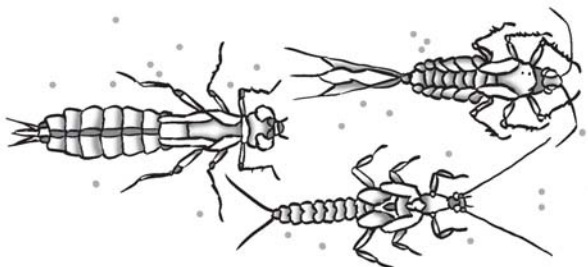
-Wear sturdy walking shoes that can get wet, and bring a pair of shoes to change into if your shoes do get wet.

-Bring a sack lunch, water, and a screw top drink. A day pack is ideal, leaving hands free to work with.

Please be aware of our **Field Site Rules**:

1. Stay with your group.
2. Walk on trails.
3. No smoking please!
4. Leave only footprints, take only memories.

We hope that your field trip is both enjoyable and educational for you. Thank you for your assistance and participation.





PART III

FIELD SITE VISIT



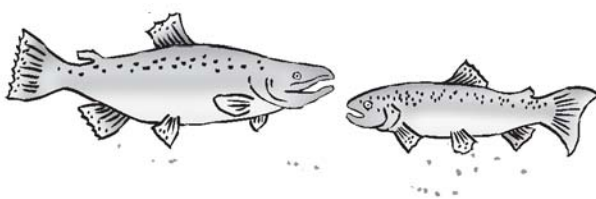
NATURE TIPS

Take time to be quiet. Wildlife will be frightened by noisy groups of humans. At some point during your visit, take time to sit quietly, separated somewhat from the group, and observe the sounds and sights of the wetland.

Follow the guidelines of this site, particularly those regarding staying on designated paths.

Be kind to plants and animals. Watch where you step. Certain plants or animals that may seem common at the wetland may be rare everywhere else, and may even be endangered. Do not remove any species of plants or animals unless your group has received special permission.

Be prepared to get your feet wet and muddy. Wear old, sturdy shoes that you don't mind getting wet and muddy, and be sure to bring along an extra pair of shoes and socks to change into at the end of the trip.



TIPS FOR THE TRAIL

"People don't care how much you know until they know how much you care."

Self discoveries are retained longer than lectures. People learn best by doing.

GUIDELINES FOR GUIDED FIELD STUDY:

1. Welcome. Happy to have you at Willow Creek. My name is...
2. Before we get involved in activities here, I'd like to tell you a bit about what we are doing here...
3. Today each team will be participating in assessing the health of this creek. Salmon were last seen here in 1995, and we are gathering information to see what we can do to improve the health of this creek and watershed so salmon may return.
4. You know that a stream can be viewed as a narrow strip of water which drains the watershed, the ridge tops, and land surrounds the stream.
5. You also know that because runoff to streams originates from rain that falls in the watershed, whatever happens on the land is reflected in streams.
6. Streams tell us the watershed health.
7. When designing an assessment program, it is helpful to consider the following questions: Why do we want to assess this stream? What do salmon need for a healthy home?
8. What do we need to do to be safe here? Listen and acknowledge their responses, and add any additional safety guidelines you believe are important, (see following page).



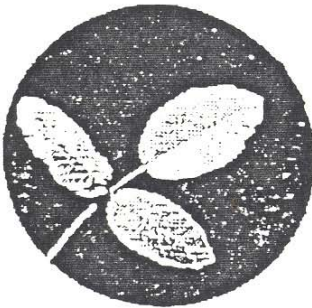
STREAM SAFETY:



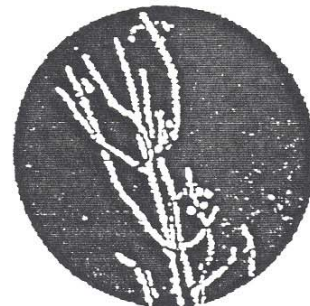
These safety guidelines may seem extreme for our small creeks, but they are important guidelines for having a safe and enjoyable experience while working around waterways.

- 1) Never enter a stream without someone else on shore to watch you in case you fall in or get swept away.
- 2) If the water is above your knees, use extra caution. The deeper you get in the water, the more surface area you have exposed to the force of the water, allowing a greater opportunity to be swept into the stream.
- 3) Rivers, streams, and creeks are always moving faster than they look. Streams that have no whitewater are especially deceptive and are often moving faster than streams with whitewater. Take a minute and look at the water, especially during winter.
- 4) If you try to cross a stream with water above your knees, keep your body faced toward the opposite bank to minimize your surface area against the current.
- 5) Rocks will be slippery (both in the water and at the water's edge), so take your time and avoid big jumps from rock to rock.
- 6) If you fall in, don't panic. If the water is deep, try to float with your feet faced downstream and your head up and calmly make your way to shore. If you encounter any obstacles while floating, use your legs as shock absorbers to push away from rocks and logs. Do not try to run along the bottom; you could get your foot stuck and be pulled under by the current.
- 7) Do not drink water from the creek and avoid touching your eyes and mouth while in the water. Always wear gloves while working in the creek.
- 8) Streamside vegetation can often include **POISON OAK**, which may or may not have leaves and either way can give you an extremely irritating rash. Learn what the plant looks like both with and without leaves and avoid it even if you think you don't react to the plant's oils.
- 9) Keep in mind that the longer you stay in the water, the more likely you are exposing yourself to the possibility of hypothermia
- 10) Always wear some type of shoes while in the water, preferably shoes rather than sandals to protect your toes.
- 11) Because water reflects light, it is possible to be sunburned in areas not normally exposed to the sun, especially the back of your legs and underneath your eyebrows. Wear plenty of sunscreen on exposed skin and remember to re-apply to areas that may have been washed off by the water.

Poison oak with leaves:



Poison oak without leaves:



Willow Creek Watershed Field Site Activity

Introduction to Willow Creek Watershed and Bus Ride

LEVELS: Middle and High School

OBJECTIVES: The students will:

1. Receive a journal in which to write their observations.
2. Review the definition of a watershed.
3. Review the crumpled paper watershed model they made in the classroom.
4. Review that salmon were last seen in Willow Creek in 1995.
5. Understand that the goal of the Willow Creek project is to monitor and restore the Willow Creek watershed with the hope that salmon will return in the future.
6. Understand that they can participate in the success of this project and also, specific ways in which they can assist.
7. Understand that erosion and sedimentation is one of the challenges we are facing in restoring the Willow Creek Watershed.
8. Understand that there are some land use practices that increase erosion and sedimentation and what they are.
9. See examples of how the sediment is filling in the streambed.
10. Dialogue regarding how the sediment affects the salmon in Willow Creek.
11. Understand the safety guidelines used at Willow Creek and be shown examples of poison oak and stinging nettle.

MATERIALS:

1. Journals (one for each student)

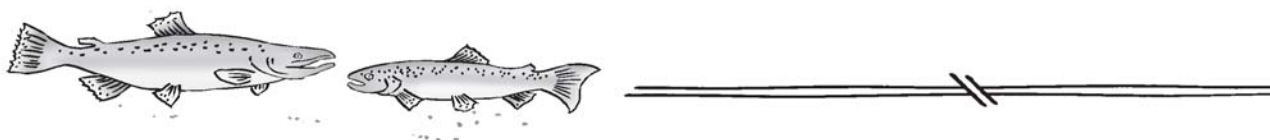
TIME: 20 minutes

Willow Creek Watershed Field Site Activity

Introduction to Willow Creek Watershed and Bus Ride continued

DIRECTIONS:

1. **Board** the school bus at Bridge 1, which is near the Ferry Keepers House. Welcome everyone to Willow Creek Watershed and give each person a journal. Ask them to look at the topographic map and locate where we are, and explain the relationship between our location, the creek, and the ridge tops. Ask them to locate the watershed boundary on the topo map and see the relationship to that and the actual ridge tops.
2. **Discuss** what they remember about the crumpled paper watershed models they made during the classroom visit. Help them understand that activities that occur in watersheds, from the ridge tops to the streams, affect the quality of the water in the stream and consequently, the salmon's habitat or home.
3. **Ask** participants to write their name, the date, weather conditions, and their thoughts in their journals.
4. **Continue** to Bridge 2
5. **Stop** the bus at Bridge 2 and ask participants to locate where we are on the topo map.
6. **Ask** them to observe their surroundings, the vegetation, trees, stream flow, and structures.
7. **Explain** that in 1953 the stream channel was straightened near this stretch of the creek for agricultural irrigation purposes. What do you think happened here as a result of straightening the creek?
8. **Ask** them what the salmon might experience at this part of the stream.
9. **Ask** them to write in their journals what they see and think.

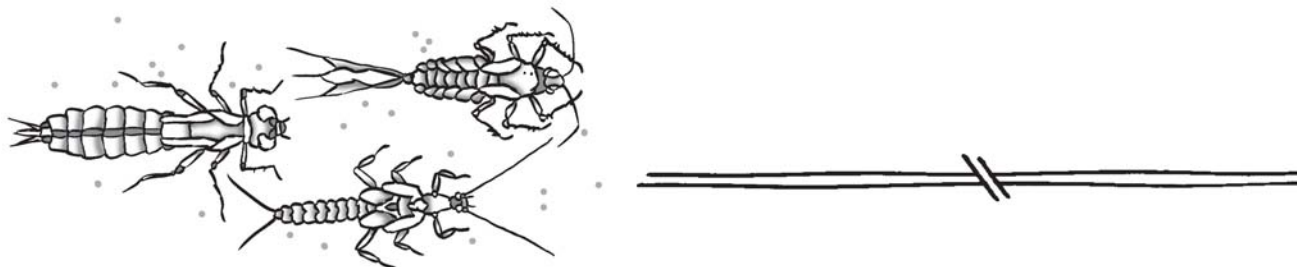


Willow Creek Watershed Field Site Activity

Introduction to Willow Creek Watershed and Bus Ride continued

DIRECTIONS:

10. **Continue** to Bridge 3.
11. **Ask** participants to find where we are on the map, look at the location, and write in their journals what they see and think.
12. **Explain** that 15 years ago, a 6 foot tall Ranger said he walked under this bridge, Ask the participants if they think that would be possible today.
13. **Drive** to the field site and locate on your map where we are.
14. **Welcome** them to the Willow Creek Field Site.
15. **Explain** the ground rules, stay with your group, use caution and watch for poison oak and stinging nettle.
16. If a Ranger is available, they will **provide** a safety talk before breaking into groups.
17. **Direct** the three groups to gather together and assign each group to one of the station volunteer leaders.



Willow Creek Watershed Field Site Activity

Erosion Station

LEVELS: Middle and High School

OBJECTIVES: The students will:

1. Review what a watershed is and point out examples of watershed characteristics (ridgelines, tributaries, stream, riparian corridor, gradient, rock types, vegetation) at the Willow Creek Field Studies Site.
2. Review the definition of erosion and sedimentation.
3. Understand that too much sedimentation can harm salmon habitat.
4. Review that salmon were last seen in Willow Creek in 1995, what happened?
5. Explore the relationship of land management to water quality.
6. Explore some alternative land management practices that can reduce erosion and sedimentation and improve water quality.
7. Review some of the land management practices used in Willow Creek Watershed since the late 1800s.
8. Explore changes a student could make in their own life style to help reduce erosion and sedimentation into creeks.

MATERIALS:

1. Two gallons of water
2. One showerhead watering can
3. One open spout watering can
4. Xeroxed copies of page 61 "Streamkeepers" (have been compiled into the student's pocket journal)
5. Six laminated copies of the Willow Creek Topo Map

TIME:

Preparation: 10 minutes (fill 2 one gallon plastic containers with water and gather other materials from the field box)

Activity: 40 minutes

Willow Creek Field Activity

Erosion Station continued

DIRECTIONS :

YOU MAY USE THESE IDEAS AS A SPRINGBOARD FOR YOUR OWN CREATIVITY

1. **Welcome** participants, mention that salmon were last seen in Willow Creek in 1995.
2. **Ask**, "How can erosion and sedimentation affect salmon habitat?"
3. **Review** the definitions of erosion and sedimentation, and what examples they see of erosion in the Willow Creek Watershed.
4. **Walk** along the road toward the gated area, which opens to a logging trail.
5. **Stop** along the road where you have a view of the ridgetops and Willow Creek riparian corridor. Refer to the crumpled paper watersheds made in the classroom.
6. **Ask** participants what a watershed is and what watershed characteristics they see? Review "Streamkeeper" pages 38 - 40 for ideas.
7. **Distribute** laminated topo maps of the Willow Creek watershed, ask them to look at the map with another person and find the red line that indicates the ridges and highest land, explain how this area creates the watershed boundary.
8. **Ask** them to point out the ridgetops, talk about how everything goes downhill, dependent upon gravity. Things will move downhill if they are disturbed from the top and the bottom. Tell them to follow you for a demonstration.
9. **Guide** them to an area with a slope. Standing on the hillside ask them to form a line down the hill, leaning over on the person below them. Then have the bottom student move, note resulting domino effect. Do it again with the top student gently pushing, same effect. What effects do gravity and water have on soil?
10. **Talk** about the importance of trees and ground cover and how plants protect the soil from erosion. Show what happens when bare land is exposed to water.
11. **Demonstrate** with the shower head watering can how leaf litter lessens erosion as compared with water falling on bare soil.

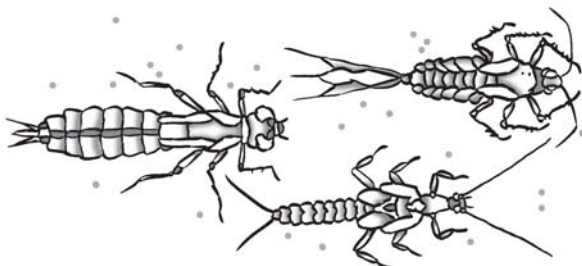


Willow Creek Watershed Field Activity

Erosion Station continued

DIRECTIONS :

12. **Discuss** how important redwood trees are in the collection of water from fog, how their needles are flat and comb moisture out of the fog, and can contribute 10 inches of water to recharge the ground water annually.
13. **Demonstrate** with two watering cans. The one with no nozzle shows how the water comes out straight and thin and washes soil away. The second watering can with a shower head shows how the water flows more evenly and is spread over a larger area, causing less erosion.
14. **Direct** participant's attention to road drainage design, reiterate the concept that water spread over an area equals less erosion. Show how the berm near the gate to the logging road catches sediment before it gets to the tributary. Show how the road construction, with culverts, creates erosion and sedimentation problems. Show the check dams (weirs) in the culverts that have been built to catch the flow of sediment. *(This activity was done can't be done at Pomo Campground)*
15. **Explain** that cattle often graze in pastures. What is the load that the land can support, how many sheep or animals are too much for the land? Remember grasses with their roots help hold the soil and prevent it from eroding. Should there be a buffer between the grazing land and the creek?
16. **Use** journals, refer to xerox of Healthy Riparian Habitat and Unhealthy Riparian Habitat. Ask the participants to draw a picture of what the watershed looks like now and what they would like it to look like in the future. Let them describe the changes they have seen or heard about. What do they think it might have looked like 100 years ago and what could it look like 100 years from now?
17. **Ask** what changes a participant can make in their own life style to help reduce erosion and sedimentation into creeks.
18. **Finish** off at the parking lot, a perfect example of what we should not do so close to the creek, or walk to the bridge over Willow Creek.
19. Participants then move to the Sedimentation Station and you **welcome** a group that have just completed the Macro Invertebrate Station.



Willow Creek Watershed Field Visit Activity
Sedimentation and Stream Quality Station

LEVELS: Middle- High School

OBJECTIVES: The students will:

1. Understand the importance of the stream bottom to salmon.
2. Identify different substrate size categories of sediment (see "Streamkeeper's", page 102).
3. Understand how sediment is moved within a stream.
4. Understand the impacts of fine sediment on salmon spawning.
5. Understand the concept of embeddedness.
6. Identify what types of sediment exist in the cross-section of the stream where they are located.
7. Analyze whether or not the cross-section of the stream where the sediment is located is embedded.
8. Be able to distinguish a pool from a riffle.
9. Measure and record the temperature and pH of Willow Creek.
10. Dialogue regarding our lifestyles and what we can do to prevent unnecessary amounts of sediment from entering a stream.
11. Write in their journals.

MATERIALS:

1. 10 rulers and pencils
2. Data sheets to record substrate size
3. Data sheets to record embeddedness
4. 6 clipboards
5. 6 laminated posters of "Pacific Salmon Life Cycle"

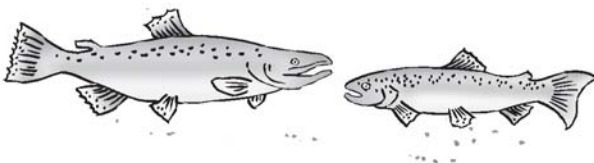
TIME: 40 minutes

Willow Creek Watershed Field Visit Activity

Sedimentation & Stream Quality Station *continued*

DIRECTIONS:

1. **Welcome** the students to the creek, stand overlooking the stream and encourage the participants to relax and observe the stream for 2 to 3 minutes and see how many different things they notice.
2. **Ask** them what they see, acknowledge all responses and appreciate their willingness to explore this topic with you.
3. **Velocity Exercise**
 - See the Field Trips section of this manual for an activity entitled, "Creek Side Races" or see "Streamkeeper's", pages 108 to 117. You can easily add a velocity exercise at this point.
 - Explain that salmon have historically used this stream for spawning, however, they have not been seen in Willow Creek since 1995.
 - Walk them over to the sedimentation station. While walking, ask what they have learned so far about Willow Creek and watersheds in general. Acknowledge and encourage their responses.
 - Draw attention to Lanny's display of gravel and stream bottom habitat reminding them how too much sediment can harm salmon habitat.
 - Invite them to sit or stand on the area adjacent to the creek, where you will explain what you will be doing together.
 - Divide into teams of two. Tell them that they will be collecting data at the creek to determine if the creek is currently a healthy habitat for salmon.
 - Explain that the stream bottom is crucial for salmon survival as salmon primarily use a certain size of gravel to bury their eggs. This is where fish reproduction and egg development occurs. The right type of gravel is only found in certain parts of streams.
 - Tell them that bacteria, fungi and algae grow on the stream bottom, and that they serve as food for macroinvertebrates (spineless bugs that live in the water), which are a major food source for salmon.



Willow Creek Watershed Field Visit Activity

Sedimentation & Stream Quality Station continued

DIRECTIONS:

4. Substrate Exercise

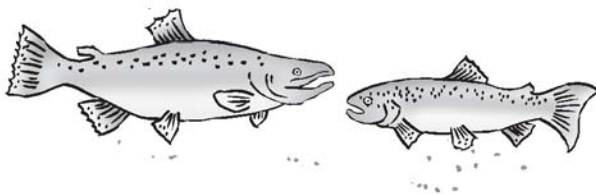
- Explain that now you are going to identify different types of substrate or gravel in the stream. Collect different types of sediment from the creek before hand and have them on display for the students.
- Show and review the different types of substrate and tell the names of each based on their size, (see page 102 in "Streamkeeper's").
- Demonstrate how to measure and record the information on the data sheets. Pass samples of gravel and cobbles so they can practice measuring substrate.
- Ask the participants to remember how the different sizes of substrate affect salmon spawning habitat.
- Go to the creek in teams of two, and begin measuring and recording the information on the data sheets.

5. Substrate moves within a stream

- Explain that different sizes of sand, gravel and boulders are generally found in different parts of the stream.
- Distribute three to four topo maps of the Willow Creek watershed; point out that the slope of the channel gradually decreases from the headwaters to the mouth.
- Explain that the larger sediment types are found in the higher zones of the creek where the slope of the stream bottom is greater, while the smaller types are found near the mouth.

6. Impacts of silt and mud on salmon spawning

- Draw attention to the poster, "Pacific Salmon Life Cycle", or to the demos that Lanny made.
- Remind them that salmon create redds or nests in the gravel and then cover their eggs in 8 to 14 inches of gravel.



Willow Creek Watershed Field Visit Activity

Sedimentation & Stream Quality Station *continued*

DIRECTIONS:

- Ask what fine mud or silt can do to the salmon eggs, acknowledge all answers. Review that mud and silt can smother the salmon eggs, or trap the sack fry in the gravel after they have emerged from the eggs.
- Explain that fine sediment can prevent water from circulating through the gravel where the eggs are, which results in preventing a continuous supply of oxygen for the developing fish.
- Tell them that fine substrate particles can decrease water clarity and light transmission through the water, affecting the food source for macroinvertebrates and thus salmon. In addition, when there is a lot of silt in the water it can clog the gills of fish and other critters.

7. Embeddedness Exercise

- Ask participants, "What is embeddedness?" Acknowledge all answers. Define embeddedness as the extent to which cobbles are surrounded or covered by fine sediment.
- Explain that when cobble embeddedness is above 40% salmon spawning habitat is lost and macroinvertebrate populations are threatened. Demonstrate what 40% embeddedness looks like when measuring cobbles and gravel.
- Demonstrate how to measure for embeddedness and how to record the results.
- Demonstrate how to randomly select a pebble.
- In teams of two the participants proceed to gather data, remind the students that the data they collect is going to be used to assess this section of the stream and will be compared with data collected in future field visits.
- After the participants have done their sampling, have a member from each group list what they found and ask them, "Is the type of substrate here good for spawning salmon?", and "Is embeddedness a factor in this area?"

8. Temperature

- Have them measure and record stream temperature (should be measured close to the middle in terms of depth & width).
- Discuss whether the temperature is favorable for salmon (42°-55°F).

Willow Creek Watershed Field Visit Activity

Sedimentation & Stream Quality Station *continued*

DIRECTIONS:

9. pH

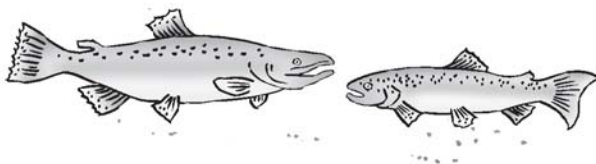
- Have the team measure and record up to 5 pH readings (from 5 locations with very different conditions).
- Discuss whether the pH is favorable for salmon (6.4-8.2).

10. Analysis & Prediction

- Have each team read there results, discuss whether or not the conditions are favorable for salmon.
- Discuss what can be done to improve habitat for salmon.

11. Journal Exercise

- If the creek is too high to gather data, or if you want to intersperse a reflective activity, please refer to the **Field Trip Section of this Volunteer Manual** for additional ideas.



Willow Creek Watershed Field Site Activity
Macro Invertebrate Station

LEVELS: Middle School and High School

OBJECTIVES: The students will:

1. Understand the definition of a Benthic Macroinvertebrates.
2. Understand where the spineless ones live and why.
3. Understand how and why we collect them to help us determine water quality in the stream.
4. Learn the field techniques for collecting and identifying BMIs.
5. Learn to use dichotomous charts and become familiar with some of the common creek macroinvertebrates.
6. Record the results of their findings, e.g. list the critter and the number of them found.

MATERIALS:

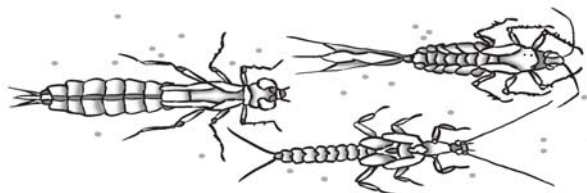
1. BMI sampling equipment
2. BMI preserved samples
3. BMI poster/laminated Dichotomus charts
4. Journals

TIME: 40 minutes

Willow Creek Watershed Field Site Activity Macro Invertebrate Station continued

DIRECTIONS:

1. **Explain** the safety and ground rules before going down to the stream.
2. **Review** with participants what BMIs are, where they live, what they look like, the reason for collecting macroinvertebrates, and the techniques you will use (read "Streamkeeper's Field Guide", pages 129 to 139).
3. **Describe** the various features of the stream habitat. Riffles, pools, runs, and glides. Have students identify these features.
4. **Demonstrate** how you will use the kick net and other sampling equipment such as sieve bucket, brushes trays, pipets, magnifiers ice cube trays.
5. **Assign** roles to the participants; net handlers (2 per net), stream bed agitators (2 per net), net washers (2 per net), specimen gatherers (2 per tray), BMI identifiers (balance of group- all participate when collection is complete).
6. **Ask** participants where they think the macroinvertebrates live in the stream, what they think they eat, and how they catch their food. Then record observations.
7. **Have** net handlers place the net in the riffle. Brush larger stones in stream bed followed by "BMI Boogie". Empty nets into sieve buckets & sieve bucket contents into shallow trays. Use pipets & tweezers to extract BMI and place into ice cube trays.
8. **Identify** BMI using dichotomous key charts. Discuss with participants what they think the sample BMI eat and why (shredders chew, scrapers take algae from rocks, collectors eat fine particles, and predators eat others). Return BMI to their habitat.
9. **Engage** class in a discussion of their findings with emphasis on what quality of water is indicated. Does and adequate food supply exist? if not, have students give reasons why and how to improve the condition of their habitat.
10. **Clean** and store equipment.
11. **Record and interpret** data in journals.





Willow Creek Watershed Field Site Visit
Closing dialogue

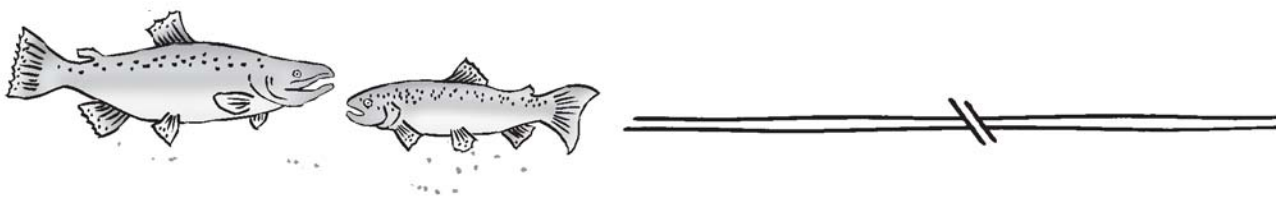
Before students get on the bus:

1. Thank everyone for their visit to Willow Creek and their participation. Express our joy in having the opportunity to explore the watershed with them and the opportunity to learn together. Tell them we are interested in what they experienced and what they remember from each station.
2. Ask what they remember from each station. Draw them out. Ask what affect erosion and sedimentation have on the creek where salmon use to spawn.
3. Ask what are some changes we can make in our own life styles to help decrease the amount of erosion and sedimentation in the streams.
4. If we have a restoration project that they could participate in invite them. Give the necessary information for them to know what the next step involves.
5. Close with an inspiring, positive comment and say good bye.



PART IV

WATERSHED BACKGROUND MATERIAL



VOLUNTEER'S WATERSHED READING

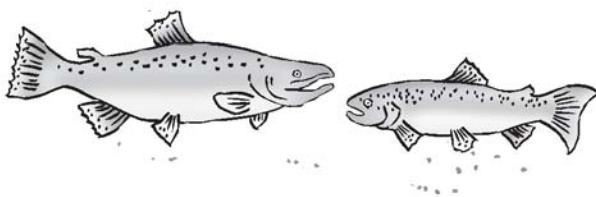
Dear Volunteers,

If you love creeks, kids, and other forms of wildlife, I believe you'll enjoy 'Streamkeeper's Field Guide'. Please read the following pages, in "Streamkeeper's", It will give you a deeper understanding of watersheds, creek monitoring and a few chuckles, as it is illustrated by a team of talented cartoonists. Enjoy, and we look forward to comparing notes and having fun with you and the students in the field.

Stewards of Slavianka and State Park Staff

Please read the following pages in "Streamkeepers" and the handouts included in your manual in this section.

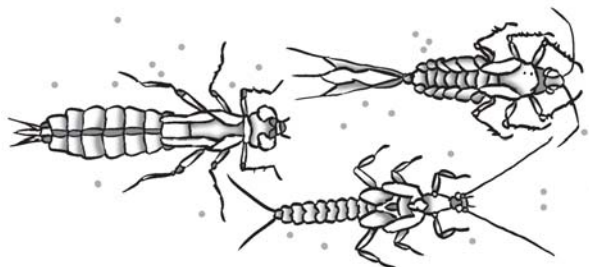
1. Understanding Watersheds, Chapter One
2. Watershed Investigations, Chapter Two





PART V

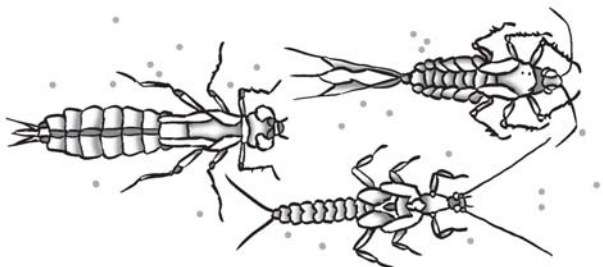
WATER QUALITY FIELD STUDY PROCEDURES



Volunteers,

Please read the following pages in "Streamkeepers" and the hand-outs included in this section of your manual.

1. Field Procedure: Stream Bottom Survey, pages 101 – 104
2. The Spineless Ones – Benthic Macroinvertebrates, Chapter 6
3. Water Quality - Chapter 7



Willow Creek Watershed Classroom Activity

The Salmon Are Missing!

LEVELS: Middle School and High School

OBJECTIVES: The students will be able to:

1. Understand what pH is and the lethal pH limits for aquatic organisms and salmon;
2. Experience testing for pH, temperature and turbidity in the water samples we bring to the classroom and discern if salmon could live in that water;
3. Understand what macroinvertebrates are and be introduced to some of their adaptations to live in the stream;
4. Understand what sediment is and how it affects the spawning gravel's that salmon deposit their eggs in;
5. Review the habitat needs of salmon.

MATERIALS: Refer to instructions for setting up stations: pH, macroinvertebrates, turbidity.

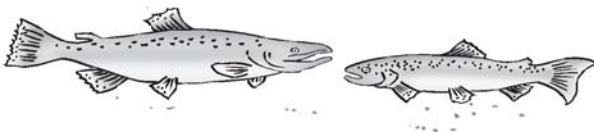
TIME: In Preparation set up the stations (refer to instructions for setting up stations: pH, macroinvertebrates, turbidity) The activity takes 35 minutes.

Willow Creek Watershed Classroom Activity

The Salmon Are Missing!

DIRECTIONS:

1. Explain Salmon were last seen in Willow Creek in 1995 and they were once there in numbers so large that people said they could walk across the backs of them.
2. Explain now the salmon are missing. What has happened? What has changed? We can use your help to investigate the quality of the water where fish live and evaluate its ability to support life. Today we will be measuring pH, macroinvertebrates and turbidity (clarity of water) to see which water samples are healthy enough for salmon to live in. We have a station to test for each of these important factors that affect the life of salmon.
3. Break class into 3 groups, and assign each group to a water quality testing station. Explain that they will have 10 minutes at each station, and when you indicate the time is up they move on to the next station.
4. Indicate when it is time to move on to the next station, and after the groups have participated at all stations, ask students to return to their seats.
5. Acknowledge that they have had the opportunity to see ways to test for the health of water and whether it is suitable for the needs of salmon. Explain that we will continue to explore water quality and how it affects salmon at the field site.
6. Ask teacher to distribute, review and dialogue with students regarding handout (What to Bring to the Field Site) so their questions are answered.



Station Set up Water Quality Activity

Each station has a test tube rack with test tubes filled with the following samples and materials:

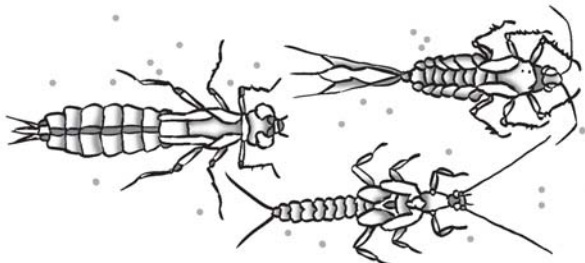
pH station test tube rack

- pH – very acidic (clear soda)
- pH – pond water sample
- pH – very basic (baking soda) above 8
- pH – pond water sample

1. pH paper
2. Envelopes with data collection sheets
3. Poster “Help Keep Pollution Away From Waterways “
4. Chart, “pH of Common Substances and Lethal pH Limits for Aquatic Organisms”
5. 3 papers answering questions regarding pH

Macroinvertebrate Station

1. 3 papers answering questions regarding macroinvertebrates
2. Laminated macroinvertebrate cards, e.g. stonefly ,mayfly, and dragonfly nymphs, blackfly, caddisfly, midge and riffle beetle larvae, riffle beetle and water penny



Willow Creek Watershed Classroom Activity
Water Quality Station Set Up continued

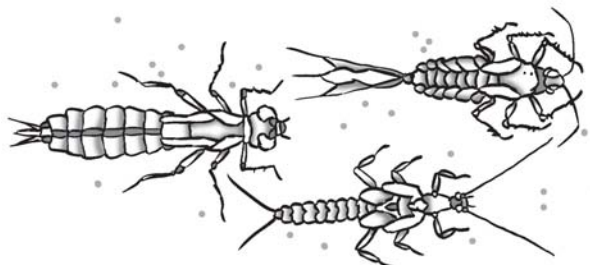
Turbidity or Sedimentation Station test tube rack

- Turbidity – slightly murky
- Turbidity – tap water
- Turbidity – tap water
- Turbidity – very murky

* Note: for turbidity – mix pond water with sediment

1. Sample of salmon eggs
2. Sample of sack fry
3. 3 papers answering questions regarding turbidity
4. Samples of embeddedness = 0%, 30% and 50% (p101 "Streamkeeper")
5. Samples of macroinvertebrates that salmon eat

Give each group a data collection sheet, and an envelope with cardboard inside, to record their findings on.



pH

What is pH?

1. pH measures the chemical condition of the water as acid, alkaline, or neutral. If water in a stream is too acidic or too basic (alkaline), the critters living in the stream may be harmed or killed.
2. The pH test measures the strength of the hydrogen found in the water. A water sample is measured on a scale from 0 to 14, see chart.
3. Pure deionized water contains equal numbers of hydrogen and hydroxyl ions and is considered neutral. It will show a measurement of 7. A pH of 0 is very acidic, and a pH of 14 means the water is basic (alkaline) with little or no acid.

pH

Why is pH important?

1. At the extreme ends of the pH scale (2 or 13) physical damage to gills, fins, and exoskeleton occurs.
2. Each stream tends to have a narrow range of pH values. Many stream organisms adapt to the specific pH range of their home waters. For some critters, a small change in pH can be lethal, while others can tolerate a broader range. See chart.
3. Changes in pH may alter the concentrations of other substances in water to a more toxic form. For example, as pH increases, smaller amounts of ammonia are needed to reach a level that is toxic to fish. And, as pH decreases, the concentration of metals may increase because higher acidity increases their ability to be dissolved from sediments into the water. Metals such as copper and aluminum can disrupt the function of fish gills or cause developmental deformities.



pH

What causes pH to change in water?

1. The input of basic or acidic substances (natural or manmade) affects the pH of water.
2. The natural pH of stream water will depend on many of the plants and soils found along the river. There are natural sources of acid such as pine trees and natural sources of bases such as limestone.
3. The manmade chemicals from household cleaning products, paint or automotive fluids, if dumped outside may get into waterways and harm fish or wildlife. See poster "Help Keep Pollution Away From Waterways".
4. Acid rain is an example of how human influences contribute to the pH of a body of water. Air pollution from car exhaust and other fossil fuel burning has increased the concentrations of sulfur and nitrogen oxide in the atmosphere. These pollutants can move far from their original release sites. They fall back to earth with rain, as weak sulfuric acid and nitric acid.



Turbidity

What is turbidity?

1. Turbidity is a measure of the cloudiness of water. Cloudiness is caused by suspended solids (mainly soil particles and plankton - microscopic plants and animals) that are suspended in the water.
2. Soil erosion, waste discharge, urban runoff and bottom feeding organisms such as carp and insects that stir up sediments and algae growth are causes of high turbidity.
3. Suspended solids may include clay, silt, industrial wastes, and sewage.



Turbidity

Why is it important to test for turbidity?

1. At high levels of turbidity a variety of critters that live in the water may die.
 2. High sediment loads can clog the gills of fish.
 3. When the sediment settles it can smother salmon eggs and water insects.
 4. Sediment can also fill in (embed) the gravel salmon use to spawn in.
 5. Generally, 85% of the salmon eggs will die when 15 to 20 percent of gravel voids are filled with sediment.
 6. Water warms as suspended solids absorb heat from sunlight. Oxygen levels then fall.
 7. Photosynthesis decreases because less light penetrates the water, which also causes a drop in oxygen levels.
-
-

Turbidity

What are some of the causes of turbidity?

1. Soil erosion due to removal of vegetation, road cuts, urban runoff and waste discharge.
2. Livestock over-grazing compacts the soil, degrades riparian habitat, and disturbs gravel beds at crossings. Livestock excessively enrich the stream through their excrement.
3. Intense tree harvest.
4. Residential and urban encroachment that lacks procedures to be in harmony with wildlife habitat.
5. Excessive fertilizers and algae growth.



PART VI

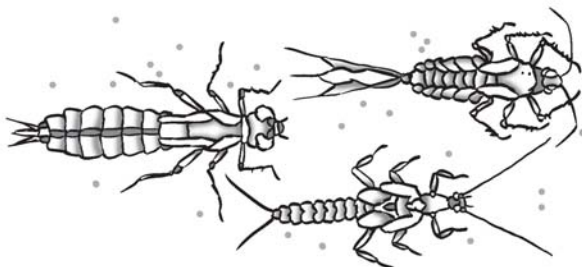
ADDITIONAL BACKGROUND
INFORMATION





PART VII

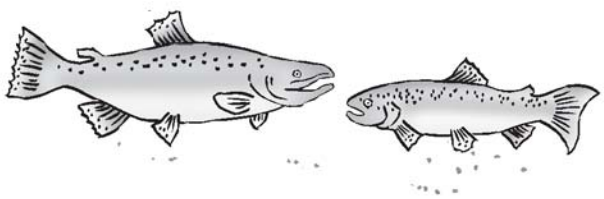
WATERSHED MIDDLE SCHOOL IDEAS FOR FIELD TRIP ACTIVITIES





PART VIII

RESOURCE LIST



WATERSHED CURRICULUM RESOURCE LIST FOR EDUCATORS

STEWARDS OF THE COAST AND REDWOODS WATERSHED RESOURCES INVENTORY

The following resources are available at the Stewards of the Coast and Redwood's Office. For more information please contact Stewards at 707-869-9177.

1. WATERSHED EDUCATION RESOURCES

- a. *The Streamkeeper's Field Guide: Watershed Inventory and Stream Monitoring Methods* by Tom Murdoch, Martha Cheo & Kate O'Laughlin. The Adopt-A-Stream Foundation.
- b. *Sourcebook for Watershed Education: Global River's Environmental Education Network.*, Ann Arbor, MI Forest Ecosystem Unit; Adopt-A-Watershed.
- c. *Water Quality High School Unit*; Adopt-A-Watershed
- d. *Aquatic Ecosystems Middle School Unit*; Adopt-A-Watershed
- e. *2001 Aquatic Macroinvertebrate Bioassessment Project: Student Water Quality Monitoring*; The City of Santa Rosa
- f. *Full Option Science System: Environments*; Britannica Science System
- g. Adopt-A-Watershed Leadership Institute Portfolio
- h. Adopt-A-Watershed 2001/2002 Leadership Institute Binder
- i. *Hands On Save Our Streams: The Save Our Streams Teacher's Manual for Grades One through Twelve* by Karen Firehock
- j. *Creek Watchers: Exploring the Worlds of Creeks and Streams: Learning Activities for Ages 10 -15*; California Aquatic Science Education Consortium (2)
- k. *Wetlands Protectors: Guarding Our Wild and Watery Lands: Learning Activities for Ages 10-15*; California Aquatic Science Education Consortium
- l. *Water Quality: A Field Based Water Quality Testing and Monitoring Program for Middle Schools and High Schools*; SDCWA
- m. *Rivers Curriculum Guide: Biology*; Dale Seymour Publications, Southern Illinois University
- n. *Rivers Curriculum Guide: Chemistry*; Dale Seymour Publications, Southern Illinois University
- o. *Rivers Curriculum Guide: Earth Science*; Dale Seymour Publications, Southern Illinois University
- p. *Rivers Curriculum Guide: Geography*; Dale Seymour Publications, Southern Illinois University
- q. *Rivers Curriculum Guide: Mathematics*; Dale Seymour Publications, Southern Illinois University
- r. *Rivers Curriculum Guide: Language Arts*; Dale Seymour Publications, Southern Illinois University
- s. *Discovering Salmon: A Nature Activity Book*; Field, Nancy & Sally Machlis, Dog Eared Publications, Middleton, WI.
- t. *The Streamkeeper Video*; Adopt-A-Stream Foundation
- u. *Life Cycle of the Salmon Video*; Oregon Sea Grant
- v. *The Return of the Salmon Video: Restoring the Fish to Rivers and Watersheds*; Oregon Sea Grant

2. CITIZEN MONITORING RESOURCES

- a. *California Salmonid Stream Habitat Restoration Manual*; California Department of Fish and Game
- b. *Central Coast Regional Citizen Monitoring Guide*; Central Coast Regional Water Quality Board (2)
- c. *Watershed Restoration: A Guide for Citizen Involvement in California*; NOAA Coastal Ocean Office (2)
- d. *Water Quality Control Plan: North Coast Region One*; CA Regional Water Quality Control Board
- e. *Russian River Watershed Enhancement Program*
- f. *City of Santa Rosa Aquatic Macroinvertebrate Bioassessment Project: A Manual for Citizen Monitoring*
- g. *Groundwork: A Handbook for Erosion Control in North Coastal California*; Marin County Resource Conservation District
- h. *Opportunity, Responsibility, Accountability: Nonpoint Source Pollution Control Program*; State Water Resources Control Board, CA (2)
- i. *Stream and Hillside: Natural Resources Protection Guide*; Napa County Conservation Information Group
- j. *California Department of Fish and Game Stream Inventory Report: Willow Creek; 2000*
- k. California Coordinated Resource Management and Planning
- l. *Measuring the Health of California's Streams and Rivers: A Methods Manual for Water Resource Professionals, Citizen Monitors and Natural Resources Students* by Jim Harrington and Monique Born
- m. *Blue Gold: The Global Water Crisis and the Commodification of the World's Water Supply* by Maude Barlow

ADDITIONAL WATERSHED CURRICULUM RESOURCES

(The following helpful resources are not yet available through Stewards of the Coast and Redwoods.)

Adopting a Stream: A Northwest Handbook. Adopt-A-Stream, PO Box 5558, Everett, WA 98206. (206)338-3487.

Aquatic Resources Education Curriculum. Kendall Hunt Publishing Co., P.O. Box 539, Dubuque, IA.

Delta Labs. 1987. *Adopt A Stream Teacher's Handbook*. Delta Laboratories, Rochester, NY.

Dychman, C. & A. W. Way. 1981. *Clean Water, Streams and Fish: A Holistic View of Watersheds*. Municipality of Metropolitan Seattle, Seattle, WA.

Farthing, P., Bill Hastie, Shan Weston & Don Wolf. *The Stream Scene: Watersheds, Wildlife and People*. Oregon Department of Fish and Wildlife, Portland, OR.

Gray-Hubbard, S. & S. Tialnder. 1989. *Stream Team Guidebook*. City of Bellevue Storm and Surface Water Utility. City of Bellevue, Bellevue, WA.

Higgins, D. 1990. *California's Salmon and Steelhead: Our Valuable Natural Heritage*. California Advisory Committee on salmon and Steelhead Trout, 1271 Fieldbrook Rd., Arcata.

Lewis, B. 1991. *The Kid's Guide to Social Action: How to Solve the Social Problem You Choose—and Turn Creative Thinking into Positive Action*. Free Spirit Publishing, Minneapolis, MN.

Living in Water: An Aquatic Science Curriculum. National Aquarium in Baltimore, Department of Education and Interpretation, Pier 3, 501 E. Pratt St., Baltimore, MD.

Mitchell, M.K. & W. B. Stapp. 1990. *Field Manual for Water Quality Monitoring: An Environmental Education Program for Schools*. Thompson Shore Printers, Dexter, MI.

Pond and Stream Safari: A Guide to the Ecology of Aquatic Invertebrates. Cornell Cooperative Extension Publications, Ithaca, NY. (607)731-8121.

Save Our Streams. Izaak Walton League of America. 1701 N. Fort Meyer Dr.#1100, Arlington, VA 22209.

United Nations. 1977. *Small Streams and Salmonids: A Handbook for Water Quality Studies*. United Nations Educational, Scientific and Cultural Organization, Paris, and Municipality of Metropolitan Seattle, Seattle, WA.

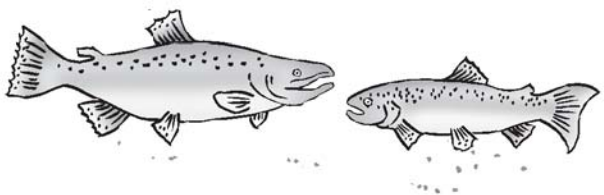
Water, Water Everywhere. Hatfield Marine science Center, Extension Sea Grant, Newport, OR 97365.

Western Regional Environmental Education Library. 1987. *Aquatic Project Wild*.

Adopt-A-Watershed Curriculum - Exceptional curriculum units are available from Adopt-A-Watershed. These teacher's guides also have accompanying classroom kits at varying costs. For more information please call 530/628-5334 or visit their website at: <http://www.adopt-a-watershed.org/>

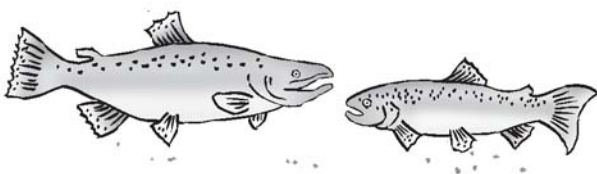


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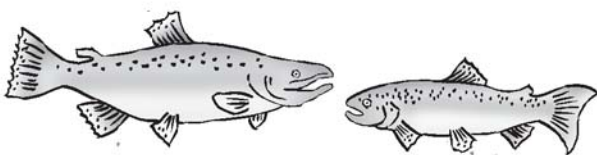


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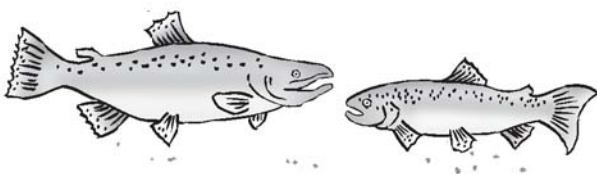


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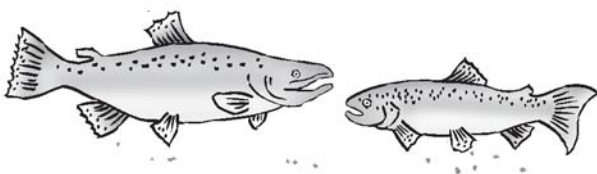


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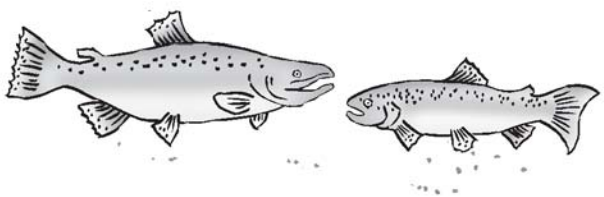


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