Mountains to the Sea Watershed Curriculum

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What is Mountains to Sea?

Mountains to Sea is a comprehensive watershed education program that introduces both teachers and students to our local watersheds by studying the journey of water from the mountains all the way to the sea and focusing on the events and processes in between. The Mountains to Sea program utilizes curriculum, in-class presentations, field trips, and additional resources to aid teachers in integrating the important topic of watersheds into their school curriculum.

Why was it created?

The Mountains to Sea program was developed by the Youth Education Working Group of Project Clean Water. Project Clean Water is a unified community effort to improve water quality in Santa Barbara County's creeks and ocean. Members of the Youth Education Working Group include the County of Santa Barbara and the City of Santa Barbara's Creek Restoration and Water Quality Improvement Program, as well as members of local organizations and interested citizens. The goal of the Mountains to the Sea program is to create an awareness in students about our unique local watersheds, and through that awareness, engender an increased respect and desire to protect them. This curriculum will also help students make that crucial connection between everyday human impacts on land and the quality of the environment in our watersheds and ocean.

How can it be used?

The curriculum is designed for Grades 4-8, but can also be adapted for other grade levels. Each activity has been referenced to the California State Board of Education Science, History - Social Science, and English-Language Arts Content Standards for grades 4-8th. A complete list of the corresponding standards is included in Appendix D.

The curriculum guide is broken down into five main activity sections:

I. All About Water
II. Watershed Descriptions and Wonders
III. The Problems with Pollution
IV. Pollution Solutions
V. The Watershed / Ocean Connection: Impacts on the Ocean
Additionally, appendices include information on: in-class presentations and field trips, a glossary, the California Content Standards reference guide, and additional resources. The Mountains to Sea program is designed to be implemented chronologically, as a complete, year-long curriculum. However, it is also possible to tailor a program to fit into a shorter amount of time; teachers or districts may select from among the activities, presentations and field trips within each section to create shorter curricula. Suggested in-class presentations and field trips are included in each section to strengthen and build upon the material covered in each activity throughout the curriculum guide. To help coordinate custom curricula or for questions on the curriculum, please contact: Darcy Aston, Santa Barbara County, at 568-3546; Alison Jordan, City of Santa Barbara, at 564-5574; or Amy Findlay, Community Environmental Council, at 682-6113.

Feedback regarding the Mountains to Sea Watershed Curriculum is greatly appreciated. An evaluation form is included at the back of this guide (Appendix G), and can be mailed back. You can also find an electronic version of the evaluation form on-line at the Project Clean Water web site, where it can be filled out and sent on-line at www.countyofsb.org/project_cleanwater

Acknowledgments

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Format and Instructional Strategies

The Mountains to Sea Watershed Curriculum is designed to help teachers inform students about local watersheds and the affects of human actions on the waterways. It is arranged into five sections. The curriculum is most affective as a yearlong program, starting in the fall with Section I, and moving from one activity to another, through the sections. At the end of the year, students have a complete understanding of all the important issues and concepts that are involved with one of the most important natural resources on earth, water.

Each section begins with an overview of the main theme through the activities and field trips of that particular section. Each activity within the section stands alone, complete with background information for the teacher, and assessment of student knowledge after completion of the activity. Each section lists field trips and presentations provided locally that aid the students understanding of the concepts presented in that particular section. Appendix A, “In-Class Presentations and Field Trips” includes descriptions of the field trips and presentations and contact information.

All five sections contribute a different concept to the understanding of watersheds. If there is not enough time within the school year for all the activities, we suggest that at least one or two activities in each section are completed for the student to receive a full understanding of the subject matter. Throughout the curriculum various pollutants are discussed. Appendix C is included to provide a quick reference chart on the pollutants that contaminate local waterways. Appendix B is a glossary of the key words from each activity. Additional materials are available and are listed with contact information in Appendix E.

Below you will see an overview of the segments of each activity, as they will appear on the actual lesson pages.
Sample Lesson Page

Summary
A brief description of the concepts, skills, and affective dimensions of the activity.

Objectives
The qualities or skills students should possess after participating in the activity.

Materials
Supplies needed to conduct the activity.

Management and Safety Conditions
Conditions that need to be taken into consideration when conducting these activities.

Procedures
Provides step-by-step directions to address concepts.

Closure
Brings closure to the lesson and includes questions and activities to assess student learning.

Assessment
Presents diverse assessment strategies that relate to the objectives of the activity, noting the part of the activity during which each assessment occurs. This also aids the teacher in assessing the students’ understanding of the concepts.

Keywords
Significant terms defined in the Glossary, Appendix B.

Preparation Time
The approximate time needed to prepare for the activity.

Lesson Time
The approximate time needed to complete the activity.

Incorporates:
This lists the various subject matters which the activity incorporates.

Correlation of Activity to California Content Standards
The California educational standards that each activity meets, fourth through eighth grade, in the subjects English, Science and History. A reference chart of the standards and activity correlations is included in Appendix D.
This section covers the properties of water; its availability to humans, and its uses, both past and present.
Teacher Background Information

Water is the most important natural resource on earth. Not a single living thing can survive without it. A water molecule is made of two hydrogen atoms and one oxygen atom. This molecule is very unique. Opposite to all other molecules on earth, it expands in its solid form, when it is frozen. All other chemicals shrink in size when frozen or solid. This molecule is also put together with semi-strong hydrogen bonding between the molecules to give them the adhesiveness to stick together and make a steady glass-like look, and yet, be easily broken to form small rain drops and droplets. \( \text{H}_2\text{O} \) comes in various forms depending on the temperature and pressure of its surroundings. Water molecules can be found in the very loose form of water vapor, the intermediate flowing form of water, and the solid phase of ice. No new water is ever made. The molecules simply change forms as they go through the water cycle.

Only 2.8% of the total water found on earth is fresh water. All of the rest is found in the oceans and seas, as salt water. Out of the 2.8% of fresh water, 2.2% is locked up in glaciers and icecaps, and unavailable for drinking. This leaves only .6% of all water on earth to be used by all living inhabitants that need fresh water, including plants, animals and humans. Of this, only .003% is clean, available fresh water (i.e. not polluted or inaccessible). Humans consume the most water, using it for cleaning, cooking, drinking, industry and much more. We live in a variety of different habitats and climates. There are many people living in Santa Barbara County, which is classified as semi-arid, due to low annual rainfall levels. Other areas of Southern California are classified as a desert. To be able to inhabit these dry areas, we have built reservoirs, dammed rivers and moved water hundreds of miles. In California, 75% of the total rainfall occurs in the northern regions, while 80% of the total state water needs are in the southern region. This has resulted in many different federal, state, and local water projects, to provide water supply for southern California, including Santa Barbara County. Living in the semi-arid climate of the South Coast of Santa Barbara County, it is crucial to understand the origins of the water we use.

Class Presentations and Field Trips (refer to Appendix A)

City of Santa Barbara El Estero Wastewater Treatment Plant
City of Santa Barbara “The Story of Water” In-Class Presentation
Goleta Sanitary District’s Wastewater Treatment Plant In-Class Presentations and Field Trips
Local water agencies in-class presentations
The Water Cycle

Summary:

Through observation of a simulated water cycle, students understand the flow of water on Earth.

Background:

Water molecules are constantly traveling through the earth’s atmosphere. They change forms relative to their location and temperature (water in the ocean, lakes and rivers, gas in the air, and ice on the glaciers). No new water is ever made, so we are drinking the same water today that the dinosaurs drank thousands of years ago. Studies have shown that even glaciers in the most remote parts of this world contain traces of pollution. This is because wind and water can move particles thousands of miles from more populated and polluted regions to isolated, clean areas, causing pollution in the most unexpected places.

Objectives:

Students will:

Understand the effect of temperature on water.
Define and explain the water cycle and the processes associated with it.

Materials:

- Water Cycle diagram (see Appendix F)
- Worksheet – Student and Teacher copy (see Appendix F)
- Heat source (hot plate or canned heat)
- Heavy glass tumbler
- Glass flask
- Tablespoon of sand
- Water
- Saucepan with lid

Optional: 1 copy for each student of the "Official Captain Hydro Water Conservation Handbook." These are available from DWR for free. See above for contact information.

Management and Safety Considerations:

Take precaution with hot water.

Procedure:

1. Class Discussion

Review water cycle diagram with students.

Q. Why is the movement of water called a cycle?
A. It repeats itself over and over.

Q. How important is heat from the sun in the cycle?
A. Without it, nothing would happen.

Q. Plants, animals and human beings do not appear in the diagram. What part do they play in the cycle?
A. All release water into the atmosphere. All use it.

2. Teacher Demonstration

Heat some water until it is near the boiling point (steaming). Pour it into a tall, heavy glass tumbler until the glass is half full. (Use an oven mitt so that you don’t burn yourself). Rotate the tumbler so as to moisten the sides clear to the top. Place some very cold water in the glass flask and set it on top of the tumbler as shown.
**3 Direct students to worksheet**

Q. Which parts of the experiment represent water as found in: rain? Lakes or rivers? Clouds?
A. (See answers on worksheet)

Q. What heats water in rivers or lakes?
A. The sun.

Q. Where in the experiment did the following take place? Evaporation? Condensation? Precipitation?
A. (See answers on worksheet)

**4 Teacher Demonstration**

Place a saucepan half-filled with water on the hot plate or on a tripod with a burner beneath. Add a tablespoon full of sand to the water.

Let the water come to a boil. Palace a tight lid on the saucepan. After 3 minutes remove the lid and show it to the class.

Q. Why is the lid not sandy? Does this tell you anything about rainwater not being salty, even though it often starts as ocean water?
A. Salt and sand are heavier than water and are left behind when water evaporates.

Q. Besides oceans, lakes and rivers, are there any other sources of water that become rain when they evaporate?
A. Glaciers, snow and transpiration. Transpiration is the process by which all plants give off to the atmosphere the water they do not use coming from the ground. A single birch tree can give off 60 to 80 gallons of water to the air on one warm day. The atmosphere itself always carries huge amounts of water waiting to be condensed and fall as rain.

**5 Review Exercise (oral or written as teacher desires)**

Explain the natural water cycle.

Define: evaporation, condensation, precipitation, and transpiration.

Q. Why do some parts of the country get large amounts of rain while other parts are almost deserts?
A. Nearness to sources of water, mountains, wind and other factors influence where rain will fall.

Q. What part does wind play in governing the amount of rain a place gets? Mountains?
A. Wind must be present to transport rainfall; mountains impede the movement of rainstorms.

Q. Are the parts of the world where it rains heaviest very hot or very cold places? Can you tell why?
A. Usually very hot (Hawaii, the tropics) with much vegetation. A abundant moisture and heat are available.

**Closure:**

A film or video on the water cycle would be appropriate here.

An excellent video, The Water Cycle- Grades 4-6, is available free to purchase or loan from Department of Water Resources (DWR). Call 916-653-4893 to arrange to receive a copy to keep or loan. For a video catalogue of all DWR’s videos, see web site mentioned at beginning of this activity.

**Assessment:**

Worksheets are a good assessment tool.

**Key words** (see Appendix B)

<table>
<thead>
<tr>
<th>Evaporation</th>
<th>Condensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>Transpiration</td>
</tr>
</tbody>
</table>
Section II: Watershed Descriptions and Wonders

This section defines watersheds and describes how they function, and explores where we live within our watersheds.
A watershed is a gathering place for water. It is an area of land from which all runoff flows and gathers to form creeks, rivers, and eventually makes its way to a large body of water. The topography of the land dictates the places where water will gather, into the valleys and areas with low altitude. These areas gather the rainwater or runoff, which has come from higher locations. This water still travels due to gravity, until it reaches an area that is level, such as the ocean, or a lake. On the South Coast of Santa Barbara County, our watersheds start at the Santa Ynez Mountains, where it tends to rain more often, and occasionally snow. From the mountains, water flows down hill into creeks that carry the runoff through the foothills and the more populated areas of urban development before reaching the Pacific Ocean. It is important to understand that we all live in a watershed and that everything we do has an impact. Being aware of our local watersheds and our place within them is the beginning of a larger awareness and care for our natural surroundings.

Class Presentations and Field Trips (refer to Appendix A)

City and County of Santa Barbara Watershed In-Class Presentations
Visit to a local creek (Creek Watchers or self-guided)
Santa Barbara Museum of Natural History (Self-guided nature walk next to Mission Creek)
Santa Barbara Botanic Garden Field trip
What Is A Watershed?

Summary
Students are introduced to watersheds and their functioning through construction and utilization of a watershed model.

Background
A watershed is an area of land where water flows off the land to a common watercourse or body of water. On the South Coast, our watersheds drain to the Pacific Ocean. The physical features of the land determine the nature of a watershed. A divide is the ridge between drainage areas (or watersheds). As an example, the Continental Divide is the ridge that divides the U.S. and causes all river systems east of it to flow to the Atlantic Ocean and all those west of it to drain to the Pacific Ocean. These large watersheds are made up of smaller ones. Human activities, such as building dams to impound water, diverting water over divides from one watershed to another, or changing the topography of the land to build roads, houses and other structures, can alter watersheds. Learning about and modeling a watershed is a way to help people grasp the realities of the water system on which they depend — where the water comes from, where it goes, and what kinds of choices people can make to use and conserve it responsibly. The Santa Ynez Mountains are the main feature of our local watersheds. Water falling on the south side of the mountains drains to the Pacific Ocean (recharging ground water along the way), water falling on the north side drains into the Santa Ynez River, becoming part of our local surface water supply and eventually reaching the Pacific Ocean at Lompoc.

Objectives
Students will:
- Construct a three-dimensional model of a watershed.
- Experiment with water flow in a hypothetical watershed.
- Understand the concept of a watershed.

Materials
• Spray bottle with water
  Option 1:  
  • 8 1/2 x 11 sheets of paper
  • Water Soluble Color Marking pens
  Option 2:  
  • Plywood sheet approximately 1m x 1m
  • Plaster of Paris, clay, or similar material
  • Waterproofing material or household plastic wrap

  Option 3:  
  • Plastic or cardboard box
  • White plastic trash bag
  • Newspaper

  Option 4:  
  Using only hands (for procedure, see Appendix F)

Management and Safety Considerations
Group students in small enough groups so they can all participate in building the watersheds.

Procedure
Ask students:
- What is a watershed?
- Why are watersheds important?
Tell students they are going to build a model of a watershed in groups.

Provide student groups with the materials to build a model of a watershed using one of a number of different media. Take paper, Plaster of Paris, clay, and/or other materials of your choice.

**Option 1:** Take piece of paper, put over hand and crumple around index finger making the point at your index finger be the "mountain." Have students take water soluble color marking pens along ridge lines to represent mountain ridges, creeks, etc.

**Option 2:** Ask the students to work in small groups to create their Plaster of Paris or clay model. They should cover the model with household plastic wrap.

**Option 3:** Each group should create a landscape by putting the crumpled newspaper in the bottom of the box, and then placing the plastic bag over the top of the newspaper. Tell them to make sure that the edges of the plastic bag stay outside the box.

Once completed, ask the students to describe the type of land formations they see in their landscape (hills, mountains, valleys). Ask them to predict what will happen when they spray water over the landscape.

Tell the students that the spray bottle represents rain. Ask the students to spray water on the model and trace the path a drop of water takes across the watershed and into the watercourse. For Option 1 models: see how colors of pen flow down ridges to "valleys."

Discuss the relationship between the physical features of the watershed (paying special attention to how the shape of the model effects the flow of the water) and the location of human activities.

Ask your students what would happen if they changed the physical features of the model. Ask them how they might create a more rapid or slower flow of water or to have more or less water collect in a specific location.

**For Option 2 and 3 models:** Have your students rearrange the model by adding rocks to test their ideas. Repeat this variation several times.

**For Option 2 and 3 models:** Have students create a town in the watershed. Use something to represent buildings (small game pieces, toy buildings, coins, etc.) Add red food coloring to the watershed to represent nonpoint source pollution coming from the town and watch it flow into the creeks and ocean.

**Option 4:** See Appendix F, page F4.

**Closure: Class Discussion**

Ask students to describe ways in which human activities change the shape of the watershed, and, consequently, the path along which water will flow.

Ask the students to discuss ways that the “town” could keep the nonpoint source pollution (red food coloring) from entering the watershed.

**Assessment**

Assess students by participation in discussion and if they completed creating the watershed model.

**Key words** (see Appendix B)

- Hydrology
- Nonpoint source pollution
- Percolate/ infiltrate
- Point source pollution
- Runoff
- Watercourse
- Watershed

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**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

**4th Grade:** English- Written and Oral English Language Conventions: 11. Listening and Speaking: 11
Science- Investigation and Experiment: 6.c

**5th Grade:** English- Listening and Speaking: 15.

**6th Grade:** Science- Shaping Earth’s Surface: 2.a, 2.b. Investigation and Experimentation: 7.a
**Summary**

Students increase their understanding of wetlands by using a household sponge to demonstrate how wetlands capture, store, and release water.

**Background**

Wetlands form in a variety of places, under a variety of circumstances. Wetlands often form along edges of rivers, streams, lakes, and ponds. Some of the places may seem surprising: in low-lying woods; in roadside ditches designed to collect rainwater runoff; in low spots in fields; even on mountains and hillsides where snowmelt and rainwater run constantly. Wetlands are characterized by certain plants and animals that are in and near water.

Numerous combinations of soil types, water sources, and topography lead to the formation of wetlands, but the common denominator is always water. Wetlands are wetlands. When we understand where water comes from and how and where it flows, we can predict where wetlands will form. The source of water for a wetland is either surface water, groundwater, or both. This activity will investigate both sources.

Below are descriptions of some of the different combinations of elements that lead to the formation of wetlands.

1. Some wetlands are fed by precipitation and surface water. Wetlands are formed when runoff and rainfall collect at the base of a slope or when surface waterways, such as rivers, overflow and saturate the surrounding land. When it rains, much of the water that hits the ground runs over the surface of the land through the force of gravity, eventually collecting in the low spots. Some of these low spots become waterways - rivers, streams, ponds, lakes, bays. The land along the edges of these waterways is usually low-lying as well and often becomes saturated.

2. Saturated land is usually a wetland. When a waterway overflows, as it might during a heavy rainstorm, low-lying banks and shores become flooded. These areas are the waterway's floodplain. Floodplain wetlands may be marshes, fields, or even forests since a floodplain may extend several miles beyond the edge of the water, depending upon topography. However, not all of the area within a floodplain may be an actual wetland at any given time.

3. At the base of any sloping land, rain and runoff can collect and saturate the soil, essentially forming a wetland. Some examples are: in mountain valleys where snowmelt collects; meadows at the base of a hill; and storm water management ponds (a constructed feature built to collect and filter runoff).

4. In areas where the water table is high, groundwater often seeps into pore spaces in the soil near the surface, forming a wetland. This groundwater may have originally run downhill from uplands, seeped from waterways, or collected in confined areas to form the wetland. Slope wetlands are formed where groundwater comes to the surface along sloping land. Many ponds and streams are fed in this way by groundwater, as well as by rainfall and surface water. Thus, wetlands may receive from both above and below the ground.

**Objectives**

Students will:

- Understand what a wetland is.
- Describe how groundwater and surface water wetlands are fed.
- Identify areas in their community that may be wetlands.
Materials

- Jug of water
- Blue food coloring
- Shovel or hand trowel

For each group:
- Paper cup
- Scissors
- Cardboard
- Two thick sponges

- Wetlands Handout (see App. F) 1 per student
- 5-inch x 8-inch piece of cardboard covered with foil

Management and Safety Conditions

None

Procedure

1. Warm Up
   Ask the class to name some local areas they know of that are always muddy. Ask them to picture these places and guess where the water comes from or why it stays where it does. One example might be the ground below a rainspout, where water often collects.

   Tell students that wetlands may form in areas where 1) rainwater and/or groundwater collect; 2) the ground is concave and water collects on top of an impervious layer (e.g., a pond); or, 3) waterways overflow their borders.

2. Sponge “Wetlands”
   Divide the class into small working groups. Hand out supplies. Have each group create a pond or depression in one sponge, by cutting away a small circle in the center of the sponge. Do this by folding the sponge in half and cutting out a half-circle, making sure not to cut all the way through to make a hole. In the same way, each group should make a stream or river in the second sponge. Have them cover the bottom of the cutaway portion with a strip of cardboard, which represents the waterway’s bed. Note: If your students are younger, prepare the sponges ahead of time.

3. Water Flow
   When all of the models are ready, give the groups paper cups of colored water to pour into the waterways. Have students tilt the stream sponge to allow water flow and watch and describe what happens. The water will be absorbed into the banks of the waterways and seep into the surrounding ground, creating wetland conditions. Students may pick up spills with the sponge, too, just as wetlands are fed by and store groundwater from below.

4. Cardboard “Hillsides”
   To illustrate that wetlands are also fed and formed by surface water, describe how rainwater that lands on a hill or slope runs downhill by the force of gravity. Have each group use the 5-inch x 8-inch foil-covered cardboard piece to represent a hillside. The bottom of each piece should rest on a sponge and the other end should be held up. Have groups pour water onto the foil near the top of the slope and describe what happens. Water should collect in the sponge at the base of the hill until the sponge is saturated; some water may seep out, away from the hill.

5. Overflow
   Now that the sponges are saturated, repeat step three. The waterways should overflow, demonstrating floodplain wetlands. This is also surface water.

Closure

Have students identify the water sources that feed wetlands and summarize how wetlands regulate surface-water runoff.
Take the group on a walk around the school or community to find a body of water. Bring along a shovel or hand trowel. From the edge of a pond or stream, ask students to walk to the farthest spot away from the water where they think water has seeped into the ground. Dig a few holes and investigate the moisture content of the soil. Ask whether or not it could be a wetland. Are they surprised at what they find?

**Assessment**

Have students:
- Identify sources of water in wetlands.
- Investigate nearby soils and conclude whether or not the area could be a wetland.

**Extensions:**

If students collect soil samples, have them determine how much water the samples contain. Comparing the weights of samples before and after drying does this. (Remove water from soil samples by setting them in the sun until they are dry, or baking them in an oven at 150 degrees C [300 degrees F] for 30 minutes.)

**Key Words** (see Appendix B)

Groundwater
Surface water
Water table
Runoff
Here you Are in the Environment

Summary

Students utilize local, regional and national maps to gain understanding of how a region’s geography affects ecosystems. In addition, students will analyze how humans affect ecosystems.

Background

It is important to realize that we are all an integral part of larger ecosystems and to understand our interaction and place within the immediate and larger scale environments which surround us. Using maps to trace and identify watersheds can help students realize their own place in the bigger ecosystem. Looking at maps (city and topographical) makes it is easy to see the lack of realistic, physical barriers between air, water, and soil in the local and global environment. This helps show visually how all the parts of the ecosystem are interconnected. If one element of the system is affected, all other parts are also affected.

Objectives

Students will:
Identify the impact of humans on ecosystems.
Learn to use maps and understand them as a tool.
Understand the lack of realistic barriers between air, water and the soil in the local and global environment.
Analyze local watershed issues that affect the marine ecosystem.

Materials

• A geographical city map with schools and local beaches
• World maps
• A globe
• 8x10 inch state maps for students’ science log
• 4x5 inch maps of local area for students’ science log
• Transparent overhead sheets to overlay map for marking
• Newspaper clippings of the local air and soil pollution debates
• News clippings of the Santa Barbara beach bacterial contamination
• Santa Barbara City Watershed Map – see Appendix F
• South Coast Watershed Map – see Appendix F
• Local topographic maps

Management and Safety Considerations

No safety issues involved.
Respect the integrity of the large maps, whether or not they are borrows. Don’t mark on them or damage them otherwise.
Here You Are in the Environment

Procedure

1. **Awaken enthusiasm**
   - Hang a selection of local, state, and world maps around the class. Extra maps can be borrowed from the local city library or local university. Make sure that some of the maps are attractive and unique (waterways and underground water, vegetation, or hot springs).

   - Open lesson with a short personal story: My friend caught a fish while fishing at Goleta Pier. When she prepares the fish for dinner, she noticed a small pine cone in its gut. This type of pine does not grow by the shore, but is common at La Cumbre Peak. It has been a puzzle as to how the fish came to swallow this pinecone. (Choose any fishing site, and any top of mountain, visible from your schoolyard to help students imagine the sites.) If a student suggests that a person brought the cone in their pocket down from the mountain, do acknowledge the possibility and their creative thinking. However, ask if the cone could reach the beach via the watershed flow after a rain.

   - Ask the class to help plan an imaginary field trip to follow the trail of that pinecone.

2. **Focus attention**
   - Have students locate their school on these maps.
   - Have them sort the maps which show the school and set them in one area.

3. **Direct experience**
   - Divide students into groups of 3-4 people. There should be a set of smaller maps for each group.
   - Ask students to identify the various maps they have available. Have them sort the maps, as they think appropriate.
   - Hang the local area maps on top of each other on a wall. Have students find a few personal locations such as their street, the school, a local market, and the place their parents work.
   - Hang the state maps up and have students locate where their city may be on that scale map.
   - Do the same with the world map
   - Spend just enough time to have everyone realize that we are looking for the same location, but one map gives us information, while another one does not.

4. **Discussion Suggestions**
   - Lead conversation to the conclusion that in order to follow the trip of that cone from a local mountaintop to the ocean, the world map will not be useful. The state map may be somewhat better, and the county map will work the best.
   - Have students locate La Cumbre Peak (or your place of choice) on the map. If possible, get them out of the class to see the location from the schoolyard. Help them gain an experience that is as real as possible. (A field trip to really experience the path the cone took would be the best, of course.)
   - Placing a clean sheet (an overhead or partly transparent paper), have students use a ruler and draw a bird’s-eye view: between the location on the mountaintop and Goleta Bay.
   - See if your imaginary line follows canyons where the rainwater could indeed drain all the way to the beach? Can you identify a creek or a canyon? If not, have students mark the way to the closest canyon/creek, then follow all the way down to the harbor or ocean.
   - Ask students whether there are people living along that path. Have them check the city map to check for streets and structures there.
   - Ask the students to use a clean sheet of transparent paper and map a path from your school to the nearest beach. Try to scale to the scale of the local map you are using so that you can overlay on the professional map.
   - Suppose farmers or gardeners up the hills fertilized their gardens, or sprayed a potent pesticide which is toxic to fish, crabs, lobsters, and dolphins – or a toxin that kills seaweed. Imagine the path that the toxic water from the mountains will take to the ocean? If the water travels at a speed of one meter per minute, and the pesticide was sprayed 1,000 meters (one kilometer)
up the hill, how long will the toxin take to reach the beach and kill animals there? (1000 minutes = 1,000/60 = 100/6 = 16 hours! Less than one day.)

What about what we pour/dump on the street or spray in or backyard. Where does that go? Share the local watershed map.

Find your school and neighborhoods on that watershed map. How many creeks are between your school and your home? Your home and the ocean?

What about the toxins or dust with viruses and bacteria which become airborne and circulate in the air up and down the hill and over the city? Read clippings from local disputes about farming practices.

Could pollution in the ocean travel to land and contaminate the land and our hills? Gasses escape from oil drilling sites - we can smell it sometimes in our area. Students will develop critical thinking even by realizing that the harmless salt spray close to the beach lands on windows and gardens. It dictates which plants can live in those gardens.

Present the globe, and discuss the pollution (air, water, or soil) dumped into the environment anywhere around the globe. What are the chances of it reaching us? If we pollute, what are the chances for our pollution to reach the other side of the globe?

Permanent air currents, and seasonal winds, travel at speeds of as much as 200 miles per hour. The distance between LA and Santa Barbara is 100 miles. Even on calm days, pollution from LA reaches us on less than one day. We see it as a yellow-gray layer at the islands. The distance between Brazil and us is about 20,000 miles. If a nuclear plant in Brazil releases radioactivity, when will it reach us? (At an average mean of 10 miles per hour air currents - 2,000 hours = 83 days! - that is less than 3 months.)

What about water pollution? The oceans circulate slower than air because water is denser than air and the continents act as barriers. But the waterways are connected, and water from the Arctic Ocean does reach our Pacific on a time scale of a few hundred years. If a Russian nuclear plant releases radioactive isotopes in February 2000, by air it will reach us by Christmas. In the ocean it may take 100 years to reach here and our grandchildren will be exposed to the radiation in their local ocean and may get cancer because of it.

Have students write about instances they know of, or can imagine, when items from their neighborhood could have washed down to the beach.

5 Taking Action - Extended Discussion with Students

Next time you are on your own street, try to locate the storm drains. Consider where the rain that falls on your roof ends up. Where do the pesticides you spray in your garden end up?

Where are we on the map in relationship to our oceanic neighbors? The seaweed, fish, lobsters, snails, otters, seals, dolphins, and whales are all forced to live in everything that we place on and in the soil.

Who cares if the organisms in the ocean die or suffer? Why is it important for us? Why is important for the environment? When humans contaminate the environment, we breathe it! We drink it! We eat the contaminated vegetables! We eat the contaminated fish and lobsters.

How can we protect ourselves? Can we isolate ourselves from the pollution out there in the environment? In spite of our advanced technology, there is no way we can isolate pollutants or store them permanently - not on land and not under water. In time, even the most effective toxic storage tanks and sites leak. And when they do, the pollutants get into our water, soil, and air and we, together with all our creature neighbors and partners on planet Earth, breathe it, eat it, and drink it!

Closure

Discuss the responsibilities everyone has to protect the environment for all living things.

Conclude with students that we as a group can be responsible if we choose to be. We can also affect each other by expecting that we all be responsible for the environment, for our own sake, and that of all creatures.
Have the students develop a class story line: A family sprayed their vegetable garden with pesticides to protect it from some insects or fungi, but the family didn’t read the directions before they used the pesticides and they sprayed way too much. The H2O molecules in that garden heard the toxic molecules were sprayed on the sidewalk and got very worried. The water molecules were not happy to be mixed with chemical agents when they landed on the sidewalk. The toxic molecules immediately attached themselves to the water molecule and wouldn’t let go. They stayed on the ground for many weeks. Then the rains came, and the contaminated water molecules mixed with toxic molecules reached the ocean. They re-evaporated hoping that now they will finally be freed of the pollution. As they rose into the air, they quickly met more pollution molecules who grabbed the water molecules and did not let go of them. Together they visited the mountains, rained down on gardens and vegetable farms, and entered the plants and bodies of children who drank water when they were very thirsty. Everywhere the water went, it met pollution. How did this happen? Who is responsible?

The above story can cause anxiety in thoughtful children. Some may not want to drink water or eat vegetables anymore. Although we need to teach responsibility and awareness, we also need to assure them that as long as we pay attention and use chemicals properly or (discuss organic alternatives), we are OK. If we know what can be harmful to the environment, we can choose alternatives to protect the environment.

**Assessment**

Have each child draw, paint, or write a story about an environment that became polluted.

**Key words** (see Appendix B)

- Geological maps
- Maps
- Molecules
- Relief maps
- Pollution
- Fumigation
- Responsibility
- Storm drains
- Three-dimensional maps
- Topographical maps
- Watershed
Storm Drain Walk

Summary

Local storm drain pathways, and the possibilities of pollution within the neighborhood.

Background

In Santa Barbara County, water from urban areas travels two different pathways. (1) Water used inside our homes, schools and buildings is carried through pipes to wastewater (sewage) treatment plants. Once it arrives there, the wastewater is treated and ultimately ends up in the ocean or is recycled for irrigation. (2) Water that runs off of streets and buildings flows onto the storm drains. Storm drains are a large part of the watershed in urban areas. Anything on the street – including trash, fertilizer, pesticides, motor oil, and pet waste – can enter a storm drain. All storm drains flow directly to creeks and to the ocean. This waste, called nonpoint source pollution, contributes to the elevation of bacteria levels in creeks and the ocean. Pollution from contaminated runoff can affect aquatic ecosystems and cause the ocean to be unsafe for people to swim in.

Understanding how the storm drain system works is necessary in keeping a watershed healthy. With the knowledge of how these systems work, people can understand the connection between solid and liquid pollutants and the storm drains, creeks and the ocean. It is only with this understanding that we can begin to prevent pollution problems in our watersheds.

Objective

Students will:

Become aware of the two pathways that wastewater travels in the watershed, i.e. know the difference between the sewer and storm drains.

Be able to identify storm drain systems within the watershed.

Observe storm water and urban drainage patterns within the watershed.

Materials

- Paper and pencil for each student
- Copies of the Storm Drain Observation Sheet for each student (See Appendix F)

Optional: topographic, watershed and subwatershed maps of your school area. See attached map of the South Coast watersheds.

Optional: trash bags for picking up trash on your walk

Management and Safety Considerations

Students will be outside so remind all students to follow all traffic safety practices and to stay in the group. If you decide to pick up trash on your walk, use caution when picking up sharp, soiled, or otherwise potentially harmful objects.

Procedure

1. **Discuss in class the following:**
   - Where does the water that flows on the streets and sidewalk go? What is a storm drain?
   - Where does the water that goes down the sink drain and toilet go? What is the wastewater (sewer) system? (Discuss differences between the storm drains and sewer system.)
2 Outside the classroom

Take the class outside of the school. Ask the students the following questions:

What is the name of the street your school is on?

What are the names of three other streets that surround your school?

Where is the closest storm drain?

Is there pollution such as oil, trash or animal (dog, horse, etc.) waste on the ground? Is there pollution in the storm drain?

Are there oil stains on the school parking lot, on the street and near the storm drains?

Optional: Collect litter found on the street as you walk. Use caution when picking up sharp, soiled, or otherwise potentially harmful objects. Identify possible sources of the litter.

3 Look for storm drains

Use the Storm drain Observation Sheet.

Have students repeat activity in their home neighborhood. Compare results.

4 Making a map

When you are back in the class, draw a map of what you saw while on your walk. Be sure to write the names of all streets, including the street that your school is on. You can also use a copy of a map that your school is on such as the Thomas Bros. Map.

Put an “X” on the map where you saw the storm drain openings called catch basins.

Note if it has been stenciled, or marked, with the saying, “DO NOT DUMP, DRAINS TO OCEAN!”

If you saw creeks or other natural waterways, draw them on your map.

Optional: Compare students’ maps to the topographic, watershed and subwatershed maps of your school area.

5 Class Discussion

Discuss types of pollution, sources of that pollution and how students can help keep pollution from entering the storm drains around their school or home.

Closure

Discuss students’ experiences on the storm drain walk. Discuss what types of pollutants students found and how they can help keep these pollutants out of the storm drains. Ask students to write a paragraph or two about their experience and list three things they can do to keep pollution out of the creeks and ocean.

Ask the students, “what should go down the storm drain?” Answer: Only rain down the storm drain!

Assessment

Storm drain Observation Sheets would be useful assessment tools.

Key words (see Appendix B)

Catch basin
Storm drain
Wastewater (Sewage) Treatment Plant
Creek Walk

Summary

Students observe a local creek to learn about its functioning and overall health.

Background

On the South Coast of Santa Barbara County, storm drains lead to creeks and all creeks flow to the ocean. One of the best and simplest ways to monitor the health of a creek or stream is by going on a creek walk. Walking a creek allows one to assess the quality of the natural aspects of creek habitat, such as vegetation, presence or absence of natural and human debris, and stability of the banks. It also allows one to locate sources of possible pollution such as pipe discharges from industrial facilities or businesses, storm drain discharges, dump sites along the creek, or construction sites along the creek. Walking a creek provides a good opportunity to document pollution sources and report them to the agencies in charge of monitoring water quality. You can also determine which creeks are not polluted and monitor their health on a regular basis, if desired. Creek Watchers provides an excellent creek monitoring program. (See Appendix A). To report any problems noticed along the creek walk, please call the Project Clean Water Quality Hotline at 1-877-OUR-OCEAN. Refer to the back of the brochure “Ocean Begins on Your Street” (included in the binder) for more contact information.

Objectives

Students will:
Collect data through visual observation.
Gain experience and knowledge about the proper methods for reporting pollution or other problems found at a creek site.
Understand how things such as natural vegetation, stable banks, and unpolluted water are all a part of the health of the creek system.
Analyze how the health of a local creek can be improved and report findings to proper agency.

Materials

- A simple field guide of riparian plants (included in Appendix F)
- Topographic map of creek to be walked (purchase at local hiking store)
- Camera and film in waterproof zip-lock plastic bag, or disposable cameras
- Protective footwear — rainboots or old tennis shoes
- Extra shoes, socks, and pants to change into after the walk
- Clean water and soap for washing hands afterward

For each group of four to six:
- Clip board (or cardboard and tape)
- Pencil
- Creek Walk Notebook and Observation Sheets (included in Appendix F)
  Reproduce 4-6 Observation sheets

Management and Safety Considerations

Participants should wear sturdy shoes. When selecting a site on the creek, pay attention to how the site is accessed: Is the access point on school or public property? If not, permission will need to be granted from the owner of the property before going down to the creek. Select a creek access point that is easy and safe to use. Avoid steep or unstable slopes or places with severe erosion.
Creek Walk

Correlation of Activity to California Content Standards

For a detailed reference to the standards, see Appendix D.

4th Grade: English-Writing Strategies: 11, 12a-e, 1D. Writing Applications: 2.3a,b. Written and Oral English Language Conventions: 11, 12, 13, 14, 15. Listening and Speaking: 11, 12, 15, 16, 17, 18, 19. Speaking Applications: 2.2a,b.

5th Grade: English-Writing Strategies: 12a-c, 16. Writing Applications: 2.3a-c. Written and Oral English Language Conventions: 11, 12, 13, 14, 15. Listening and Speaking Strategies: 11, 12, 13, 14, 15, 16. Speaking Applications: 2.2a-c.


7th Grade: English-Writing Strategies: 11, 12, 16, 17. Written and Oral English Language Conventions: 11, 12, 14, 15, 16, 17. Listening and Speaking Strategies: 11, 12, 13, 14, 15, 16.


8th Grade: English-Writing Strategies:12. Writing Applications: 2.6b,c. Written and Oral English Language Conventions: 11, 12, 13, 14, 15, 16. Listening and Speaking Strategies: 12, 13, 14, 15, 16, 17a,b.

Procedure

1. Before the walk

   Contact Urban Creeks Council, City or County of Santa Barbara or another resource to determine a suitable area for creek walk near your school (see resources list in Appendix E).

   Arrange for transportation that will deliver you to the starting location and pick you up at the ending location of your creek walk.

   Form suitable student groups of 4 to 5 students

   Arrange for students to bring protective footwear, such as rainboots or old sneakers to wear during the creek walk. They should also bring an extra pair of pants, shoes, and socks to change into at the end of the creek walk. The dry clothes should be left with the car or van that will pick you up at the end of the walk.

   Go over the Observation Sheets with the students. Use the following information to make sure group members become familiar with the things they will be assessing on the creek walk.

   Review water quality tests that may be performed in Lesson 6.

   Discuss the poster / display to be produced from information gathered from creek walk. (see assessment below)

2. Vegetation

   The vegetated area on either side of the stream, along with the flowing water, forms the creek habitat. Vegetation is critical to creek health because it shades and cools the water, holds the soil in place, adds nutrients to the stream in the form of leaves, provides woody debris to help form habitat for aquatic life, and provides habitat for streamside wildlife. Vegetation also acts as a filter for sediment and pollution coming into the water from the land. On their data sheets, the students will be assessing the quality of the vegetation as missing, trampled, sparse, dense, landscaped, or tree canopy. Every 50-100 yards they will describe the vegetation using one or more of these terms.

3. Pools and Riffles

   Pools are deeper than adjacent areas in the stream. Pools are formed when natural debris such as rocks pile up and slow the flow of water. The presence of pools is very important to healthy creek habitats, since they provide feeding and resting areas for young fish and other aquatic life. Riffles are areas of the creek that flow faster than other areas, often over rocks. Riffles are good habitat for aquatic insects and important spawning areas for fish. Every 50-100 yards, the students will describe the condition of the creek with regard to pools and riffles as none, few, or many, mostly pools, or mostly riffles.

4. Erosion

   Look at the banks of the creek. Are there things that have caused it to erode, e.g., are parts of the bank caving in or wearing away? Describe these conditions and mark any eroded areas on your map. For example, is there runoff from surrounding land uses that has scoured out the banks of the creek? Have people been riding their bikes along the edge or in the bottom of the creek? What potential problems can you think might result from the erosion you see? How could these problems be reduced or prevented?

5. Adjacent Land Uses

   Generally describe the types of land uses that are present near the creek. Do you see houses, farms, businesses, or vacant land? How do these land uses affect the condition of the creek?
Human Flood Control Improvements

Do you notice any areas where it looks as though efforts have been made to stop erosion along the edges or bottom of the creek? These might include cement along the banks or bottom of the creek (chanelization), pipe and wire revetments (barricades) along the edges, large boulders placed on the bottom or sides of the creek. These types of structures are attempting to slow down or alter the pathway of the water moving through the creek in order to keep the banks from eroding. They may be used to protect an existing structure or prevent the sides or the bottom of the creek from being scoured out during periods of high flows. How successful have these flood control structures been? How are they affecting the areas around them, e.g., do you notice areas of high erosion where these structures stop? Are pieces of garbage and plants natural debris in them?

Closure

Have the students discuss how each of the elements they have observed effect the creek. These are important parts of the discussion of what makes up a creek environment. What is the general overall condition of the creek they have observed.

Assessment

Produce poster board displays of their walk including: pictures, narrative, and observation sheets. Poster boards will be shared with the rest of the class.

Key words (see Appendix B)

Creek
Stream
Riparian vegetation
Understory plants
Invasive species
Native species
Pollution
Erosion
What Is A Healthy Creek?

Summary

Students learn about the biological and physical properties of local creeks, and how changes in these characteristics can affect the health of a creek.

Background

A healthy creek provides habitat for a variety of fish and wildlife, plant species and aquatic insects. The basic elements needed to support aquatic and riparian life are good water quality, adequate flow and proper water temperature, habitat diversity and food availability. The plants and animals that inhabit a healthy creek create a delicate balance. Our creeks are the connection between the mountains and the ocean. They provide a unique ecosystem for riparian plants, amphibians, fish, and insects.

As a creek travels through the watershed, it may pick up various pollutants, which adversely affect the health of a creek. Nonpoint source pollution, such as pet waste, pesticides, herbicides, fertilizers, and motor oil, can enter the creek in urban and storm drain runoff and cause harm to the aquatic life in the creeks. Many homes and farms use fertilizers to stimulate plant growth, but if these chemicals run off into creeks, they can cause aquatic plants to grow at an unnaturally high rate. The increase in the plant growth can make it difficult for the sunlight to penetrate into the water, and can severely decrease the diversity of aquatic life in the creek.

A creek is a dynamic, living resource that moves within its channel and floodplain, and adapts to natural and human-induced changes within its environment. In an urban area, creeks are constricted by development; houses and businesses are often built in areas that creeks used to flood as part of their natural cycle. Flood control structures, such as concrete channels and bank stabilization structures, are then built to protect the urban development. These structures provide flood protection but can affect the health of a creek by reducing vegetation, changing habitat, and affecting the way water is filtered by the natural system. For example, concrete channels do not allow for filtering of pollution or growth of vegetation (i.e. habitat).

On the creek walk described in the previous lesson, students may have observed both natural and human elements as part of the creek environment. In this lesson, they will illustrate the things they observed as part of an urban creek, and discover how these things fit together to describe the overall health of the creek.

Objectives

Students will:

Understand that there are both natural and human-created elements in an urban creek environment.

Become aware of how urban impacts affect the health of a creek.

Materials

- Paper
- Felt pens/crayons/colored pencils/paint
- Samples/illustrations of native & non-native riparian vegetation
- Illustrations of local riparian wildlife

Management and Safety Considerations

It would be helpful to circulate among the groups (or ask an assistant to do this) as they develop...
their drawing to keep them focussed. You can ask questions that will get them thinking about what they've observed on their creek walk or other experiences they've had in local creeks.

**Procedure**

1. **Drawing a creek**
   In small groups, students make a drawing of what they think a creek is. If they have gone on a creek walk, have them include things they noticed during that experience. Their illustrations are then shared with the whole class.

2. **Class Discussion**
   The teacher leads a discussion that includes who (humans & other life forms) uses the creeks, and which qualities or characteristics would make a creek healthy or not.

   To help the students with their illustrations, you can provide examples of both native and non-native plants found on the creek walk. You could also provide illustrations of these plants if samples are difficult to obtain.

   Below are some of the elements you will want to discuss with the students. This is just a representative list; you may want to mention other elements as well. Our local creeks are unique; many do not flow year-round except on especially wet years. It's interesting to remind students that even the absence of water can be a characteristic of a healthy, natural creek. Ask the students how each element contributes to the health of a creek.

   **Characteristics of a healthy creek:**
   - Native vegetation (canopy & understory)
   - Animal life (fauna)
   - Water quality
   - Stable banks

   **Functions of a healthy creek:**
   - Plant/animal habitat
   - Water supply
   - Filtering of pollutants/sediment in water
   - Flood protection
   - Aesthetic & recreational value

   **Urban impacts to creeks:**
   - Channelization/bank alteration (for flood control)
   - Removal of vegetation/loss of habitat
   - Polluted runoff (nonpoint source pollution)

**Closure**

During this project, students may have formed an idea of “good” and “bad” elements of a creek. You can now ask them to list ways that they can personally help protect their local creek. What should the community do? How about the government? How do you balance the needs of the community (i.e. for flood protection, use of automobiles, etc.) with the desire to have a healthy creek environment?

**Assessment**

Students should be able to name some natural attributes of a healthy creek. They should also be able to discuss ways that creeks are affected by urban development.

**Key words** (see Appendix B)

- Canopy
- Nonpoint source pollution
- Habitat
- Riparian
- Native Vegetation
- Understory
- Non-native Vegetation

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**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

**4th Grade:** English - Writing Applications: 2.3, a, b
Science - Life Science: 3 – a, b, Earth Sciences: 5 – c
History: 4.1- 3

**5th Grade:** English - Writing Strategies: 12, a, c

**6th Grade:** English - Written and Oral English Language: 14
Science - Focus on Earth Science: 2 – b, Ecology: 5 – e

**7th Grade:** English - Written and Oral English Language, 16

**8th Grade:** English - Written and Oral English Language, 15
Section III: The Problems with Pollution

This section introduces the concept of nonpoint source pollution.
Pollution is becoming an increasing problem as the population of humans on earth increases. Water covers over 70% of this earth, and comes into contact with many of the chemicals and other pollutants produced by human activity. As water flows through a watershed, it picks up pollutants it comes into contact with and transports them downstream. Much of the pollution in the creeks and ocean on the South Coast of Santa Barbara County comes from nonpoint sources. Nonpoint source pollution does not have a point of origin that can be clearly determined. Examples of nonpoint source pollution are fertilizer, herbicides, pesticides, pet waste, soil, motor oil, car-washing soap, litter, and grease. All these pollutants make their way to the creeks and ocean, and affect the water quality, habitat, wildlife and the delicate balance of the ecosystem. Pollution can also affect the quality of the water supply, while harming the plants and animals that live there.

Ocean pollution affects all the plants and animals which live there, and in turn, indirectly harm those who enjoy seafood. Additionally, many people use the ocean for recreational purposes and are directly in contact with the pollutants. Many regular beach goers and surfers have reportedly become sick due to high levels of pollution. To monitor ocean pollution in the County of Santa Barbara, 20 beaches are tested regularly to determine the presence of bacteria. Sites are tested for levels of fecal coliform, total coliform, and enterococcus bacteria. Samples are taken back to a laboratory for testing, however results take up to two days to determine due to the time needed to allow for the growth of bacteria. If the samples are high in bacteria levels, the area is posted accordingly and retested. Samples are taken 25 yards down current from creek mouths or storm drains. Refer to the Pollution Fact Sheet, Appendix C, for more information about specific pollutants, or check the County Environmental Health Services web site at www.sbcphd.org/ehs.

Class Presentations and Field Trips (refer to Appendix A)

Creek Watchers In-Class Presentation
City and County of Santa Barbara Watershed In-Class Presentations
South Coast Watershed Resource Center Field Trip
Why Do Beaches Close?

Summary

This activity is an introduction to ocean pollution and its causes.

Background

Local beaches are tested for bacteria levels on a regular basis. If the levels are too high, the beach is determined unsafe for human activity and signs are posted to inform people of unsafe conditions. Many beach postings occur after the first rains of the season. The rain picks up bacteria and other pollutants and carries it through the watershed to the ocean. Water which drains off the land, streets, and structures is called runoff. Runoff along the streets enters the storm drains through the openings in the curbs of streets, which are called catch basins Runoff travels through the storm drains and directly into the creeks, which then flow to the ocean. See Activity 4 “Storm Drain Walk” in Section II). A more detailed description of the County’s ocean water testing program appears in the Teacher Background Information for this section, or visit http://sbcphd.org/ehs/oceanmn.htm. Refer to the Pollution Fact Sheet, Appendix C, to learn more about bacteria and pollutants found in the ocean.

Objectives

Students will:
Understand the concept of beach advisories and closures.
Discover the causes of beach closure and advisories.
Understand the difference between the waste water system and storm drain water system.

Materials

- Current newspaper articles regarding beach advisories and beach closures (See article in Appendix F)
- Section of the newspaper that explains the testing and advisories
- Project Clean Water home page - lists current local beach status: www.countyofsb.org/project_cleanwater
- “Healthy Creeks and a Clean Ocean Depend On You” brochure

Management and Safety Considerations

None

Procedure

Start with a relatively current headline from the newspaper pertaining to water quality issues. Depending on the length of the article, either reproduce it for the students (short articles) and read it together out loud, or read short important passages to them (longer articles).

Discuss the content of the article. At some point direct the discussion to beach closures. It is important to draw upon the students’ personal experience here. Which beaches do they like to visit? Where are the good surf spots? Have they ever seen a warning sign at the beach about water quality? Include some historical posting information for various beaches.
The procedures for testing and the standards for closing and posting advisories are complicated, so discuss in general a summary of the procedures and standards as mentioned in this section’s Teacher Background Information. Also, discuss the difference between beach closures and advisories.

**Closure**

The lesson ends with the discussion of where the bacteria might be coming from. Explain how stormwater runoff goes directly into creeks and the ocean and is separate from the sewer system. Show a map or other image with locations of creeks/watersheds and the coastline.

**Assessment**

Have students write down possible sources of bacteria and other pollutants that enter the ocean.

**Key words** (see Appendix B)

Advisory
Bacteria
Microorganism

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**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

**4th Grade:** English- Reading: 1.1, 2.4 Listening and Speaking: 11.18, 11.10

**5th Grade:** English- Reading: 11.2.3, 2.4 Listening and Speaking: 15
Creek Watchers

Summary

Students participate in Creek Watchers by monitoring a local creek's water quality and habitat.

Background

Creek Watchers is a Santa Barbara-based educational and community outreach program, administered by the Community Environmental Council (CEC), an environmental non-profit organization. Creek Watchers was created in response to local beach closures due to poor water quality. Since the fall of 1998, volunteers have monitored the water quality and habitat of creeks on the South Coast of Santa Barbara County. The purpose of Creek Watchers is to instill in community members a sense of stewardship of our creeks, improve their overall connection with their natural surroundings, and to gather water quality data. The data collected is used in projects such as the Southern California Wetland Recovery Project in order to learn more about our watersheds and make informed decisions on future restoration projects. You can get involved in Creek Watchers by calling the CEC at 963-0583, ext. 149 or sign up on the Creek Watchers website http://www.sbwater.org/projects/creek_watchers. A username and password will be provided for on-line access to the data entry form as well as forms for sharing student field logs, comments, or other information they have learned. All of the forms needed for the project, as well as other background information, are available on the Creek Watchers web site.

To receive a free LaMott test kit (value $25), teachers must attend a Creek Watchers workshop at the Community Environmental Council and commit to their class collecting data once a month. Or teachers interested can schedule a one time field trip to collect data.

Objectives

Students will:
Learn to take water samples and observe the habitat.
Learn to record data accurately and observe changes to a site over time.
Gain an awareness of what makes a healthy creek.
Grow a stronger connection with a nearby creek and the environment.

Materials

• LaMott Water Testing Kit
  (Provided by the CEC’s Creek Watchers Program. See “Background” section above.)
• Creek Watchers data forms
• pen or pencil
• rubber gloves

Management and Safety Considerations

Participants should wear sturdy shoes. While taking and handling water samples rubber gloves should be worn. When selecting a site on the creek pay attention to how the site is accessed: Is the access point on school or public property? If not, permission will need to be granted from the owner of the property before going down to the creek. Select a creek access point that is easy and safe to use. Avoid steep or unstable slopes or places with severe erosion.
Procedure

During the project, students select a specific site on a nearby creek to study. Once a month students visit this site to take water quality tests (when the creek is flowing), record the data and evaluate the habitat of the area. They will use a LaMott kit to perform a number of tests, including pH, phosphates, nitrates, dissolved oxygen, turbidity, and coliform. The results of these tests will be added to the Creek Watchers database at CEC either in hard copy or on the website for viewing by other students.

Closure

Have students:
- make a chart of their findings
- write a description of how their site changed over time
- decide if the habitat and water quality at their site is excellent, good, fair or poor
- journal how they feel about their creek site or about creeks in general and how that has changed through this project

Key words (see Appendix B)

Coliform Bacteria
Dissolved Oxygen (DO)
Erosion
Eutrophication
Nitrate
Nonpoint Source Pollution (NPSP)
pH
Phosphate
Turbidity

Correlation of Activity to California Content Standards

For a detailed reference to the standards, see Appendix D.

4th Grade: English- Writing Strategies: 11, 13, Writing Applications: 2, 1, a, b, c, Written and Oral Language Conventions: 14 Science- Life Sciences: 2 - a, b, 3 - a, b, Earth Sciences: 5 - a, c, Investigation and Experimentation: 6 – d, f History- 4.1, 3

5th Grade: English- Writing Strategies: 11, b, Written Language and Oral English Language Conventions: 14 Science- Earth Sciences: 3 d, Investigation and Experimentation: 6 – a, g, i

6th Grade: English- Written and Oral English Language, 14 Science- Shaping Earth’s Surface, 2b, Life Science, Ecology: 5 c, e

7th Grade: English- Written and Oral English Language, 16

8th Grade: English- Writing Applications, 2.3, b, c, d, Written and Oral English Language, 15 Science- Ecology - life-science: 5: c-e
Deadly Waters

Summary

Students analyze the pollutants found in a hypothetical river. They graph the quantities of pollutants and make recommendations about actions that could be taken to improve the habitat.

Background

All the water that has ever been available to our planet is on or in the earth right now. On the entire planet there are 326 million cubic miles of water. If the earth were a globe 28 inches in diameter, all of the water on the planet would fill approximately one cup. Of that amount, only 0.03% is in river systems and freshwater lakes. This means that only slightly more than one drop would fill all the rivers and lakes. This represents all the water in the world that is clean and accessible for all living things.

Rivers, lakes and streams are vital components of the water cycle. All the rain and snow that falls on the land either seeps into the water table or is carried to the sea. In addition, water evaporates or finds its way through plants and transpires back into the atmosphere to form clouds and precipitate again.

With a picture of the scale and interconnectedness of our planet's fresh water resources in mind, it is apparent how fragile this vital substance is. Yet each day water is being contaminated by pollution – pollution that can stress ecosystems beyond their capacities to support life.

Pollution is a complex topic. Most current resource books include four categories of pollution.

**Chemical Pollution:** The introduction of toxic substances into an ecosystem, e.g., chemicals found in acid rain, contamination of water supplies by pesticides.

**Thermal Pollution:** Varying temperatures above or below the normal condition, e.g., turbine heated water from power plants.

**Organic Pollution:** Oversupplying an ecosystem with nutrients, e.g., fertilizer runoff.

**Ecological Pollution:** Stresses ordinarily created by natural processes, such as:

- Adding a substance that is not a naturally occurring substance in the ecosystem (adding something that is not usually there), e.g., extreme tides pour saltwater into habitats ordinarily protected from the sea water;
- Increasing the amount or intensity of a naturally occurring substance, e.g., abnormal increase in sediments in runoff water to produce silt;
- Altering the level or concentration of biological or physical components of an ecosystem (changing the amount of something that is already there), e.g., introduction of aquatic plants via bird droppings, etc.

Most of us view pollution as being predominantly caused by humans. In the definitions above, chemical pollution through the introduction of toxic substances is clearly human caused. Organic pollution in lakes and rivers typically results from chemical fertilizers used in agriculture. Thermal pollution is dominantly caused by humans through power generating plants and many industries. Some dams also introduce unnaturally cooled water by releasing water from the bottom of the dam.

Surprisingly, these three forms of pollution – chemical, thermal and organic – can take place without human intervention. When pollution takes place without human intervention, it is most often ecological pollution. (At times, human activity can also increase pollution via naturally occurring substances. For example, road building and some forest practices can increase siltation.) Natural ecological pollution, in the larger view of things, may be beneficial rather than harmful. Whether beneficial or harmful or neither, ecological pollution – which is dominantly derived from natural processes – does affect wildlife and wildlife habitat.

Preparation Time

One hour to prepare material

Lesson Time

An hour or longer

Incorporates:

Science
Social Studies
Health
Home Economics
Industrial Arts
Vocabulary
To understand pollution’s causes and effects prepares us to be able to take constructive action now and in the future to protect and maintain a healthy environment.

In its many journeys, water may be contaminated by thousands of different substances and conditions. For the most part, these substance and conditions alter water in such ways that it becomes a hazard to wildlife, wildlife habitat and humans as well. Some effects are direct. Others are indirect.

The major purpose of this activity is for students to increase their understanding of water pollution and its potential effects on humans and wildlife habitats.

**Objectives**

Students will:

Name and describe different kinds of pollution that can affect water as well as animals and plants that live in water.

**For Older Students:**

Identify major sources of aquatic pollution

Make inferences about the potential effects of a variety of aquatic pollutants on wildlife and wildlife habitats.

**Materials**

- nine different colors of construction paper (2 sheets each)
- writing or graph paper
- Scotch tape or glue
- paper punch
- Pollutant Information Sheets (listed at the end of this activity - one for each student)
- ¼ teaspoon measure (for paper punch tokens)
- 1 tablespoon (for ½” square tokens)

**Management and Safety Conditions**

None

**Procedure**

1. **Tokens**
   
   Before the activity begins, make 100 tokens of each or the nine colors of construction paper. The construction paper may be folded in quarters to speed up the process of cutting or punching. For younger students, cut the construction paper into ½” squares using a paper cutter. For older students, punch out construction paper tokens with a paper punch. Put all the tokens, either ½” squares or punched tokens in a container. Stir them so the colors are thoroughly mixed. Make one copy of the Pollutant Information Sheet for each student.

2. **Class Discussion**
   
   List the four major categories of pollution on the chalkboard and discuss each. They are chemical, thermal, organic, and ecological. Refer to the background for a description of each. NOTE: the first three are dominantly caused by humans, although there are rare cases where natural processes can cause them. Ecological pollution is typically natural, although there are cases where it is caused by humans.

**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

4th Grade: English - Listening and Speaking Strategies, 1.1, 1.6, 1.7, 1.8.
Science - Earth Sciences 5a, Investigation and Experimentation 6c,e,f

5th Grade: English - Listening and Speaking Strategies, 1.1, 1.4, 1.5.
Science - Earth Sciences 3a,b,c,d,e, Investigation and Experimentation 6a,g,h

6th Grade: English - Listening and Speaking Strategies, 15.
Science - Investigation and Experimentation 7a,c,e,g

7th Grade: English - Listening and Speaking Strategies, 15.
Science - Evolution 3e, Investigation and Experimentation 7c
Pollutant Information Sheets

Pass out the Pollutant Information Sheets. Review each kind of pollution with the students. Talk about how some of these can fit into more than one of the four kinds of pollution. Color code each with a different color of the construction paper. Write a short description of the pollution on a piece of paper of the color to which it is coded. (Some teachers have simply copied the Pollutant Information Sheets, cut the descriptions apart, and pasted the appropriate paragraphs on each of the colored paper with its corresponding description of the kind of pollution it represents in a convenient place.

Research Teams

Once all the kinds of pollutants have been discussed, and the students understand that each kind of pollution will be represented in this activity by one color of paper, tell the student that they are to divide into teams of three. These will be research teams; each team will analyze the pollution content of a hypothetical river. Distribute the colored paper tokens that have been cut or punched from the construction paper. Pass the container with the colored paper tokens for each research team to measure out for themselves 1/4 teaspoon of the paper-punched tokens, or one tablespoon of the 1/2" square tokens. Also, provide each team with a piece of graph paper.

The teams must separate the colored tokens into piles; using the color key, they should identify each type of pollutant. Once this is done, they should count the number of each kind of pollutant they have identified and then use graph paper to construct a simple bar graph showing the whole array of pollutants. Arrange the pollutants in the same order as they are displayed in the color key that is posted in the classroom. This makes it easy to compare each team’s findings. Remind them that each has a different river. Their results are not likely to be the same!

When they have the bar graphs completed and have compared the team’s results, tell them that any quantity above two units of each kind of pollutant is considered damaging to wildlife habitat. In their hypothetical rivers, what pollutants would be likely to cause the most damage to wildlife and wildlife habitat? Give examples and discuss the kinds of damage that could be caused.

Optional:

Invite the students to match the pollutants with the four categories of pollution listed at the beginning of the activity. Some seem to fit rather easily; others could fit in more than one category, depending on the source of the pollution. For example, is the thermal pollution human or naturally caused (power plant water effluent or thermal hot springs)?

Extension:

• List five things you can do – starting today – in your own life to reduce the number of pollutants you add to the environment.
• Conduct a field trip to a local waterway and attempt to identify what, if any, kinds of pollution are affecting it.
• Is DDT still being used, and where? Find out the current status of this pesticide use in the U.S. and other parts of the world.

Assessment

Describe the effects that large quantities of the following things might have on an aquatic environment, consider short-term and long-term effects: hot water, fertilizer, soil (silt), heavy metals, etc.

Water is taken from a river, treated, used by people of a community, sent to a city sewage treatment plant, and put back into the river. Is this aquatic pollution? Defend your response.

Keywords (see Appendix B)

Pollution  Groundwater  Point source pollution  Nonpoint source pollution
Appendix C provides a more extensive pollution fact reference guide.

SEDIMENTS

Particles of soils, silt, clay and minerals wash from the land and paved areas into creeks and tributaries. In large unnatural quantities, these natural materials can be considered a pollutant. Construction sites can be a source of sediments. Sediments may fill stream channels and harbors that later require dredging. Sediments suffocate fish and shellfish populations by covering fish nests and clogging the gills of bottom fish and shellfish.

PETROLEUM PRODUCTS

Oil and other petroleum products like gasoline and kerosene can find their way into water from ships, oil drilling rigs, oil refineries, automobile service stations and streets. Oil spills kill aquatic life (fish, birds, shellfish and vegetation). Birds are unable to fly when oil loads the feathers. Shellfish and small fish are poisoned. If it is washed on the beach, the oil requires much labor to clean up. Fuel oil, gasoline and kerosene may leak into groundwater through damaged underground storage tanks.

ANIMAL WASTE

Human wastes that are not properly treated at a wastewater treatment plant may contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery (diarrhea), hepatitis, flu and common cold germs are examples of diseases caused by bacteria and viruses in contaminated water. The main source of this problem is sewage getting into the water. People can come into contact with these microorganisms by drinking the polluted water or through swimming, fishing, or eating shellfish in polluted waters. Often unexpected flooding of barnyards or stock pens can suddenly increase the toxic effects of animal waste in water. Animal waste can also act as a fertilizer and create damage by increasing nutrients. (see Fertilizers)

INORGANIC CHEMICALS

Inorganic chemicals and mineral substances, solid matter and metal salts commonly dissolve into water. They can come from mining and manufacturing industries, oil field operations, agriculture, and natural sources. These chemicals interfere with natural stream purification; they destroy fish and other aquatic life. They also corrode expensive water treatment equipment, and increase the cost of boat maintenance.

DETERGENTS, AND FERTILIZERS

Many of these substances are toxic to fish and harmful to humans. They cause taste and odor problems and often cannot be treated effectively. Some are very poisonous at low concentrations. Fertilizers contain nitrogen and phosphorous that can cause large amounts of algae to grow. Large algae blooms can cover the water’s surface. The algae die after they have used all of the nutrients. Once dead, they sink to the bottom where bacteria feed on them. The bacterial populations increase and use up most of the oxygen in the water. Once the free oxygen is gone, many aquatic animals die. This process is called eutrophication.

ACID PRECIPITATION

Aquatic animals and plants can live in a rather narrow range of pH levels. pH is a measure of the acidity of a solution. When water becomes too acidic, due to inorganic chemical pollution or from acid rain, fish and other organisms die.

PESTICIDES, HERBICIDES, FUNGICIDES

Chemicals designed to kill or limit the growth of life forms (such as weeds and insects) are a source of pollution. Runoff and groundwater flow spread these toxic substances to waterways.
Summary

In this activity, students calculate both the volume and the weight of rainfall that runs off from their school, and where it goes. They consider relationships between rainfall and runoff, including effects on wildlife and the environment.

Background

Rainfall is familiar to students— but runoff is a relatively abstract concept. Although we may notice and in fact get drenched in a rainstorm, we don’t typically stop to wonder how much rain is actually falling. The volume and mass of the water in a rainstorm is astounding when you calculate the values.

Developing an understanding of precipitation and runoff is an important part of understanding the water cycle and movement of water in watersheds. Rainfall is the most common form of precipitation in our local climate and is one way water re-enters aquatic habitats. Once rain falls upon a surface, water begins to move both laterally outward and vertically downward. Lateral movement is runoff and finds its way into streams, rivers and lakes. Vertical movement seeps into porous soil and rock, and re-charges groundwater supplies.

Paving and soil compaction can reduce an area’s water absorbing capacity, and therefore increase runoff. Reduced absorption rates can negatively impact vegetation and groundwater recharge.

Runoff is the dominant way that water flows from one location to another. It is in runoff that many pollutants find their way into the creeks and ocean. See the Teacher Background Information for information on nonpoint source pollution.

Objective

Students will:

- Describe relationships between precipitation, runoff and aquatic habitats.

Materials

- Writing materials
- Meter or yardsticks
- Long piece of twine with marks every yard or meter
- Rain gauge
- Local rainfall data:
  - For the City of Santa Barbara, visit [http://ci.santa-barbara.ca.us/departments/public_works/water_resources/](http://ci.santa-barbara.ca.us/departments/public_works/water_resources/)
  - For the County of Santa Barbara visit [www.cinms.nos.noaa.gov/pcwcurric.stm](http://www.cinms.nos.noaa.gov/pcwcurric.stm) and look at Appendices E, F, and G.

Procedures

1. Have the students determine the total area of the school ground.

   For the purposes of this activity, the outer dimensions of the property will satisfy. There is no need to subtract the area of the buildings since it is assumed that rain falls upon them as well.
The formula for calculating area is:

\[ \text{Area} = \text{Length} \times \text{Width} \]

The length and width of the school ground must be measured. The students can use a length of twine every (approximately 100 feet in length). Mark the twine every three feet. The marking can be done with an ink marker, short pieces of string tied every yard, or a know each three feet. If a trundle wheel is available, it is convenient to use for measuring.

**Note:** A trundle wheel is a device that makes the measurement of linear distance simple. It is a wheel that operates a counter or clicks as it is rolled over the surface attached to a handle. Each revolution of the wheel represents one yard or meter. Check to see if the school has one. City road crews often have them and may loan one to you for a few days.

The main difficulty with calculating the area in this activity comes from irregularly shaped school grounds. Try not to get bogged down in detailed exactness. A healthy approximation will do.

Design a workable approximation.

Here is an example:

```
2  Rainfall Data

Once the area of the school grounds has been established, the next step is to determine the amount of rain that falls in the area. Calculate the annual rainfall on the school grounds using local rainfall data:

If you are located within the City of Santa Barbara, visit http://ci.santa-barbara.ca.us/departments/public_works/water_resources/ and look under Gibraltar and Downtown.

For the County of Santa Barbara visit www.cinms.nos.noaa.gov/pcwcurric.stm

3  Rainfall Calculations

With the depth of rainfall determined, and the area of the school ground measured, the next step is to calculate the volume of rainfall. For example, suppose the area of the school ground is 50,000 square feet and the annual rainfall is six inches or .5 feet. Then the volume of rain would be:

\[ 50,000 \text{ square feet} \times .5 \text{ ft of rain} = 25,000 \text{ cubic feet of rain} \]

The volume of rain is 25,000 cubic feet of rain

4  Rain Weight Calculations

Knowing the volume, the students can now calculate the weight of the rain. Water weighs 62.5 pounds per cubic foot, thus the weight of six inches of rain (25,000 cubic feet) is:

\[ 25,000 \times 62.5 = 1,562,500 \text{ pounds or } 781.25 \text{ tons of rain} \]

**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

4th Grade: English- Listening and Speaking, 11
Science- Investigation and Experimentation 6a,b,d,f

5th Grade: English- Written and Oral English Conventions, 14.
Science- Earth Sciences 3b,c,d,e, Investigation and Experimentation 6f,g,h,l

6th Grade: English- Written and Oral English Conventions, 14.
Science- Investigation and Experimentation 7c,e,h

7th Grade: English- Written and Oral English Conventions, 16.
Science- Investigation and Experimentation 7c,e,h

8th Grade: English- Written and Oral English Conventions, 15
Where Does Water Run Off After School?

Closure

Discuss the large volume of water that moves through the water cycle each year. Let the students know that no new water is ever made, water simply changes forms through the water cycle.

All of the measurements and calculations done in this activity are intended to impress upon students that there are remarkable volumes and weights of water moving through the water cycle. Even short periods of rainfall produce amazing amounts of water. All the water that the students measure eventually finds its way to a wildlife habitat. A major issue of concern is how humans affect the quality and quantity of water that eventually reaches aquatic habitats. Have the students write answers to the following questions and hold a discussion while the students share their answers.

Where does the water from rainfall go when it leaves the school site?

How much water is absorbed by the different surfaces on the school site? (Lawns, soil, vegetation areas)

With what kinds of potential pollutants does the water come in contact?

Where is the location of the nearest wildlife habitat that receives the school’s runoff? (a nearby creek, a creek which the nearby storm drain drains into, the ocean)

How do people use the water between the time it leaves the school and arrives in the wildlife habitat?

What are some of the positive and negative effects that the water may have on the environment at various points on its journey?

If you were to lose a napkin from your lunch on a windy day, where would it end up, if it were to rain later that day?

What can you do to help reduce the amount of pollution in the water?

Assessment

Have the students explain their answers during the class discussion. Review the students’ written answers to the questions.

Keywords (see Appendix B)

- Runoff
- Precipitation
- Volume
- Area
- Weight
Oil in Aquatic Ecosystems

Summary

Students investigate the effect of oil on feathers and eggs.

Background

Oil can affect aquatic ecosystems in many ways. Bird feathers that become soaked with oil no longer insulate, and birds may suffer from hypothermia. Additionally, birds may sicken and die if they ingest oil while trying to clean their oily feathers. Bird eggs can absorb oil through the shell, and the young will not hatch. Surface tension is caused by an attraction between molecules on the surface of a liquid. You have no doubt observed insects "walking" on water, due to these phenomena. Oil decreases the surface tension of water.

Objectives

Students will:
Understand the impact that motor oil has on the environment.

Materials

- Student worksheet, “Oil in Aquatic Ecosystems” (see Appendix F - 1 per group)
- New motor oil (about 500 ml per group)
- Beakers or jars, large enough to hold three eggs (1 per group)
- Hard-boiled eggs (3 per group)
- Feathers (1 per group)
- Hand lenses (2 per group)
- Water (about 500 ml for each group)
- Small bowl of water (1 per group)
- Small amount of ground pepper (for each group)

Teaching Tips

After the activity, be sure the oil is disposed of properly. Call 1-800-CLEANUP for the nearest oil recycling center or check for locations on the Earth’s 911 website, www.cleanup.org

The teacher may wish to have each group complete and report on a specific part of the three investigations instead of having each group do all three.

Procedures

1. Small Group Discussion
Divide students into groups of 4 or 5
Ask students to remember any oil they may have seen in their watershed that may end up in aquatic ecosystems. Possible examples:
- Oil poured down a gutter or a storm drain.
- Oil "slick" in water in a puddle.
Oil In Aquatic Ecosystems

Oil spilled on the ground when changing oil in automobiles.
Oil drips from automobiles.
Ask students what effects they think oil might have on birds and other organisms when it is present in an aquatic ecosystem.

2 Pass out worksheet to each group
Have students complete the worksheet in Appendix F.

Closure

Facilitate a class discussion about the results of the students' investigation. Then ask students:
Have you seen any evidence of oil pollution in aquatic ecosystems in our adopted watershed?
If so, where?
What is the source of the oil?
What some of the possible consequences?
What are some possible solutions?

Correlation of Activity to California Content Standards

4th Grade: Listening and Speaking Strategies: 11
Science: 6c,d,f.
5th Grade: English- Listening and Speaking strategies: 11
Science: 6g,h,l.
6th Grade: Science: 7a, e, g, h.
7th Grade: Science: 7 c.
Section IV: Pollution Solutions

This section focuses on actions that students and community members can take to reduce nonpoint source pollution.
As pollution increases in our environment, so does awareness of the problem. More people are interested in protecting the natural environment than ever before. Pollution, contributed potentially by all of us in small quantities and from many different locations, is very difficult to track and stop, and is referred to as nonpoint source pollution. These small quantities add up to become the largest contributor to water pollution in our local environment. Education and awareness are the key for long term solutions to the water pollution problem. The first step in awareness is knowledge. As students learn at a young age about the concept of pollution and become aware of their natural surroundings, their day-to-day actions will reflect their knowledge. Once people know the consequences of their actions, they are more aware of their actions as a whole. This is why teachers and educators play such an important role in the health of the environment. Teaching children where the water in our storm drains go allows them to see the affect they can have in preventing this pollution. Also, pointing out the various ways in which humans pollute on a day-to-day basis allows students to become aware of those actions and practice alternative methods.

Along with preventative measures, once the pollution has already occurred, there are ways to help clean up our environment. One way to help is by restoring an altered ecosystem to its natural state. Creeks and rivers carry water through the watershed as it makes its way to a large body of water. Creeks can help greatly in filtering out pollutants to help reduce the pollution in the water. Native riparian vegetation along the rivers and creek banks take in the water slowly and filter out the pollutants from the running water. Many disturbed ecosystems cannot function properly to help reduce the pollution and flow of water. Additionally, humans have built concrete bedding along numerous creeks to direct the flow of water away from residential and business areas. Concrete does not allow for any filtering of the water and thus causes the water to flow much faster than in a natural creek setting. Creek restoration helps to restore creeks to their natural condition, greatly decreasing the pollution that flows through them.

**Class Presentations and Field Trips** (refer to Appendix A)

- South Coast Watershed Resource Center Field Trips
- Growing Solutions Greenhouse
- City and County of Santa Barbara In-Class Watershed Presentations
- Santa Barbara Botanical Garden Field Trip
The Benefits of Creek Restoration

Summary

Students are introduced to the importance of restoring disturbed creeks to their natural state.

Background

Creek restoration is the process of rejuvenating a creek from a degraded condition to a more natural, healthy state. Creeks may be degraded by pollution, invasion of non-native plant species, bank erosion, and the encroachment of development into the creek corridor. Non-native plant species often compete better for the limited resources and slowly push the native species out completely, decreasing habitat and food sources for animals. This includes endangered species such as Southwestern Pond Turtles, Tidewater Gobies, and Steelhead. Also, native plants in creeks and marshes can help filter and clean the water before it reaches the ocean. Many organizations and agencies, such as the Urban Creeks Council, the Audubon Society, and County and City departments, are working to restore creeks locally.

Objectives

Students will:

- Understand the reason for creek restoration.
- Know what plants are native and non-native to their local environment.
- Learn how to plant native species and help restore the creek ecosystem.

Materials

- Interpretive Guide Bird Refuge Vegetation (produced by Santa Barbara City Parks Department, with focus on natural revegetation) – see attached. For more information look at the Manual of California Vegetation by the California Native Plant Society, available through their web site http://www.cnps.org
- Pictures of native animals and plants that live near creeks
- Seedling pots
- Soil mix/dirt
- Buckets/water holding devices
- Native seeds, seedlings, and cuttings (Contact Urban Creeks Council’ at 968-3000 or email at sbucc@silcom.com; or Growing Solutions at 452-7561, or email atgrowingsolutions@wavecrazy.com for assistance)
- Specific directions on growing local seeds, seedlings, and cuttings

Management and Safety Considerations

Participants should wear sturdy shoes. When selecting a site on the creek pay attention to how the site is accessed: Is the access point on school or public property? If not, permission will need to be granted from the owner of the property before going down to the creek. Select a creek access point that is easy and safe to use. Avoid steep or unstable slopes or places with severe erosion.
Procedure

1 Healthy creeks (1 hour)

Students will first be introduced to the concept of a healthy, native creek, by watching a slide show and/or be shown pictures, depicting local birds and reptiles in a healthy creek environment, as well as creek beds choked by kudzu and other non-native plants. The rest of the hour class can be spent in a discussion about why we want healthy creeks, and what the threats are (pollution, non-native plants). A guest speaker could give this presentation. Contact Santa Barbara County Water Agency at 568-3546, City of Santa Barbara Parks Department, Open Space Planner, at 564-1976, or Urban Creeks Council at 968-3000 for potential speakers.

2 Native and non-native vegetation (1 hour)

A second hour class will focus on identifying key native and non-native species (5-10 each). The plants can be shown on slides or photos, or possibly presented to the class in pots. Students can be taught ways of describing and recognizing the plants (height, number and shape of leaves, presence of flowers, etc).

3 Planting seeds, seedlings, and cuttings (3 hours)

Focus on planting seeds and cuttings, with the goal of re-planting them in a creek restoration project. Contact Urban Creeks Council on designing a class project to restore a neighborhood creek or donate plants raised to another restoration project. Urban Creeks Council’s phone number is 968-3000 or email at sbucc@silcom.com

If the class has time (one or two months), these plants could be started and later planted in a creek. Otherwise, the plantings could be done with assistance from Urban Creeks Council or Growing Solutions (phone number is 965-4692) and the class could then use more mature seedlings to transplant, if the teacher wants to do the optional restoration project.

Pot native seedlings. The class can care for the plants they pot up and monitor growth, color, shape, water absorption, etc. Students label plants using the common & scientific name, as well as the drainage where the seed was collected. Use native plants reference guides to determine which plants to grow. The Santa Barbara Botanic Garden has many good references (682-4726).

Starting cuttings of natives in different soil/planting mediums. Cottonwood, willow, blackberry, elderberry, etc. Contact Urban Creeks Council for cuttings. Some cuttings can go directly into soil in containers and some cuttings go into an aerated water bath to stimulate root growth. Materials needed include more soil mix/dirt and some buckets/water holding devices.

4 Optional restoration project

Contact Urban Creeks Council for help on designing a project. Possible project could be restoration such as planting natives or removing non-natives. Possible student activities: weed removal, horsetail translocation, digging holes big enough for trees and picking up litter.

Closure

Quiz and/or assign a paper on definitions of key concepts such as native verses non-native plants, examples of native plants, and the importance of native habitat in creeks.

Assessment

Quiz and/or paper could be used to assess participation in this activity.

Key words (see Appendix B)

Native
Riparian

Correlation of Activity to California Content Standards

For a detailed reference to the standards, see Appendix D.

4th Grade: English- Writing Strategies, 1.2, a, b, c, d, e, 13, Writing Applications, 2.3, b Science- Life Sciences: 3 a, b. History- 4.1- 3, 5

5th Grade: English-Writing Strategies, 12, a, b, c, Writing Applications, 2.4 a, b, c, Written and Oral English Language, 14
Science- Investigation and Experimentation: 6 a

6th Grade: English- Writing Strategies, 12, a, b, c, Writing Applications, 2.2, a, b, c, d, Written and Oral English Language, 14

7th Grade: English- Writing Strategies, 12, Writing Applications, 2.3, b, Written and Oral English Language, 16

8th Grade: English- Writing Applications, 2.3, b, Written and Oral English Language, 15, 16
Don’t Let Your Pollution Leave Home

Summary
How pollutants find their way into the environment’s water system. Examples of point source and nonpoint source pollution are discussed, as well as how to prevent them.

Background
See Activity “Storm Drain Walk” in Section II and “Teacher Background” of Section III.

Objectives
Students will:
Understand the concept of point-source pollution and nonpoint source pollution.
Be able to identify possible sources of pollution, their affects on the environment, and how to reduce them.

Materials
• Task Card (included in Appendix F)

Management and Safety Considerations
Encourage students to work together in groups to come up with the answers.

Procedure
Distribute a Task Card to each group of 3-5 students. Define and discuss “storm drains” and “nonpoint source pollution,” and how substances we use at home can travel through the storm drain system and end up polluting lakes, streams, rivers, estuaries, bays, and the ocean.
Discuss why estuaries are particularly sensitive to pollution.
Challenge the students to find 10 potential causes of nonpoint source pollution on the Task Card and to trace the pollutants’ pathways onto the ground or into a waterway.
Refer to the answer key and discuss the 10 causes and 10 ways to prevent nonpoint source pollution.
For each case, ask the students what might be done to insure that no pollution would occur?

Closure
“To understand the potentially harmful effects of discarding pollutants onto the ground or into waterways it is necessary to understand the basic principles of the water cycle and especially to appreciate how water, moving in the cycle, can carry pollutants and be harmed by them. A series of “what might happen if...?” questions can help develop this understanding.

Assessment
Task Cards can provide assessment of students’ participation.

Key words (see Appendix B)
Estuary  Nonpoint Source Pollution  Point Source Pollution
### Answer Key

<table>
<thead>
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<th>CAUSE</th>
<th>PREVENTION</th>
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</thead>
<tbody>
<tr>
<td>1. Pouring oil down the storm drain</td>
<td>1. Recycle or take it to a hazardous waste disposal site.</td>
</tr>
<tr>
<td>2. Littering near a stream (or anywhere)</td>
<td>2. Throw trash in garbage cans.</td>
</tr>
<tr>
<td>3. Car leaking oil or radiator fluid onto driveway</td>
<td>3. Keep cars in good condition. Clean up leaks with absorbent material such as sawdust or hay.</td>
</tr>
<tr>
<td>4. Cleaning paint brushes on lawn</td>
<td>4. Clean brushes in a container, taking care not to spill solvent. Reuse solvent or take it to hazardous waste disposal.</td>
</tr>
<tr>
<td>5. Paint can spilling onto lawn</td>
<td>5. Take care not to spill paint on the lawn. It could soak into ground and water below.</td>
</tr>
<tr>
<td>6. Cleaning porch with chemical cleaners</td>
<td>6. Use only non-toxic cleansers out of doors, such as baking powder, borax or commercial cleaners labeled as environmentally safe.</td>
</tr>
<tr>
<td>7. Sprinkling water and pesticides on flowers</td>
<td>7. Use natural pesticides such as planting marigolds nearby, introducing ladybugs, or commercial products such as Safer.</td>
</tr>
<tr>
<td>8. Car cleanser spilling into street</td>
<td>8. Wash car with safe cleansers and take care not to spill undiluted product onto the ground.</td>
</tr>
<tr>
<td>9. Gasoline spilling on driveway</td>
<td>9. Take extra precautions not to spill hazardous products. If spills occur, clean up with absorbent materials such as sawdust or hay.</td>
</tr>
</tbody>
</table>

**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

**4th Grade:** Science – Investigation and Experimentation: 6 c
English – 10 Listening and Speaking Strategies, 11, 16

**5th Grade:** English - 10 Listening and Speaking Strategies, 15
Summary

The following activity highlights some of the pollution problems and the solutions that are important in our everyday lives, while promoting awareness of the effects of our actions on the environment.

Background

Many people are unaware that anything that enters the storm drains will flow directly into creeks, without treatment, and then flow to the ocean. Daily, many people contribute in small amounts to the pollution in our waterways. These small amounts of pollutants add up to become a large pollution problem in the County of Santa Barbara. Here are a few ways that residents contribute to nonpoint source pollution:

- Using excessive fertilizers, herbicides or pesticides on their landscaping.
- Not properly cleaning up after their dog.
- Having a car that leaks oil.
- Dumping green waste (i.e. lawn clippings pruned branches, etc.) on the sidewalks, in the gutter or creeks.
- Washing the car on the street, where the suds drain into the storm drains.
- Littering.

All these pollutants make their way from our backyards, sidewalks, and driveways to the storm drains, and end up in the Pacific Ocean. Stormwater pollution prevention can be simplified to these two tenets:

- Only let rain go down the storm drain: prevent pollution, toxins, and organic debris from entering the storm drain system.
- Catch the rain before it runs away: develop landscaping or other mechanisms to catch and use rain water in the yard or garden before it runs off into the storm drain system. Eliminate dry weather urban runoff.

Additionally, behaviors that reduce our use of natural resources and that reduce the amount of pollution we created are definitely beneficial to our environment! Reduce, reuse and recycle.

Note: It is recommended that you conduct Activity #4 in Section II, “Storm Drain Walk” prior to this activity.

Objective

Students will:
- Increase their awareness of storm water pollution problems.
- Increase their knowledge of storm water pollution prevention.
- Learn to use a scientific survey to quantitatively study urban storm water problems

Materials

- City Survey (included in Appendix F)
- Pencils

Management and Safety Considerations

Tell students to simply observe others actions, and not to directly speak to strangers.
**Procedure**

1. **Focus Attention**
   Ask students if they know why storm drains are there? Where the contents go after entering the storm drains? If they do not seem to know, explain in detail in front of the class. (Remind students of what they learned in the “Storm Drain Walk Activity.”) Or, if some students know, ask them to explain to the class. Then, ask students to list storm drain pollution problems and pollution solutions that they saw on their way to school, or within the past week.

   You may want to write some of the student answers on the board.

2. **City Survey**
   Hand out the *City Survey Activity* and explain that you will be doing a scientific survey of storm water pollution problems and pollution solutions. Review the work sheet directions and categories.

   Direct students to tally their observations as they walk or ride home from school or make observations throughout a day.

   Students should total the tallies for both the pollution problems and the pollution solutions and compare the totals.

3. **Class Discussion**
   Discuss the results of the *City Survey* in class.

**Closure**

Ask the students the following questions:
Were you surprised by what you observed?
Did you find more problems or more solutions?
Which types of problems and solutions were most common?
What conclusions can you make?

**Assessment**

*Fourth or fifth grade students:*
Have students write their interpretation of the City Survey, and write their own answers to the above questions.

*Fifth through eighth grade students:*
Have students write a three-paragraph essay incorporating their answers to the following questions:
What kinds of pollutants they observed and how each will effect the environment.
Discuss why they think people pollute. Is it just time consuming to be more careful? Do people not care about the environment?
What would happen if each person in their neighborhood were to do all the things in the pollution problem list?
What can they do to help the problem of water pollution in their neighborhood?

**Key Words** (see Appendix B)

- Storm drain
- Storm water

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**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

*4th Grade: English - Writing Strategies, 1.1, 1.2a, b, c, d, Writing Applications, 2.3 Science - Investigation and Experimentation, 6c*

*5th Grade: English - Writing Strategies, 1.1a, b, c, Writing Applications, 2.1a, b, Written and Oral English Language, 14. Science - Investigation and Experimentation, 6i*

*6th Grade: English - Writing Strategies, 12b, c, Writing Applications 2.2b, c, d. Written and Oral Language Conventions, 14. Science - Investigation and Experimentation, 7e*

*7th Grade: English - Writing Applications, 2.3b, c, Written and Oral Language Conventions, 16. Science - Investigation and Experimentation, 7c*

*8th Grade: English - Written and Oral English Language Conventions 16.*
The Watershed-Ocean Connection
Impacts on the Ocean

All South Coast watersheds drain to the Pacific Ocean; this section highlights that connection.
Teacher Background Information

The end point of a watershed is a body of water. On the South Coast of Santa Barbara County, this end point is the Pacific Ocean. All the water from the south side of the Santa Ynez Mountains flows over the land, into the creeks and into the ocean.

Each year, winter rains wash sand, mud and other debris into the Santa Barbara Channel. During the spring and summer tiny, single-celled plants, called phytoplankton, increase their populations dramatically and provide the primary energy source for the entire marine food web. This creates an alternating pattern of brown terrestrial sediments and green marine algae suspended in the surface waters of the Santa Barbara Channel and also in the sediments in the Santa Barbara Basin.

Knowledge of the composition, concentration, and origin of suspended and dissolved materials in the U.S. coastal ocean is critical for properly monitoring marine resources and evaluating the impact of human activities.

Class Presentations and Field Trips (refer to Appendix A)

South Coast Watershed Resource Center Field Trip
City and County of Santa Barbara Watershed In-Class Presentation
Plumes and Blooms

Summary

Introduction to the concept of seasonal plumes and blooms and the current research being conducted into understanding and monitoring these processes. Demonstrates how a sediment plume forms, where it goes, and how it is deposited on the sea floor.

Background

The UCSB Plumes and Blooms project is an ongoing investigation into the driving mechanisms and impacts of sediment plumes and phytoplankton (planktonic plant life) blooms in the Santa Barbara Channel. Sediment plumes happen when winter rains wash mud, sand, and other debris into the channel via creeks and storm drains. Phytoplankton blooms occur naturally in the channel every spring, when there are increased nutrient levels in the channel due to the sediment plumes, which causes green algal blooms. Sediment plumes and phytoplankton blooms are part of the physical and biological processes that have made the channel what it is today. They can have a profound effect on the marine life of the Santa Barbara Channel. By understanding the dynamics of these processes we can better understand the Channel's environment and the role we play in it as a community.

The alternating pattern of spring blooms and winter plumes produces a “tree ring” like structure in the Channel’s geologic record. This gives scientists the rare opportunity to examine the channel’s historical records and review important climatic changes and processes. The data can provide information on annual rainfall patterns and forest fire occurrences that have happened over hundreds and thousands of years. The Plumes and Blooms project also matches the physical data collected in the Channel to satellite images called seaWiFs (satellite images of ocean color). This gives scientists an opportunity to use satellite images of ocean color as an indicator of the physical conditions of water masses.

The Plumes and Blooms project research cruises are conducted twice monthly and involve collecting data at seven different locations known as stations. The seven plumes and blooms stations create a linear transect of the Santa Barbara Channel. Many scientific instruments are deployed at each station and a variety of seawater properties are measured. These properties include temperature, depth, salinity, silicate levels, chlorophyll levels, and turbidity. The data is then published via the Internet on the Plumes and Blooms website (http://www.icess.ucsb.edu/PnB/PnB.html). The goal of the plumes and blooms project is, “to understand the potential impacts of current storm runoff in the ocean, such as possible changes in light conditions for the subsurface plants and animals (plankton), the spread of terrestrial sediments and possibly human related pollution.” – Leal Mertes, UCSB scientist.

Objectives

Students will:
Learn about the Plumes and Blooms research project.
Learn the concept and causes of plumes and blooms in our local environment.
Be exposed to data from the project.
Learn more about human impacts on the ocean.

Materials

- A large, clear container, or a small aquarium.
- A bucket of sand, dirt, or potting soil.
- An egg crate or box that is about the same height as the aquarium.
Have students work in small groups at the computers.

Procedure

1. **Plumes and Blooms Discussion**
   
   Define plumes and blooms for students, and discuss the following:

   **Plume Discussion**
   
   Ask the students to think about what happens when it rains in the winter. Talk about the flow of water in the watershed and where the water ends up (creeks à the ocean).
   
   Direct the discussion toward water content and what materials might get mixed in with the water on its way down to the ocean. These materials can be soil from the area, fertilizers from the farms, pollution from industrial centers, or trash from State St. Use local map here to identify the 3 main creeks in Santa Barbara that drain into the ocean (Arroyo Burro, Mission, and Sycamore).
   
   Discuss how creeks, streams, and other geographic features are the sources of sediment plumes in the ocean. Talk about the winter rains causing plumes and of the process.

   **Bloom Discussion**
   
   Use the seasonality of plumes to segue into Phytoplankton blooms and their seasonal occurrence (spring/fall).
   
   Point out that, like land-based plants, many marine organisms also have a spring bloom period.
   
   Make the connection between sediment plumes and heightened nutrient levels in the ocean.
   
   Explain how higher nutrients allows for phytoplankton blooms.

   **Combination Discussion**
   
   Discuss what happens to these plumes and blooms after they have run their course. i.e. The plumes settle out of the water column onto the sea floor forming a layer of sediment. The blooms live out their life cycle and then settle onto the sea floor forming a layer of plant material in the sedimentary record. (This is how the tree ring like structure of the sedimentary record is formed)

2. **Demonstration (can be performed by students and/or teacher)**

   Fill aquarium or other large clear container half way with water.
   
   Place a box or egg crate next to it on a table. Make sure that whatever you use is about the same height as your container.
   
   Take your disposable bake pan or similar container. Cut out one side and fill with soil.
   
   Make sure water will flow easily from your pan to your container.
   
   Pour water into pan forming a small creek that should be rich in sediment.
   
   Watch sediment plume enter the aquarium. Point out the fact that it settles on the bottom of the tank.
   
   Sprinkle your colored rice on the surface of the water, this is your phytoplankton bloom.

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**Correlation of Activity to California Content Standards**

For a detailed reference to the standards, see Appendix D.

**4th Grade:**

- **English- Writing Strategies:** 1.5, 1.7, 1.9,
- **Writing Applications:** 2.4,
- **Written and Oral English Conventions:** 1.4
- **Science- Life Science:** 2: a, 3 a,b,d,
- **Investigation and experimentation:** 6: a,c,d,e,f

**5th Grade:**

- **English- Reading Comprehension:** 2.3, 2.4,
- **Writing Strategies:** 1.4,
- **Written and Oral English Conventions:** 1.4
- **Science- Earth Science:** 3: a,b,c,
- **Investigation and experimentation:** 6: b,c,f,g,h

**6th Grade:**

- **English- Reading Comprehension:** 2.1, 2.3, 2.4,
- **Written and Oral English Language Conventions:** 1.4
- **Science- Shaping the Earth’s Surface:** 2: b-d,
- **Ecology:** 5: b,e,
- **Investigation and Experimentation:** 7: b,f,g,h

**7th Grade:**

- **English- Reading Comprehension:** 2.3, 2.4,
- **Writing Strategies:** 14,
- **Written and Oral English Language Conventions:** 16
- **Science- Earth and Life history:** 4:a,b,
- **Investigation and Experimentation:** 7: a,b,c,d
Watch phytoplankton settle on bottom of aquarium.
Do this several times.
Note the layers that form on the bottom.

3 Online
Have students go online and explore both the teacher and student web sites. Website address:
www.cinms.nos.noaa.gov/pcw2/index.html

4 Website Worksheet
Give the students the website worksheet handouts and have students fill out top section of student worksheet, labeled “The Basics”.

5 Internet activity
Have students find more in depth information about the PnB project and the links that will get them started on the bottom part of the student activity sheet, labeled “The Project”.
Have student examine the discreet data sets from the PnB cruises that are posted on the site and use these to complete their worksheets.
Have students explore the Plumes and Blooms project website:
www.ices.ucsb.edu/PnB/PnB.html

Closure

Lower grades
- Primary worksheet
- Have students make independent observations on ocean conditions and what they might mean.

Upper grades
- Internet activity worksheets.

Assessment
Worksheet answers provide assessment of students’ knowledge.

Extension
To create your own personalized data set sets follow the instructions below:
Select a data set that you would like to work with.
Select Save as... in the File drop down menu.
Save the file in one of your folders or on a floppy disc.
Open the Microsoft Excel application.
Go to — > File and select Open
Open your file from its saved location.
The text import wizard will pop up and ask you to choose a file type.
Select the file type Fixed width and click the Next button.
Move down to where your actual data is and begin assigning columns to the data. Do this by
clicking in the areas between different parameters where the actual columns would be (denoted by solid black bars). Click finish. (HINT-It is easiest to denote columns only for the parameters that you want to compare.)

Now you have converted the cumbersome ASCII file into a usable Excel spreadsheet. Good work!

The next step is to clean up your data set. First, remove any rows that are unnecessary for your purposes. This will generally include the first 80 rows or so. These rows are not needed because they simply explanations of the parameters and their units.

You will also want to delete the ID # column (column A). This is done because the individual ID # have no significance other than identification of the bottle. You will also need to delete any rows that may follow your data set. Usually these are full of little squares that served as invisible place markers in the original ASCII file.

Now that your data is a little easier to work with you will want to add in the proper headers. They are already present in your excel workbook but by using the headers provided here they will be unaltered by the ASCII conversion and easier to work with.

Simply copy the header row in the provided excel file and paste it directly on top of the header row existing in your newly created file.

Now you are ready to plot your data!

**Key Words** (see Appendix B)

For a complete list of relevant key words visit the glossary section of the Plumes and Blooms website at www.cinms.nos.noaa.gov/pcw2/index.html.

<table>
<thead>
<tr>
<th>Algae</th>
<th>Dinoflagellates</th>
<th>Dinoflagellates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae Bloom</td>
<td>El Nino</td>
<td>El Nino</td>
</tr>
<tr>
<td><strong>Biogenic Silicone</strong></td>
<td><strong>Lithogenic Silicone</strong></td>
<td><strong>Lithogenic Silicone</strong></td>
</tr>
<tr>
<td>Coastal Upwelling</td>
<td>Lithosphere</td>
<td>Lithosphere</td>
</tr>
<tr>
<td>Core Cruise</td>
<td>Nitrogen</td>
<td>Nitrogen</td>
</tr>
<tr>
<td>CTD - (Conductivity, Temperature, Depth)</td>
<td>Phosphorous</td>
<td>Phosphorous</td>
</tr>
<tr>
<td>Diatoms</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1947 gmt, 04/17/1998
SeaWiFS Chl (mg/m^3)
Marine Debris

Summary

This activity focuses on the different types of marine debris and how they can affect the marine environment. Marine debris is a form of pollution.

Background

Our storm drains carry both debris and less “visible” pollution, such as bacteria, viruses, and toxins to the ocean. Most beach warning signs are posted after the ocean has tested high in bacterial levels. While bacterial levels are what we measure quantitatively as pollution, there are many other types of pollutants that are found in the ocean, such as debris and trash. This pollution is harmful to the environment and the creatures that live there. The amount of debris is astounding. Every year, millions of our taxpayer dollars are spent on beach cleaning. Even so, there is always more trash to clean up. What are the most common types of debris? Here’s the Dirty Dozen.

<table>
<thead>
<tr>
<th>The Dirty Dozen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marine debris collected by volunteers in Los Angeles County on Coastal Cleanup Day, 1997*</td>
</tr>
<tr>
<td>Type of debris collected</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>1. Cigarette butts</td>
</tr>
<tr>
<td>2. Foamed pieces</td>
</tr>
<tr>
<td>3. Plastic pieces</td>
</tr>
<tr>
<td>4. Straws</td>
</tr>
<tr>
<td>5. Paper pieces</td>
</tr>
<tr>
<td>6. Plastic food bags/wrappers</td>
</tr>
<tr>
<td>7. Plastic caps/lids</td>
</tr>
<tr>
<td>8. Glass pieces</td>
</tr>
<tr>
<td>9. Metal bottle caps</td>
</tr>
<tr>
<td>10. Other Plastic</td>
</tr>
<tr>
<td>11. Cups</td>
</tr>
<tr>
<td>12. Cups/utensils</td>
</tr>
</tbody>
</table>

Note: This data is a portion of the complete data set from the California Coastal Commission and the Center for Marine Conservation.

People do not realize that the one cigarette butt they add contributes to polluting the marine environment! Many think that their litter is small and will not have a large impact on the environment. While this may be true, the problem is that there are over six billion people on earth, and if everyone thinks in this way, there will be an incredible amount of pollution. Everyone contributes a little and this adds up to be a lot.

Impacts of Marine Debris

There are documented cases which prove that at least 267 different marine species are negatively affected by marine debris. Both entanglement and debris ingestion reports exist for many organisms including: pelicans, gulls, blue herons, ducks, loons, swans, squid, jellyfish, seastars, lobsters, shrimp, crabs, turtles, seals, sea lions, otters, baleen whales, dolphins, sharks, moray eels, and many other fishes.

**Entanglement:** Entanglement can limit an organism’s mobility, prevent it from eating, cause it to suffocate, and injure the organism leaving cuts and wounds. Often, entanglement leads to the death of the organism. Plastic is the most common cause of entanglement. Fishing line, plastic
bags, net fragments, six-pack rings, rope, and strapping bands from shipping crates are some of the most dangerous types of debris. Even mattresses, cardboard and tires have been involved in documented entanglements.

**Ingestion:** Ingestion of marine debris occurs when an animal mistakes the debris for food and eats it. The ingestion of something with no nutritional value is bad for the organism and can lead to strangulation or digestive disorders. Plastic pellets and small pieces of processed plastic are the debris items most often found in the stomachs of birds and fish. Plastic bags, balloons, and small plastic pieces are a dangerous problem for sea turtles, toothed whales, and ocean sunfish. Balloons are particularly a problem because they look like jellyfish, a favorite food of sea turtles.

**Objective**

Students will:
- Increase their knowledge of the negative impacts of marine debris on organisms.
- Increase their awareness of different types of ocean pollution.

**Materials**

- Marine Debris Word Search (see Appendix F)
- Pencils

**Procedure**

1. **Focus attention by asking the students:**
   - What types of pollution might they find on the beach or in the ocean? How might the pollution harm the organisms that live there?

2. **Class Discussion**
   - Discuss the problems of marine debris with your students (see background information). Emphasize how marine debris can harm organisms, and discuss the quantity of marine debris in our coastal environments. Discuss the meanings of the key words.

**Closure**

- How big is the problem of marine debris?
- What kinds of marine debris can cause entanglement?
- How can ingesting debris be a problem?
- Can you tell how clean water is by how it looks?

**Assessment**

**For fourth and fifth grade students:**
- From the perspective of their favorite marine creature, have your students write a letter to “Humans” about the harmful effects of marine pollution, and asking the “Humans” to stop polluting.

**For sixth through eighth grade students:**
- Write an essay (approximately one page in length) discussing the problem of pollution in the marine environment. Include answers to the following questions:
  - What are several pollutants found in the marine environment?
  - How do they contribute to the pollution problem?
  - What can the average person do to help stop this pollution?
  - What can you do as a student? Inform others? Change your habits?

**Key Words** (see Appendix B)
Appendices
Appendix A: In-Class Presentations and Field Trips
Appendix B: Glossary
Appendix C: Pollution Fact Sheet
Appendix D: California Standards Content Reference Guide
Appendix E: Additional Resources
Appendix F: Worksheets and Attachments to Activities
Appendix G: Evaluation Form
In-Class Presentations and Field Trips

City of Santa Barbara

- **Guided Tour of El Estero Wastewater Treatment Plant**
  
  **Description:** Students will learn what happens to water once it goes down the drain or the toilet and into the sewer system. Students will learn the key principles of wastewater treatment. This tour and presentation is fun and engaging. Some of the highlights include: a puzzle to show the “pieces” of the wastewater treatment process; a tour of the water quality lab with a demonstration of water quality tests; and seeing the end result of the treated wastewater and recycled water.

  **Grade Levels:** 3rd-12th grade.

  **Availability, Duration and Class size:** Monday-Friday 8am-3pm. One hour tour. Can accommodate 30 students.

  **Contact Information:** To set up a tour, call (805)897-1912. To set up a free bus service, call Alison Jordan at (805) 564-5574.

  **Correlation to Content Standards:**
  - 4th Grade: English - Listening & Speaking 1.1; 2.b. Science - ES5c, IE 6c.
  - 5th Grade: English - Listening & Speaking 11, 13; Science - ES 3b,c,d,e.
  - 7th Grade: English - Listening and Speaking 11, 13.

- **“The Story of Water” In-Class Presentation**

  **Program:** Water education presentation

  **Description:** This presentation includes colorful displays, photos, and hands-on activities to teach students about the water cycle, the local sources of our drinking water, and the importance of water conservation

  **Grade Level:** 4th - 8th

  **Availability, Duration and Fees:** Available Monday - Friday during school hours. Please call in advance for an appointment. The presentation lasts 60 minutes and is free of charge.

  **Contact Information:** Call Alison Jordan at (805) 564-5574 to schedule an appointment.

  **Correlation to Science Content Standards:**
  - 5th Grade: English Listening & Speaking 11, 13. Science - ES 3b,c,d,e.
  - 7th Grade: English - Listening & Speaking 11, 13.

City and County of Santa Barbara’s Watershed Education In-Class Presentations

- **Watershed Model Presentation**

  **Description:** An entertaining video with a talking “water drop” introduces the concept of a watershed. Then students “pollute” a watershed model and watch what happens to the creeks and ocean as it “rains”. Students will learn about local watersheds, ocean and creek water quality issues and ways to help keep the creeks and ocean clean through an interac-
tive discussion and working with the watershed model.

**Grade Level:** 3rd – 6th

**Availability, Duration and Fees:** Available Monday - Friday during school hours. Please call in advance for an appointment. The presentation and hands-on activity last 60 minutes. The program is free of charge.

**Contact Information:** Call Alison Jordan at (805) 564-5574 for an appointment, if you are located within the City of Santa Barbara. If you are located outside the City, within the County of Santa Barbara, call Darcy Aston at (805) 568-3546.

**Correlation to Science Content Standards:**
4th Grade: English - Listening & Speaking 1.1; 2.b. Science - ES5c, IE 6c.
5th Grade: English Listening & Speaking 11 13. Science - ES 3b,c,d,e.

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**Community Environmental Council**

The CEC also offers these other Green Schools Programs:
- Art From Scrap
- CEC Recycling Center
- Garden Education

**Creek Watchers Program**

**Classroom Presentation and/or Field Trip**

**Description:** Students use non-hazardous, basic test kits for hands-on water quality testing of local creek water. Take a walk down to a nearby creek or bring a bucket of creek water to the classroom. These simple kits are a fun, hands-on way to learn about creek water and what might be polluting it.

**Grade Levels:** 4-8th grade.

**Availability, Duration and Class size:** Monday-Friday during school hours; presentations range from one to two hours. Limit: one class at a time with up to 30 students.

**Contact Information:** Please call the Community Environmental Council (CEC), 963-0583 ext. 149, for more information about the Creek Watchers Program, or to schedule a presentation or training.

**Program Options:**

The Creek Watchers Program is flexible and offers several options for the structure of lessons. You can choose, for example, to have the Creek Watcher program coordinator come to your class for a presentation or you might decide you would rather go through a brief training and learn how to lead your students through an on-going monitoring program. The following program options are the most common but depending on your individual situation, we may be able to do a variation and or combination of one or more of the following. Call the CEC if you would like to discuss the program options further.

1. **In-Class Water Testing**

The Creek Watchers Program Coordinator will come to your class with a bucket of creek water from a nearby creek. Students will work in groups to test temperature, turbidity, dissolved oxygen, phosphate, nitrate, pH and bacteria (see the attached “Creek Watchers Data Form”) using basic water quality test kits. Each student has a testing “job” within the group and members work together to discuss results and record correct answers. Depending on time constraints and the age of the students, results from each group can be averaged to learn more about scientific methods.

2. **Creek Walk**

If your school is located near a creek or transportation to a nearby creek is possible, we can take the students on a walk to a creek. We will pick a location on the creek where they will gather information for a survey of the physical aspects of the creek. Students will become familiar with issues pertaining to land use, vegetation, erosion, habitat and more as they
relate to the creek. See they attached “Creek Watchers Data Form & Creek Survey” for an idea of what is covered during a creek walk.

3. **On-going Monitoring**

Go through a brief training with the Creek Watchers Program Coordinator (1-1½ hours) to learn how to use a basic water quality test kit. Work with the Program Coordinator to set up an on-going monitoring project on a creek near your school. Students use the kit to collect data from the creek once a month or on an on-going basis that works for your class. Data will be reported and included with other Creek Watchers data in a database that goes to the County Environmental Health Department. Kits are loaned to teachers as long as the class remains active with the program.

**Correlation to Science Content Standards:**
4th Grade: 2.b; 3.a,b,c,d; 5.a,c; 6.a,c,d,f.
5th Grade: 3.c,d,e; 4.c; 6.a,f,h;
6th Grade: 5.a,b,e; 7.a,b,d,e;
7th Grade: 7.a,c,e;
8th Grade: 5.d,e; 9.b,d

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### South Coast Watershed Resource Center

On-site field trips to the South Coast Watershed Resource Center, located at Arroyo Burro County Beach Park, allow students to view educational displays and participate in hands-on activities as they learn about creek, lagoon and beach ecology. Key features include an interpretive center, small wetlab, native botanical patio, Chumash tomol construction area, resource library, on-line computer stations, docent led beach and creek walks, and more. The resource library includes books, curriculum guides, videos, CD-ROM’s, and activity kits available to teachers and educators on a loan basis.

**Availability, Duration & Fees:** Tuesday-Friday, 10am-12noon. 1-2 hours. All programs are $25 per class (up to 33 students) per hour. A limited number of scholarships are available to qualifying schools.

**Contact Information:** Please contact the South Coast Watershed Resource Center for more information, hours of operation, program fees, or to schedule a field trip. Phone: 682-6113, fax 682-8113, or [www.watershedresourcecenter.org](http://www.watershedresourcecenter.org) online.

**Program Options:**

- **Our Backyard Watersheds Series**

  **Grade Levels and Size Limit:** 4-8th grade. Can accommodate 2 classes (60 total).

  **Program Description:** The series comprises four separate one-hour programs. It is recommended that you attend “Watershed Watchers” and then follow that with one of the other three programs which were designed to complement it. However, you may also choose to attend any combination of programs, up to two hours, or simply attend one of the one-hour long programs.

  1. **Watershed Watchers** [ideal for grades 4-8]

     Be part of the pollution solution by learning how native maritime cultures lived within their environment, how we impact our environment today, and how we can change our habits to reduce this impact. Activities include a mini beach clean-up, a coastal watershed model demonstration (point vs. nonpoint source pollution, impermeable vs. permeable surfaces, and storm drains vs. sewer systems), riparian roles (filtering ability, creek stability, and the problems with invasive and non-native vegetation), and more.

    **Correlation to Science Content Standards:** 4th Grade-6:c, 5th Grade-6:h, 6th Grade-4:a; 6:b; 7:b, 7th Grade-7:a.

  2. **Aquatic Ecosystems** [ideal for grades 4, 6]

     Discover the biodiversity of organisms found in and around Arroyo Burro Creek and
Lagoon, from phytoplankton to great blue herons and everything in-between. Students learn about the amazing adaptations of the organisms living in aquatic ecosystems, their place in the food web and the abiotic factors affecting their survival and success. Activities include a creek critter hunt (adaptations and lifecycles of macro- and microorganisms), bird studies (ID and adaptations), Steelhead Stories (adaptations and trials of the fish’s complex lifecycle), and more.

Correlation to Science Content Standards:
4th Grade: 2:b,c; 3:a,b; 6:c
6th Grade: 5:a,b,c,e; 7:b

3. Weathering Watersheds [ideal for grades 4, 6, 7]

Look for clues into the geologic history of our local watersheds. Find out how local geology, as well as human influences, have shaped the landscape through processes such as weathering, transport, and deposition. Search for fossils, discover the porosity and filtering ability of different soils, analyze sand samples, and more.

Correlation to Science Content Standards:
4th Grade: 5:c; 6:c
6th Grade: 2:a,b,c,
7th Grade: 4:a,c,e,f; 7:a.

4. What’s in the water? [ideal for grades 5, 8]

Explore the wonders of water, the hydrologic cycle and the types of pollutants entering our waterways and ocean. Activities include water quality monitoring, creek habitat assessment, water studies (water cycle and properties), and more. The hydrology measurements conducted on Arroyo Burro Creek will be entered into a database accessible on the World Wide Web, through the GLOBE program.

Correlation to Science Content Standards:
5th Grade: 2:f,g; 3:a,b,c,d,e; 6:b,f,h,
8th Grade: 8:a,c; 9:b,f.

Goleta Sanitary District Wastewater Treatment Plant
Classroom Presentation and Guided Tour

■ Classroom Presentation and Lab

Description: This interactive program includes a lecture and a hands-on lab. The lecture will teach students about the water cycle, the functions of the treatment plant and the language associated with sewage treatment. The interactive lab will teach students about microorganisms, pH and the different kinds of solids.

Grade Level: 4th

Availability, Duration and Class size: Tuesday-Thursday, during school hours. 1 hour lecture and 1 hour lab. Class size can vary.

Contact Information: To schedule a presentation call (805) 967-4519.

Correlation to Science Content Standards:
4th Grade: English: Listening and Speaking 11
5th Grade: Science: Earth Science, 3d,e; English: Listening and Speaking 11, 13
7th Grade: English: Listening and Speaking 11

■ Guided Tour of Treatment Plant

Description: Students will learn what happens to water once it goes down the drain or the toilet. Students will learn that the end result is clean water that is recycled or sent to the ocean.

Availability, Duration and Class Size: Monday - Friday, during school hours.
Appendix A

In-Class Presentations and Field Trips

Growing Solutions Restoration Education Institute

Field Trip

Description: Restoration topics discussed by instructor(s) on any given field trip may include soils, integrated pest management, nutrients & fertilizers, weed invasion & control, mulching, watering, landscape benefits, human uses, native plant propagation techniques, and project background.

Grade Level: all

Availability, Duration and Class Size: Monday – Friday, during school hours. Growing Solutions offers lessons for students of all ages and abilities. One time field trips, or custom lesson plans are available. All fees for lessons are negotiable. Fees may be waived when applicable.

Contact Information: To set up a field trip, call 452-7561 or e-mail growingolutions@wavecrazy.com, attention Stephanie Langsdorf or Karen Booker.

Program Options:

1. Greenhouse Native Plant Lesson(s)
   This will include working with native plant propagation, transplanting, and seed sowing in a greenhouse setting at the Santa Barbara High School Greenhouse or the Isla Vista Lathhouse. Activities for a group or class include a) transplanting native restoration plants into larger container pots, b) sowing seeds in a seed flat or other planting container, c) propagating native plant cuttings, or d) dividing root sprouts/rhyzomous native plant.

2. Hands-on Restoration In the Field
   This will include working on a real life restoration project where Growing Solutions has an active contract. Activities include a) planting native plants, b) identifying native and non-native vegetation, c) removal of non-native vegetation, d) seed collection, and e) cutting collection. The activity that the class will participate in on these "hands-on" field trips are dependent upon the time of year (ie: seasonal) and site locations are dependent upon active projects.

Correlation to Science Content Standards:

- 4th Grade: Science: Life Science 2a, 3a,b; English: Listening and Speaking 11
- 5th Grade: Science: Earth Sciences 3d, Linvestigation and Experimentaiton 6a; English: Listening and Speaking 11, 13
- 6th Grade: Science: Ecology 5c,d,e
- 7th Grade: English: Listening and Speaking 11, 13

Santa Barbara Botanic Garden

Hikin’ Through Happennin’ Habitats

Description: Plants live in communities or habitats and, like humans, share special features and adaptations that enable them to thrive in their particular environment. On this tour, students learn how patterns in the plant world offer vital clues about groupings of plants and how plants are able to meet the challenges provided by their local habitat.
Grade Levels and Size Limit: 4-6th grade. Up to 30 students for each tour.

Availability, Duration, Fee: Tuesday, Wednesday, and Thursday mornings, 9:30 and 11:00 am; occasional afternoons at 1:00 pm. One hour program. $10 per class up to 30 students for each tour. They begin to take appointments for tours the last week of August, and are typically booked full through June, by mid September. Plan early!!

Contact Information: SBBG School Program Coordinator, 805-682-4726 ext. 102, Monday through Friday.

Correlation to Science Content Standards:
4th Grade: Science: Life Science 3a,b; English: Listening and Speaking 11
5th Grade: Science: Life Science 2f, Investigation and Experimentation 6a; English: Listening and Speaking 11, 13
6th Grade: Science: Ecology 5c,d,e
7th Grade: English: Listening and Speaking 11

Santa Barbara Museum of Natural History

Mission Creek Nature Trail

Description: Have fun with your students exploring our new Mission Creek Nature Trail. Originally established in 1950 to honor the memory of Museum neighbor and benefactor Caroline Hazard, this newly installed outdoor exhibit focuses on the oak woodland, riparian woodland, and streamside habitats on our extensive grounds. Interpretive signs along the trail introduce key ecological concepts, highlight seasonal changes, and encourage appreciation and conservation of our precious natural resources. A special feature of the trail is a garden of plants important to Chumash culture.

Grade Levels and Size Limit: all

Availability, Duration, Fee: Monday 9am-5pm, Tuesday-Friday 9am-10am, 12pm-5pm. $1.50/person (1 free adult with every 5 students). A group discount rate is available to all groups making an advance reservation. Payment is due upon arrival. Call in advance to make an appointment.

Contact Information: Downloadable reservation form at: www.sbnature.org. Reserve your date(s) with the School Services Office by 1) fax: SBMNH School Services (805) 569-3170, 2) phone: (805) 682-4711, ext. 315, 3) Email: schools@sbnature2.org, 4) mail: SBMNH School Services, 2559 Puesta del Sol Road, Santa Barbara, CA 93105.

Correlation to Science Content Standards:
4th Grade: Science: Life Science 3a,b; English: Listening and Speaking 11
5th Grade: Science: Life Science 2f, Investigation and Experimentation 6a; English: Listening and Speaking 11, 13
6th Grade: Science: Ecology 5c,d,e
7th Grade: English: Listening and Speaking 11

Local Water Agencies’ In-Class Presentations

For information on your local water agency's water education program, call Rory Lang, Santa Barbara County Water Agency, at 568-3545. If your school is in the City of Santa Barbara, see the City of Santa Barbara’s “The Story of Water” Presentation, above.
**Advisory** - a report giving information on beach contamination status and often recommending action to be taken.

**Algae** - Plant like marine organisms that range in size from microscopic phytoplankton to the giant kelp that can be found washed ashore on our beaches. Algae contains chlorophyll, the same pigment used by land plants to perform photosynthesis.

**Algae Bloom** - A bloom, or rapid growth, of phytoplankton in the upper layers of the ocean, often due to an influx of nutrients, such as a sediment plume or seasonal upwelling.

**Aquifer** - water bearing layer of the earth’s crust.

**Area** - A portion of space on a surface.

**Bacteria** - prokaryotic unicellular round, spiral, or rod-shaped single-celled microorganisms that live in soil, water, organic matter, or the bodies of plants and animals (singular bacterium.)

**Best Management Practice** - an engineered structure or management activity, or combination of these, that eliminates or reduces an adverse environmental effect of a pollutant.

**Biogenic Silicone** - Silicone that has its origins in the shell structures of living organisms.

**Canopy** - The uppermost spreading branchy layer of vegetation.

**Catch Basin** - an opening on the side of street which is the entrance to the storm drain.

**Coastal Upwelling** - An ocean process that occurs most notably on the western coasts of continents when cold nutrient rich bottom water flows to the surface along the continental coastlines. Upwelling is strong in California and Chile where it is closely linked to the fishing industry. Coastal upwelling is greatly reduced during El Niño events.

**Coliform Bacteria** - Many strains of coliform bacteria are naturally present in our environment. Fecal coliform bacteria are present in the feces of humans and other warm-blooded animals but are rare or absent in unpolluted waters. Fecal coliform bacteria should not be found in sources of drinking water. Their presence in water serves as a reliable indication of contamination from human sewage or animal droppings. Although coliform bacteria themselves are not pathogenic, they occur with intestinal pathogens that are dangerous to human health.

**Condensation** - the change of vapor or gas to a liquid, usually by contact with cold.

**Core Cruise** - One of the regular bi-monthly research cruises conducted in the CINMS. The cruise involves a transect of seven sample stations in the Santa Barbara Channel beginning at Santa Barbara harbor and continuing across the channel to San Miguel Island.

**Creek** - A stream that is smaller than a river and larger than a brook.

**CTD** - (Conductivity, Temperature, Depth) Common name referring to a scientific instrument that records ocean salinity, temperature, and depth. This instrument can also record a host of other parameters such as nutrient levels and chlorophyll concentrations.

**Detention Basin** - reservoir designed to slow the rate of flow in an open drainage facility.

**Diatoms** - Diatoms are unicellular algae generally placed in the family Bacillariophyceae. The cell walls of these organisms are made of silica, and the varied shapes and beautiful ornamentation of these walls made the study of the diatoms and related siliceous organisms a favored pursuit of the early oceanographers. The cell wall is one of the major reasons why these algae are today a favorite organism of study, because the fossils are often well preserved in sediments of lake and marine systems.

**Dinoflagellates** - Any of an order (Dinoflagellata) of chiefly marine, planktonic, usually solitary phytoflagellates (which have many characteristics in common with algae) These organisms are important in marine food chains, and cause red tides.

**Dissolved Oxygen (DO)** - Dissolved Oxygen is important to the health of aquatic ecosystems. All aquatic animals need oxygen to survive. Natural waters with consistently high dissolved
oxygen levels are most likely healthy and stable environments, and are capable of supporting a diversity of aquatic organisms. Natural and human-induced changes to the aquatic environment can affect the availability of dissolved oxygen.

**El Niño** - El Niño is a phenomenon that occurs at irregular intervals and stays for an unspecified period of time. During an El Niño, the normally gusty trade winds along the equator in the Pacific fade. As the winds fade, a huge pool of warm water off the coast of Indonesia begins to flows eastward toward the Americas. This warm water heats and adds moisture to the air above it. This in turn alters storm tracks that blow across the United States and the world.

**Erosion** - the natural or human induced process of top soil being worn away.

**Estuary** - body of water at the lower end of a river which is connected to the ocean and semi-enclosed by land. In an estuary, sea water is measurably diluted by freshwater from the land.

**Eutrophication** - Too many nutrients entering an ecosystem (nutrient loading) can cause large algal blooms or other growth spurts followed by natural die-off and decay which results in a decreased amount of oxygen available. This can lead to a dangerous cycle of die-offs, which use oxygen in the decay process leading to more die-offs due to low oxygen levels.

**Evaporation** - the change of liquid to a vapor or gas, usually by contact with heat

**Flood Control Channel** - open waterway that is designed to carry large amounts of rain water. These structures are often lined with concrete to help control flood waters.

**Fumigation** - The spreading of pesticide to kill unwanted creatures.

**Geological Maps** - Maps which show boundaries of countries, cities, and roads.

**Groundwater** - subterranean water that supplies wells and springs.

**Gutter** - area formed by the curb and the street to prevent flooding by channeling runoff to storm drains.

**Habitat** - The area or environment in which an organism lives.

**Hydrology** - the scientific study of the properties, distribution and effects of water in the atmosphere, on the earth’s surface and in soil and rocks.

**Impervious Surface** - paved surface or other land cover that does not allow water to percolate into the ground.

**Invasive species** - Non-native plants and animal species; plants and animal species that have been introduced to an area where they do not occur naturally.

**Lithogenic Silicone** - Silicone that originates from terrestrial sources of rock and soil.

**Lithosphere** - The upper most layer of the earth’s crust.

**Maps** - Representation on a flat surface (paper, plastic) of Earth or any part of it. Maps can also represent your hand or the sky.

**Marine Debris** - the human litter that is found in the marine environment.

**Microorganism** - an organism of microscopic or ultramicroscopic size.

**Molecules** - The smallest unit of matter which holds its characteristics.

**Native** - growing, living or produced originally in a certain place; indigenous.

**Native species** - Plants and animal species that have evolved in a specific area over a period of time; naturally occurring species; indigenous.

**Nitrate** - Nitrate is a nutrient needed by all aquatic plants and animals to build protein. The decomposition of dead plants and animals and the excretions of living animals release nitrate into the aquatic system. Excess nutrients, like nitrate, increase plant growth and decay, promote bacterial decomposition, and therefore decrease the amount of oxygen available in the water. Sewage is the main source of excess nitrate added to natural waters, while fertilizer and agricultural runoff also contribute to high levels of nitrate.

**Nitrogen** - Nitrogen is the most abundant element in our atmosphere. It is a vital element that is essential to living ecosystems. Nitrogen is a primary nutrient for all green plants.
**Non-native Vegetation** - Plants that are not native to the local area. These plants are often invasive and compete with or replace native vegetation. This can affect habitat and food supply for native animal species.

**Nonpoint Source Pollution** - pollution which does not come from a single, identifiable point but from many diffuse sources that are spread out and difficult to identify and control. Examples of nonpoint source pollution are pesticides, pet waste, motor oil and trash.

**Outfall** - opening at the end of a storm drain system that allows water to flow into a channel, lake, river, bay or ocean.

**Pathogen** - a specific causative agent (as a bacterium or virus) of disease.

**Percolate** - to ooze or trickle through a permeable substance; infiltrate.

**Percolation** - process where surface waters are absorbed through the soil into ground water.

**pH** - a measurement of the acidic or basic (alkaline) quality of a substance. The pH scale ranges from a value of 0 (very acidic) to 14 (very basic), with 7 being neutral. The pH of surface water is usually between 6.5 and 8.2. In Santa Barbara, the pH of most surface water is higher than 8. Most aquatic organisms are adapted to a specific pH level and may die if the pH of the water changes even slightly.

**Phosphate** - a nutrient needed for plant and animal growth and is also a fundamental element in metabolic reactions. High levels of this nutrient can lead to overgrowth of plants, increased bacterial activity, and decreased dissolved oxygen levels.

Phosphate comes from several sources including human and animal waste, industrial pollution, and agricultural runoff.

**Phosphorous** - the eleventh-most abundant mineral in the earth’s crust and does not exist in a gaseous state. It is an essential nutrient for all life forms. Phosphorus plays a role in DNA (deoxyribonucleic acid), the basic building block of life. Phosphorus in freshwater and marine systems exists in either a particulate phase (found in sediment plumes) or a dissolved phase (mixed in with the seawater).

**Phytoplankton** - Microscopic marine plants that live in the upper layer of the world’s oceans and float freely in the water column.

**Plankton** - A general term for the entire community of microscopic free-floating organisms, including phytoplankton, zooplankton, and a host of other marine organisms. Plankton serves as the primary food source for most marine ecosystems. Many animals like the blue whale feed entirely on planktonic organisms.

**Point Source Pollution** - pollution from a single identifiable source.

**Pollutants** - any substance, biological or chemical, in which an identified excess is known to be harmful to desirable organisms (both plants and animals). Some pollutants are toxic or poisonous. Others are dangerous because they stick to feathers (oil and tar) making it impossible for birds to fly or find food, or clog throats and stomachs, and entangle necks (plastic bags and strips) of marine creatures.

**Pollution** - a human or naturally caused change in physical, chemical, or biological conditions that results in an undesirable effect on the environment; contamination of air, soil, or water by the discharge of harmful substances.

**Precipitation** - the fall of condensed moisture as rain, snow, hail or sleet.

**Relief Maps** - maps which show depth in real three-dimensional structures.

**Responsibility** - the moral liability to carry out a duty. We, as the technologically most advanced creatures on this planet are responsible for not polluting the environment. If we do, we will all suffer from pollution damage and disease.

**Riparian** - Referring to the riverside or riverine environment next to the stream channel, e.g. riparian, or streamside, vegetation; of, on, or relating to the bank of a natural course of water.

**Riparian Vegetation** - plants normally found along the banks and beds of streams, creeks, and rivers. “Riparian vegetation” includes understory, ground cover, and wetland plants, not just trees.
Runoff – water that flows over land surfaces and does not percolate into the ground.

Runoff Pollution – (also stormwater, urban runoff, and storm drain pollution) rain and water from irrigation, garden hoses, or other activities that washes pollutants off of streets, parking lots, yards, and landscapes and into the storm drain system.

Sediment – particles of matter that enter the water cycle. They are produced by the action of weathering and erosion.

Sediment Plume – a cloud of sediment that occurs when heavy rains or floods wash large amounts of sediment into the ocean. Visible from the air, apparent in satellite images and CTD data.

Sewer System – (also known as a wastewater collection system) the system of pipes and pump stations that transports wastewater (sewer) from homes and businesses to the wastewater treatment plant.

Source Control – action to prevent pollution at its origin.

Storm drain – a pipe that travels from the catch basin to the creeks and ocean.

Storm Drain Catch Basin – (also drop inlet, drain inlet) grated or unguarded opening in or at the side of the curb or gutter into which runoff flows.

Storm Drain System – a system which includes grates, gutters, underground pipes, creeks or open channels designed to transport rain from developed areas to a receiving body of water.

Storm Water – runoff in the storm drain system.

Stream – (also arroyo, barranca, creek) small natural waterway originating from underground springs, snow melt, runoff, or other natural sources which drains to lakes, rivers, channels or oceans.

Surface Water – water found on the surface of the land.

Three-dimensional Maps – maps which use colors to represent three dimensionality of the earth’s surface.

Topographical Maps – maps that describe high and low areas on earth by thin lines labeled with elevation numbers.

Transpiration – the exchange of water from plants and trees to the atmosphere.

Turbidity – the measure of the relative clarity of water. Turbid water is caused by suspended and colloidal matter such as clay, silt, organic and inorganic matter, and microscopic organisms. Turbidity should not be confused with color, since darkly colored water can still be clear and not turbid. Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances which can be caused by boat traffic and abundant bottom feeders.

Understory – the underlying layer of vegetation between the canopy and the ground.

Virus – any of a large group of submicroscopic infective agents that are regarded either as extremely simple microorganisms or as extremely complex molecules that are capable of growth and multiplication only in living cells, and that cause various important diseases in humans, lower animals, or plants.

Volume – the amount of space occupied by a three-dimensional object or region of space.

Wastewater (Sewage) Treatment Plant – (also known as a sewage treatment plant) - a series of tanks and other structures where the sand, dirt, nutrients, and other pollutants are removed from wastewater. The wastewater is cleaned by first allowing heavy materials to settle out of the water and then adding microorganisms that eat the nutrients in the wastewater.

Watercourse – a natural or artificial channel through which water flows.

Watershed – geographic area of land from which all runoff drains into a single waterway (ocean or lake); a gathering place for water.

Water Table – the level below that the ground is saturated with water.

Weight – The measure of the heaviness of an object.

Zooplankton – Small, free floating marine organisms that live in the world’s oceans and drift with the currents.
# Pollution Fact Sheet

<table>
<thead>
<tr>
<th>Pollutant:</th>
<th>Nutrients</th>
<th>Sediment</th>
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</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>A nutritive substance that fosters growth, especially compounds that contain nitrogen, phosphorus and potassium. Examples of these types of compounds are fertilizers and detergents.</td>
<td>Particles of soil, which often settle to the bottom of liquids.</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>Fertilizers; greenwaste; detergents from such practices as car washing, dumping of janitorial wastewater, or failing septic/sewer systems.</td>
<td>Land erosion, mostly during rain events from poorly protected construction sites, exposed landscape areas and gardens, and areas where runoff is channeled and scour exposed soils, such as at the mouth of storm drains. In addition, sediments also come from natural erosive processes.</td>
</tr>
<tr>
<td><strong>Affects</strong></td>
<td>Eutrophication: enrichment of a body of water in dissolved nutrients that stimulate growth of aquatic life. These &quot;blooms&quot; eventually die and decompose, consuming the available oxygen and creating toxic aquatic conditions. This causes some plant species to flourish while others die and the ultimate result is an imbalance in the native flora and fauna. Non-native species may replace a wide variety of native species killed by eutrophication. Thus reducing the variety and health of the ecosystem.</td>
<td>Covers and clogs feeding and spawning areas for aquatic animals, interferes with aquatic organisms respiratory functions, increases water temperature, decreases the amount of transmitted light thus decreasing the primary productivity of aquatic plants and phytoplankton, and increases the flooding risk.</td>
</tr>
<tr>
<td><strong>Alternatives</strong></td>
<td>Use organic methods: minimize the use of pesticides, herbicides or fertilizers. Compost or properly dispose of yard waste. Ensure that your septic or sewer system is properly working. Finally, when washing your car, try to keep soapy water out of storm drains or take your car to a car washing facility where the wastewater is transported to a sewage treatment plant. Never pour wastewater into the gutter.</td>
<td>To decrease risk of erosion, keep soil areas properly vegetated. Also, be sure not to sweep soil into storm drains.</td>
</tr>
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## Appendix C
### Pollution Facts

<table>
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<tr>
<th>Pollutant:</th>
<th>Metals</th>
<th>Oxygen-Demanding Substances</th>
<th>Oil, Grease, Petroleum, Hydrocarbons and Synthetic Organics</th>
<th>Pathogens</th>
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</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
<td>Fusible, ductile and typically lustrous substances that are good conductors of electricity and heat. Problematic metals in local waterways include chromium, copper, lead and zinc.</td>
<td>Organic compounds that are decomposed by microorganisms, which in turn require oxygen for their work.</td>
<td>Organic compounds that are not easily degraded by organisms.</td>
<td>Disease-causing organisms that affect human health.</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td>Mostly associated with motor vehicles, including direct atmospheric deposition from exhaust emissions, dripping or improperly transferred oil and lubricants, tire wear, brake lining wear and degradation of highway pavement material. Some may occur naturally from the parent soil material.</td>
<td>Greenwaste, litter and garbage, leaking garbage bins, improperly discarded wash water and improperly disposed of food waste.</td>
<td>Often found in components of oils and greases from vehicles and motor equipment as well as in gasoline, synthetic detergents, pesticides (including herbicides), wood preservatives and certain industrial products.</td>
<td>The primary source is fecal matter from infectious humans. Pathogens can enter creeks through failing septic/sewer lines or where people defecate directly in or near creeks. Some less common pathogens are transmitted through the feces of other animals including birds, rodents, deer, dogs, raccoons, etc.</td>
</tr>
<tr>
<td><strong>Affects</strong></td>
<td>Generally accumulate in bottom sediments and adversely affect benthic (residing at the bottom of a body of water) organisms. They can also bioaccumulate (magnify as it goes up the food chain) in animal tissue and result in chronic toxic effects for aquatic species and animals (like humans) that eat them. In high enough concentrations, dissolved metals can be immediately toxic to aquatic organisms.</td>
<td>If too many of these compounds are present, available oxygen will be consumed and anaerobic (oxygen deficient) conditions will occur. Anaerobic conditions can produce bad odors and choke organisms that require the oxygen. Effect can be worsened with increased temperatures and excessive nutrients.</td>
<td>Many are toxic to fish and aquatic organisms, causing both acute and chronic toxic effects. They may inhibit reproduction, respiration and development of tissue. Additionally, many are mutagenic (cause relatively permanent change in hereditary materials), carcinogenic and can persist and bioaccumulate.</td>
<td>Can cause many sorts of illnesses and discomfort, ranging from minor skin infections, to ear aches, pink-eye and gastrointestinal infections.</td>
</tr>
<tr>
<td><strong>Alternatives</strong></td>
<td>As often as possible, choose not to drive; instead, utilize public transportation or walk or bike to your destinations. Be sure to fix car leaks and always properly dispose of hazardous materials from cars (i.e. oil, brake or transmission fluid etc.) These materials can be disposed of at designated automobile service centers or at the Community Hazardous Waste Collection Center.</td>
<td>Always properly dispose of yard waste, compost if possible. Pick up and recycle or properly dispose of all waste.</td>
<td>Reduce use of all chemicals, including pesticides and detergents. Drive private vehicles less and utilize public transportation. If you must drive, ensure that your car is not leaking any hazardous fluids and always properly dispose of hazardous materials from cars at the Community Hazardous Waste Collection Center.</td>
<td>Be sure to always use toilet facilities or properly bury waste. Ensure that septic or sewer systems are functioning correctly. Pick up after your pets.</td>
</tr>
</tbody>
</table>
# California Content Standards

## Correlation of Mountains to Sea Activities by Grade

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<th>Activity Title</th>
<th>Pg. #</th>
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<th>Science</th>
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<td>I 1</td>
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<td>LC1.1, LS1.1, 2.2b</td>
<td>IE6.c</td>
</tr>
<tr>
<td>II 1</td>
<td>What Is A Watershed?</td>
<td>14</td>
<td>LC1.1, LS1.1</td>
<td>IE6.c</td>
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<td>II 2</td>
<td>Soak It Up!</td>
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<td>Here You are in the Environment</td>
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<td>IE6.c</td>
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<td>II 4</td>
<td>Storm Drain Walk</td>
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<td>LS1.1, 1.2, 1.4</td>
<td>IE6c</td>
</tr>
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<td>BL2a,b, BL3a,b, ES5a,c, IE6d,f</td>
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<td>LS 1.1, 1.6, 1.7, 1.8</td>
<td>ES 5a, IE 6c, e, f</td>
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<td>38</td>
<td>LS 1.1</td>
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<td>LS 1.1</td>
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<td>Don't Let Your Pollution Leave Home</td>
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<td>V 1</td>
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<td>W1.1a-c, 1.6; LC1.1, 1.2, 1.3, 1.4, 1.5; LS1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 2.2a-c</td>
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<td>W1.2a,b,c, 2.4a,b,c; LC1.4</td>
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Additional Resources

Project WET Activities Related To Watershed Education:

Available from the Project WET Curriculum and Activity Guide;

The Incredible Journey
  Shows the journey water molecules take through the water cycle.

Color Me a Watershed
  Relates how watersheds have changed over time due to human activities and different types of land-uses.

Just Passing Through
  Shows how water moves differently on barren slopes versus vegetated slopes.

For information on Project WET training workshops, call Darcy Aston at (805) 568-3546.

Project Wild Activities related to watershed education:

Oceans – Making Waves
To purchase, contact www.duke.edu/web/pwild

Bird Refuge:

Offers a Bird Refuge Curriculum Binder focusing on the study and discovery of a local natural ecosystem at the Andre Clark Bird Refuge.

For a copy of the curriculum, or for more information, contact Jim Rita at 897-1941 or Alyson Biskner at 897-1976.

CASEC materials related to watershed education:

Creek Watchers - Exploring the World of Creeks and Streams
Wetlands Protectors - Guarding Our Wild & Watery Lands
Water Inspectors - Examining H2O
Plastic Eliminators - Protecting California Shorelines
Fresh Water Guardians - Defending Our Precious Supply

To purchase CASEC materials, contact:
California Aquatic Science Education Consortium
(530) 752-8824
casec@ucdavis.edu
Related Websites

Santa Barbara Water Education Homepage
http://www.sbwater.org

Adopt-A-Watershed Partners and Sponsors
http://www.adopt-a-watershed.org/mainbuttons/partners.htm

American Water Resources Association
http://www.awra.org/

Audubon’s Birds of America
http://employeeweb.myxa.com/rrb/Audubon/

City of Los Angeles Stormwater Management Program
http://www.cityofla.org/SAN/swmd/index.htm

EARTH’S 911
http://www.3800cleanup.org/KidsSection/kidspage.htm

EPA’s Surf Your Watershed
http://www.epa.gov/surf2/

Flora of North America
http://www.fna.org/FNA/Portal/Volumes/

Global Learning and Observations to Benefit the Environment (GLOBE)
http://www.globe.gov/
http://www.globe.gov/sda-bin/wt?gdp=rgp+L(en) (Teacher Guide)
http://www.globe.gov/sda-bin/wt/gdp/tg+L=en+P(hydrology/ModelYourWatershed)

GREEN (Global Rivers Environmental Education Network)
http://www.econet.org/green/

National Watershed Network
http://www.ctic.purdue.edu/watershed/US_watersheds_8digit.html

Watershed Links Sharing
http://idea.uml.edu/watershed/links.html

USGS Water Resources Information
http://waterdata.usgs.gov/nwis-w/CA/search.components/textsearch.cgi?mode=basin

Water Education Foundation
http://www.water-ed.org/

Watershed Programs

Project Clean Water
http://www.sbcphd.org/cleanwater

River of Words
http://www.irn.org/row

Seawif images
www.icess.ucsb.edu/PnB/sw_avhrr.html

PCW home page
www.county of sb.org/project_cleanwater/

Plumes and Blooms home page
www.icess.ucsb.edu/PnB/

Clean Water Action Plan
www.cleanwater.gov

CINMS home page
www.cinms.nos.noaa.gov

PCW curriculum page
www.cinms.nos.noaa.gov/pcwcurric.stm
Supplemental Worksheets and Handouts

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Evaluation Form

Let us know what you think! Please answer the following questions and return in the self-addressed, stamped envelope attached. Your assistance is greatly appreciated!

- Did you use the Mountains to Sea Watershed Curriculum?

- Which activities did you use?

- Did you use the activities in the order presented in the curriculum? In what order would you suggest presenting the activities?

- Did you use these activities in their entirety, or to supplement pre-existing lessons?

- What material did you add to the activities?
- Which activities worked best? Why?

- Did any activities not work? Why?

- What activities will you use in the future?

- Please add other comments or suggestions for improvement of the curriculum.