Water

"All the rivers run into the sea; yet the sea is not full; unto the place from whence the rivers come, thither they return again."
—Ecclesiastes 1:7

Introduction

Junior Rangers may be surprised to learn how much water our bodies and our planet contain. The survival of human beings, animals, and plants depends on having an adequate supply of clean water.

Although 75 percent of the earth is covered with water, 97 percent of that water is found in the oceans and is too salty for us to use. Of the three percent that is fresh water, only one-third is accessible. Junior Rangers often don't realize that the supply of water—especially in California—is limited. One of the goals of this section is to teach Junior Rangers how important it is that we conserve water and keep our waters from becoming polluted.

The sample program covers the many ways we use water, the water cycle, the importance of water, pollution issues, and conservation. Depending on the location of your park, you may also want to discuss specifics of water safety, wetlands, oceans, or other relevant topics.

Interesting Water Facts

- Water makes up 75 percent of our bodies.
- We could live two months without food, but only a week without water.
- Water is the only mineral that can be found in all three states (solid, liquid, gas) on earth.
- A leaky faucet may drip enough water in one day to fill six bathtubs.

- In a normal year, about 247 cubic kilometers of snow and rain fall on our state. This is enough to cover all of California with about 23.6 inches (60 centimeters) of water.
- Due to global warming the sea level along California's coast has risen four to eight inches over the past century. It is likely to rise an additional 13 to 19 inches by 2100.

Sample Programs: Water

Water

I. Introduction
   Introduce yourself to the group.
   Introduce the Junior Ranger Program.

II. Focus
   Did you know that if you were to look at Earth from way up in space you wouldn't be able to see people, cars, or even buildings, but you would see water? That's because 75 percent of the earth's surface is covered with water. Earth's great oceans are one of the features that distinguish Earth from any other planet in the solar system.

III. Objectives
   By the end of this program, you will have learned how the water cycle works and why we must make sure that we have enough clean water.

IV. Inquiry/Discussion
   A. Water and People
      1. How much of your body is made up of water?
         75 percent
      2. Have you used water today? If so, how?
         Washed hair, brushed teeth, drank a glass of water, etc.
      3. Go to a water source in your park, or a water treatment plant.
      4. Can you think of some other things we use water for besides drinking and washing?
         a. Food: Water is in everything that we eat, and to grow our food requires a lot of water.
         b. Transportation: Boats have always been used for transporting people and goods over water.
         c. Energy: We can use water held behind dams and water in steam generators to produce electricity (hydroelectric power).
         d. Recreation: At beaches, lakes, and rivers we relax, enjoy fishing, swimming, water skiing, boating, and other fun water activities.

5. If you have old flumes, wells, or ditches in your park, talk about the historic uses of water.

B. The Forms of Water

1. Water comes in three different forms, depending on its temperature. Do you know what they are?
   Solid (ice), liquid (tap water), and gas (steam or vapor).
2. Water also appears in nature in many different forms. Can you name some of them?
   Oceans, rivers, snow, glaciers, icicles, clouds, fog, rain, lakes, puddles, ponds, etc.

C. The Water Cycle

1. Have any of you ever drunk recycled water?
   a. Pass out copies of the water cycle illustration.
   b. You all have! Nature recycles water by itself. Here's how: when rain falls, it runs down mountains in rivers and streams and it collects in lakes and oceans. The sun makes the water evaporate from the lakes and oceans. When water evaporates, it turns into an invisible gas or vapor, like the steam from your tea kettle when it's hot. This water vapor rises and cools, and the moisture in the air groups together in water droplets to form clouds. When the clouds get very heavy with water, it begins to rain or snow. Then the water cycle starts all over again! That's how nature recycles water.

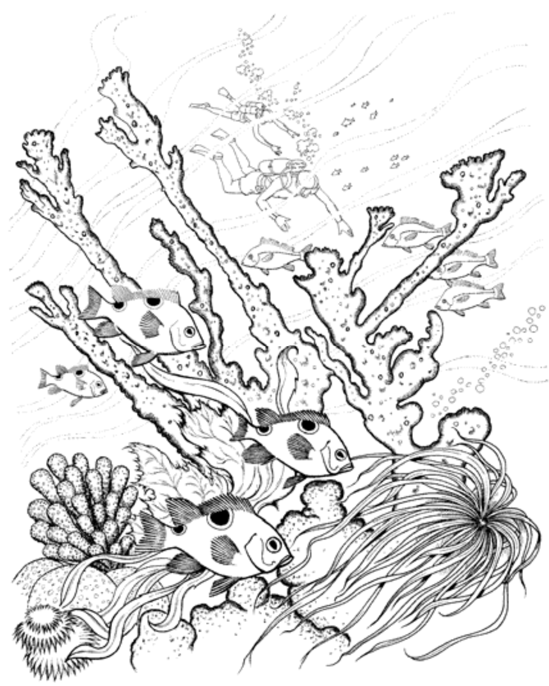
V. Application

A. Acid Rain and Other Pollutants

1. Looking at your rain cycle diagram, what do you think happens when the sky is filled with pollution? What would happen when it rains?
   The rain pulls the pollution down with it.
2. When the rain brings down pollution, it's called acid rain. What do you think happens to lakes and streams when acid rain falls?
   The water becomes contaminated.
3. What do you think happens to the animals who live in or drink from these contaminated lakes and streams, and to trees that soak up acid rain?
   They get sick, and sometimes die.
4. Besides acid rain, can you think of anything else that might make water polluted?
   Many possible answers: people putting waste into the water, chemicals or oil dumped into the water, etc.
5. Why is it important that we keep people from polluting the water?
   Because people, plants and animals all need clean water to live.
6. Should you drink water from a stream or lake when you're on a hike or nature walk?
   No! Water could have chemicals, bacteria, or other pollutants in it that will make you very sick. Bring plenty of water along when you go on a hike.

B. Conservation
   1. How many of you have heard that California doesn't have enough water?
   2. If 75 percent of the earth is covered with water, then why doesn't California have enough?
      Most of the world's water is salt water. It is expensive to take the salt out of it.
   3. What is a drought?
      When we don't get as much rain as usual.
   4. When we have a drought, we all need to use less water so that we won't run out and there will be enough for everybody. The more people we have in California, the less water there is to go around. There are now about 35 million[1] people in California who need water. Do you have any ideas about how we can save water so everyone will have enough?
      Many possible answers, including:
      a. Turn off the faucet while you're brushing your teeth, soaping up in the shower, or doing dishes.
      b. Water the lawn at night when there is less evaporation.
      c. Have your family install low flush toilets and low flow shower heads, and fix leaky faucets.

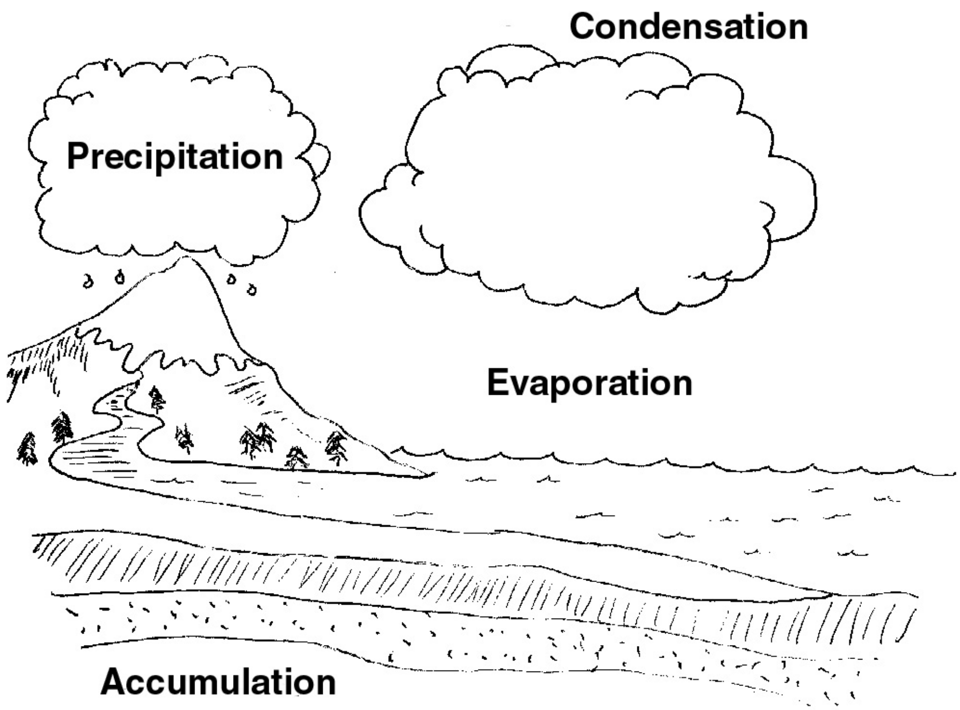
VI. Conclusion
   A. Announce the next Junior Ranger program and other interpretive programs.
   B. Stamp logbooks.



[1] Approximate population of California, 2004.

The Water Cycle

This program was developed by Stephanie Price, who suggests that the most important concept to convey with the Water section may be the water cycle and how our actions can affect it. Many children do not realize that their litter can travel through storm drains or channels into the ocean. For example, a sea turtle might think a plastic bag or balloon is a jellyfish and eat it. The turtle would later develop a blockage in its digestive tract . . . not to mention the problems caused by toxins, paper, etc! The water program can be very broad, encompassing ponds, creeks, and the ocean. Here is Stephanie's outline of how she would organize a water program:



I. Introduce the water cycle
   (Hand out copies of the water cycle diagram).
   A. Precipitation
   B. Evaporation
   C. Water vapor
   D. Snow/rain

II. Get specific with the park you are in
   A. Water source or creek
   B. Where does the water flow?
      To an ocean, river, basin, etc.
   C. Who are the people or animals that use the area?

III. Activities
   A. Before the program starts, set up one (or more if you have a large group) transect area along a creek bed or beach. Have the children walk along the ten foot transect and see how many signs of animals they can find (bugs, prints, scat).
   B. If possible, make plaster of paris prints of animal tracks found at the water's edge—deer, raccoon, etc. (This is a hit with kids). We used tin rings 1" high and 5" across (you can also use tin cans with no bottom, or square sections cut from milk cartons). Mix plaster with water in a cup with a coffee stick. Place the ring around a well-defined print and pour the plaster in. The plaster takes 30 to 45 minutes to harden.
   C. Other Activities (see activity section below)
      1. A pond park could use the "Plant Succession Crawl" activity.
      2. The "Penny Hike" activity can be adapted for a creek/beach.
      3. "Fishstick" activity is great for the ocean.

IV. Conclusion
   A. How can we protect the plants and animals in the park?
   B. How can we protect their water supply while in the park?
   C. At home?

Activities

Plant Succession Crawl[2]

Number of Children: One or more
Environment: Pond edge
Equipment Needed: Pencils and paper
Purpose of Activity: To observe plant succession
Activity:

1. Plant succession is the process by which plant composition in an area gradually changes, allowing new species of plants to come in and eventually establish themselves, replacing species that were better suited to the earlier conditions. Available light, soil and water conditions, plant competition, fire, etc. all play a role in the transition of the progressive species.
2. A very good place for observing plant succession is the area close around a pond, especially if there is a gentle slope running up away from the water. As you move farther away from the pond, the soil becomes drier and its composition changes. You will be able to observe several plant types in successive rings around the pond.
3. To see the actual process of plant succession, you would have to watch the changes in and around a pond over a period of many years. This is because

[2]From *Sharing Nature With Children*, by Joseph Cornell. Second Ed. Nevada City, CA: DAWN Publications, 1998.

plant succession is the result of plants dying and slowly building up and drying out the soil (this is also the result of sedimentation). When the soil becomes drier, the plants that like wet soil are easily forced out by their dry-soil competitors. Over a long period a pond will actually shrink and disappear as the soil level builds up higher and higher in and around it. The rings of plant life move gradually closer to the center of the pond as the wet area becomes smaller. You can see this process of plant migration happening by careful observation at any one of its points; it is rather like looking at one frame of a movie film.

4. Have the children crawl from the outside rings toward the edge of the water. By crawling and closely examining the ground, they will get a feeling for the different types of plants in the rings. Ask the children to share their discoveries as they find them. One discovery might be coming across a new ring with its special kinds of trees, shrubs, plants, and grasses, or wetter and stronger-smelling soil. When they reach the water, have each child draw a map of the pond and its surrounding area, with the successive circles of plant life. Label each ring from wettest to driest, and list the plants that grow there. Ask the children to imagine how big the pond will be in fifty or a hundred years.

Penny Hike: An ant's eye view of the world[3]

Number of Children: Two or more
Environment: The shore of a river, pond, or ocean
Equipment Needed: Container (such as a film canister) filled with enough pennies to accommodate your group, 3-D bug boxes, and a hand lens
Purpose of Activity: To encourage the close observation of the mini-world living around a body of water
Activity:

A. Variation 1:
    1. "O.K., gang, get down on your hands and knees here in a circle. Pretend you are rabbits . . . your head is six inches off the ground. Look for the smallest plant you can see. What signs are there of other animals having been here? Now sit up on your hind legs and hold your head high . . . sniff the air . . . can you see any enemies?"
    2. "This time get down low and pretend you are an ant. Get really close to the ground. How far can an ant see? Do ants need to see the way we do? What can you find in this area that ants might hide behind? Be afraid of? Eat?"

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[3] From *Manure, Meadows, and Milkshakes* by Eric Jorgensen, Trout Black, and Mary Hallesy. 2nd. Ed. Los Altos, CA: The Trust for Hidden Villa, 1986.

3. "O.K., now for the next 5 minutes each of you become an ant or rabbit. Take this penny. See how many treasures you can find to place on your penny. When your penny is full, return to the circle."

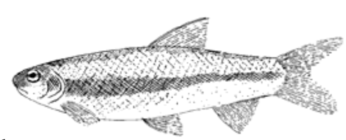
B. Variation 2:

1. As your group is walking along, casually take out your penny container. Shake it once or twice. "What have you got in your hand?" inquires a curious child. "Oh, just a dime," I reply. "There is more than one dime in there!" exclaims the child. "No, just one dime," I calmly reply. By then all the children have circled around and are paying close attention. "Want to see?" I inquire. I open the canister handing one penny to each child until I count ten. "See, one dime."
2. With interest aroused, I quickly transfer to the next step. "Want to go on a penny hike?" Again curiosity appears on faces as they try to discern what I've got in mind. To replies of "Ya," "O.K.," and "Sure," I explain that each child is to take a penny and find tiny treasures—plant, animal, rock, fungi, and so forth—to carry on a penny. (Caution, do not pick live plants.)
3. After the hike, we share our finds. After the initial sharing, try the following:
   a. Create a miniature food chain (pebble, soil, lichen, scat).
   b. Build a sculpture or miniature garden.
   c. Use bug boxes for a mini hunt. Be sure to let your captives return home.
4. Remember, the sharing is only secondary to the seeking, observing, and exploring. Get down on your belly and perceive a new world.

Schooling Fish[4]

Number of Children: Eight or more
Environment: An open space
Equipment Needed: One 24-inch stick or dowel per student; copies of lanternfish pattern (both sides); cardboard for mounting fish patterns; black indelible marker, scotch tape, glue
Purpose of Activity: By acting as a school of lanternfish, students learn how bioluminescence and schooling behavior help fish survive
Background: Each species of deep sea lanternfish shines with a unique pattern of body lights. Without its lights, a black lanternfish would be hard to see in the darkness of the deep sea. The bioluminescent spots help fish find mates and lure prey. You can discuss lanternfish adaptations with students throughout the activity.
Activity:

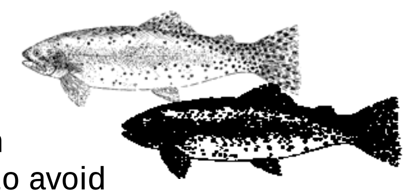
1. Before the program: make a copy of lanternfish pattern in Appendix B (both sides) for each student. For BIG impact, enlarge the fish to double size on an enlarging copy machine. Mount a fish half on both sides of a piece of cardboard to form a sturdy lanternfish.



[4] From *The Ocean Book*, by the Center for Environmental Education. New York: Dodd, Mead, 1988.

2. Group the paper fish into schools (four or five per school). To give each school a unique pattern of lights, use the marker to darken specific spots on each fish in that school. (The light patterns on both sides of a fish should match. Each school has a different pattern, but fish in the same school have the same pattern). Attach the fish to sticks.
3. Mix up the fishsticks. Give a fishstick to each student. Ask students to guess where lanternfish live. Why are they called lanternfish? Explain that each species of lanternfish has a unique pattern of body lights. Each student holds a fishstick high and looks for other fish with the same light pattern. Look-alikes unite to form a school. Have each school of student-fish list ideas about how bioluminescence helps lanternfish survive.

4. Schooling for survival: Let each school of fish swim a simple course, following these rules:
   a. The fish swim close together, but without touching.
   b. All fish in a school maintain the same speed and direction.
   c. The front fish of the school determines the direction and speed for all.
   d. Each time the school turns, the front fish becomes the new leader.
   e. A school that is forced to divide must reunite as soon as possible.
5. How did students feel about being part of a school? Was it easy to move as a group? What cues did they use to stay together? Would it be harder to school in the dark? How does schooling help fish? To show how fish school to survive, you can have many species unite to form a huge school, using the same rules. Have the school swim a fixed course while you play the predator. Attack the school, but only capture those fish who leave the ranks. The school may change direction to avoid you, but it must stick to the course (no running). If a fish turns or changes speed to avoid a predator, the rest of the school must follow. A fish who's caught becomes a predator and may help attack the school. The game ends when the school reaches the end of the course. Was it different being in a large school? Is it better to be at the outer edge or in the middle of the school? If predators joined in a school, would they feed more effectively?



Water Density[5]

Number of Children: One or more
Environment: Any
Equipment Needed: Four glasses (at least 8 inches tall), table salt, three colors of food coloring (red, blue, and yellow), clear plastic drinking straws, measuring spoons
Purpose of Activity: To understand one practical implication of varying water density is that water forms into layers with the most dense water in the bottom layer
Preparation: Mix four solutions of water and table salt, each containing 1/2 gallon of tap water and an amount of salt as follows:

Solution 1: no salt, yellow food color

[5] From *Water Inspectors*, published by California Aquatic Science Education Consortium, Graduate School of Education, University of California, Santa Barbara, CA 93106.

Solution 2: 1 tablespoon salt, green food color
Solution 3: 2 tablespoons salt, red food color
Solution 4: 4 tablespoons salt, blue food color

Activity:

(Either perform the following demonstration yourself or ask a Junior Ranger to do it.)

1. Holding a finger over the top of a drinking straw, insert it into the blue glass so that the bottom of the straw reaches half way to the bottom of the glass. Remove your finger from the top of the straw, allowing air to escape and blue water to flow into the straw. Replace your finger and remove the straw from the water. Blue water will stay in the bottom half of the straw.
2. Using the half-filled straw, repeat the above procedure with the yellow water. Gently remove the straw from the yellow water and hold it so all can observe. Ask the group to describe what they see. (They should notice that, after a while the blue water "moves down" and mixes with the yellow, forming a green mixture).
3. Repeat the above procedure, this time sampling the yellow water first, then the green, then the red, then the blue. Again ask members to describe what they see. (The colors will remain un-mixed, with the yellow on the top, blue on the bottom).
4. Ask for guesses why they mixed one time and not the other. As a hint, ask one person to taste the blue and yellow waters by dipping a fingertip into each and touching it to his or her tongue. (They should note that the blue is salty and the yellow is not.)
5. Explain that the only difference between the different colors is that they contain different levels of salt. The presence of salt, a dissolved mineral, in the water makes the water more dense and denser water is "heavier" and settles toward the bottom, underneath the less dense "lighter" water.

High Tide, Low Tide[6]

Number of Children: Two or more
Environment: Open space
Equipment Needed: Line markers
Purpose of Activity: To understand the effect of the moon on high tide and low tide
Activity:

This is a variation of the Red Light, Green Light game. Mark two lines about 100 feet apart. Appoint one person as the moon. This person stands on one line, while the rest of the group lines up on the other. When the moon turns her back and shouts "High Tide," everybody runs toward the moon. When the moon turns around and says "Low Tide," everyone must freeze. Those that move when they are supposed to be frozen must go back to the starting point. This continues until one person crosses the line. That person then becomes the moon.

[6] From *The Ocean Book: Aquarium and Seaside Activities*, by the Center for Environmental Education. New York: Dodd, Mead, 1988.

Background Information: Water

California's Water

As a rule, California gets a lot of snow in the mountains during wintertime. When warmer spring weather comes, the snow melts, supplying us with much of the water we need during the hot, dry summer months. In a normal year, about 247 cubic kilometers of snow and rain fall on our state. This is enough to cover all of California with about 23.6 inches (60 centimeters) of water. About two-thirds of this water is used by trees and other plants, soaks into the ground, or evaporates. Only about one-third of all our water runs off into rivers and streams in an average year. Most of the water we do keep winds up in California's natural storage system of lakes, rivers, and streams, or goes into our people-made systems of dams, reservoirs, and aqueducts.

Most of California's streams, rivers, and lakes are in the north. This is because about 75 percent of the water from rain and snow runs off northern mountains. Nearly half of California's water flows into the great Central Valley, mainly through the Sacramento and San Joaquin rivers. Once there were vast lakes and swampy areas in many parts of the Central Valley, but now most have been drained and made into farmlands.

At the point where the rivers join to meet the salt waters of San Francisco Bay, we have what is called the Delta. Years ago, the rivers washed rich soil into the Delta, making islands that are good for farming today. Now the water flows by these islands, through sloughs and channels, on to San Francisco Bay and the ocean.

Most of the rest of California's water—about 40 percent—goes into the North Coast basin, which stretches along the Pacific Ocean from Oregon to San Francisco. The Eel, Trinity, and Klamath rivers are in this basin—they carry over one-fourth of California's water runoff.

Another important part of our natural water supply is groundwater (water which has seeped into the ground). Groundwater collects in underground areas of rocks and sand known as aquifers. Aquifers hold huge amounts of water like giant sponges. About 40 percent of the water we use comes from wells.

Although we rely on rain and snow to keep these surface and groundwater systems flowing, nature needs some help to get all the water from up north to all the people who live down south. Furthermore, while most of the rain falls in the winter and early spring, farmers need water most in the summer.

In order to solve the problem, people have built large systems that store water from the winter and move it to areas of need for use in the drier times of the year. Nearly 200 years ago, the Spanish missionaries dug canals that carried water from streams to nearby fields. In Pueblo de Los Angeles (1770s) the Zanja Madre, or Mother Ditch, brought water from the Los Angeles River to residences. In the early 1900s, California's big cities had to do the same thing. People needed more water than they had, so they began building water systems to get it.

Los Angeles was first, building a 250-mile (402-kilometer) canal to bring water from the Owens Valley and the southern Sierra. At about the same time, Southern California farmers built canals from the Colorado River to the rich farmlands of the Imperial and Coachella valleys.

Then, in the late 1920s and 1930s, San Francisco and Oakland outgrew their local water supplies. The Hetch Hetchy Reservoir was built to bring water to these growing areas from the western slopes of the Sierra.

By the early 1940s, the Metropolitan Water District of Southern California built a 242-mile (389-kilometer) canal from the Colorado River to the many people of the southland. But even with all these efforts, there was not enough water where it was needed, so the state and federal governments built the two biggest systems of all.

The reservoirs and canals of the state's California Water Project and the federal government's Central Valley Project were built to store water from Northern California rivers. The water is transported southward through the California Aqueduct, the largest people-made water transport system in the nation. These reservoirs do more than store water. Many have power plants that use the force of the flowing water to turn electrical generators. This gives us a clean, cheap source of electricity.

Our people-made systems cannot make water—they can only store and move it. Even with all the reservoirs and pipelines to take care of California's water needs, there is still only so much water to go around. During dry years, when only a little rain and snow fall, some reservoirs may not fill up and water could run short.

We should make good use of water today, so that we'll have enough to go around for a long time to come.[7]

Wetland Destruction

Wetlands are wet environments, including bogs, ponds, marshes, and swamps. Although we may not be aware of it, America's wetlands contribute significantly to our daily well-being. Wetlands are vital ecological resources that nurture fish and wildlife, help purify polluted waters, and protect us against the destructive forces of floods, storms, and erosion. Wetlands provide us with a variety of recreational activities such as hiking, canoeing, hunting, fishing, bird watching, photography, and environmental education. Until recently, wetlands were thought to have little

[7] Information on California's water is from "The California Water Works and Why It Does." Pamphlet published by the California Department of Water Resources.

economic value. As a result, researchers estimate that more than half of the original 215 million acres of American wetlands have been destroyed since the first settlers arrived. About 90 percent of all original wetlands on the California coast have been drained or filled. Consequently, wetland wildlife populations are at an all-time low.

Water Density

Samples of water may contain different amounts of dissolved minerals. The more dissolved minerals in a sample of water, the higher the density of the water. A practical effect of differing water density is that bodies of water (a lake, pond, or the ocean) will contain different layers of water. Unless unusual conditions exist, the most dense water will be layered on the bottom, and the least dense on the top.

When fresh water flows from a stream into the ocean, the water does not mix equally but is layered, fresh water on top, salty underneath. Animals and plants, which prefer a certain level of salinity, will seek to travel in the layer most comfortable for them. Fishermen who know this are always the most successful because they know how deep or shallow to fish. Scientists who try to encourage the growth of a particular fish population must not depend simply on measurements of salinity at the surface; they must sample at various depths to verify that water of proper salinity exists in some layer in the body of water.

Home Pollutants

We tend to think of water pollution as being caused by industrial waste or sewage treatment plants. Indeed, this is often true, but individuals dumping pollutants around the home and garden contribute greatly to water pollution. Many items around the home can injure the environment if not disposed of properly, e.g. motor oil, paint, cleaning fluids, fertilizers, pet droppings, etc.

This type of pollution from residential areas is called nonpoint source pollution, which means the problem is coming from many sources in tiny amounts and cannot be traced back to one main source. Nonpoint source pollution occurs when rainfall moves over and through the ground. It picks up and carries natural and human-made pollutants, depositing them into lakes, rivers, coastal waters and even our underground sources of drinking water. Any pollutant that leaves our home can travel a long way through our water system. Storm drains, for example, are not connected to the sewer system, but instead drain directly into waterways. Anything toxic that is dumped into a gutter or a storm drain can eventually pollute a stream, river, estuary, bay, or the ocean.

When we think of pollutants we automatically assume it means fertilizers, insecticides, household cleaners, paint, oil and other chemicals we use in our houses, yards and vehicles. However, things such as loose grass clippings and leaves, soil from erosion, and pet droppings are also classified as nonpoint source pollutants.

Soil, grass clippings and leaves in runoff carry contaminants that can smother and kill aquatic life. Fertilizers, car exhaust and detergents cause explosive plant and algae growth, which depletes the water of oxygen, killing fish and animals. Pet droppings and septic tank overflows can cause diseases like dysentery, hepatitis and parasite infections by getting into drinking water and recreation areas. Oil, paint, cleaning materials and other toxic chemicals contaminate drinking water and kill fish, other animals, and plants.

Controlling and preventing nonpoint source pollution is everyone's responsibility. There are many things we can personally do to help reduce nonpoint source pollution, including:

- Plant grass, trees and shrubs in bare areas to reduce erosion and water runoff.
- Properly dispose of motor oil and household chemicals.
- Use fertilizers and pesticides sparingly on lawns and gardens, or substitute them with natural products like compost or ladybugs.
- Put trash in its place.
- Organize neighborhood cleanups.
- Recycle plastic, glass and paper.
- Pick up and properly dispose of pet droppings.
- Keep roadways, street gutters and walkways swept and clear of soil, grass and debris.

Drinking Water Safety

A human being cannot live for more than a few days without water. Our bodies are 75 percent water, and water is needed for every bodily function. In a survival situation, then, finding water, and making sure it is safe to drink, comes near the top of the priority list.

Not all water is safe to drink—never take a chance. The risk of poisoning, parasitic infection, etc. is too great. There are many signs to look for when determining whether a water source is safe to drink. The water should be clear and free of coloration or oil slicks on the surface. Fast-flowing water at high elevations and away from human habitation is usually safest, but don't forget to purify for Giardia. Giardia is a protozoan parasite that can be present in park waters. When ingested, it often causes intestinal problems such as vomiting, diarrhea, and cramps—symptoms that may persist for months.

If you're investigating a small, self-contained water source, make sure it is free of algae and animals. In the case of a large, free-flowing water source, look for a healthy assortment of plants growing in and around the water, as well as signs of fish, frogs, or invertebrate life.

There is no positive proof of drinkability, so only if you are desperate and your survival absolutely depends on finding water should you drink from a questionable water source. Filter and boil the water before drinking it. A piece of cloth will filter water nicely, but will not filter out Giardia cysts. Boil water for 20 minutes to purify it, either by heating it in a container over a fire or by dropping heated rocks into a container. This will kill all the bacteria, but you can't be sure of chemical pollutants, so pick your source carefully.

Finding the Water

Water flows downhill—find where it collects. Survey the landscape to find where you might discover the troughs, ravines, and depressions that will help the water move downward. Or follow animal tracks, or watch an animal to find where it gets its water. When drinking from a stream, be sure to boil or filter the water first.

Another way to get water is to dig a hole and wait for water to seep into it (it may take awhile). Gather the liquid with a piece of cloth or dried grasses. You may want to dig several holes. Then filter and purify the water.

A solar still is one of the best ways to get drinking water where it is scarce. You have to carry the things you'll need with you, though. You need a six-by-six sheet of clear plastic, six feet of surgical tubing, and a container to catch the water. Dig a hole four feet across and three feet deep. Place a container in the hole. Lay the tube in place so that one end is in the bottom of the container and the other end runs up and out the side of the pit. Cover the hole with the plastic sheet, securing the edges of the material with dirt and weighting the center of the sheet with a rock. The plastic should now form a cone. The low point of the cone must be directly over the container and no more than three inches above it. You can put crushed, edible, herbaceous plants such as cactus in the hole to increase the still's output. You can also get water directly from these plants. Collecting dew is one of the safest drinking sources—use a rag or safe grasses to do it.

If you're in a situation in which water is scarce, follow the following guidelines:

- Don't eat anything if you don't have water to drink with it.
- Travel slowly, during the coolest hours.
- Don't expose your skin to the hot sun if you can help it.
- Drink as much and as often as possible.
- At high altitudes, or in cold or wet weather, force yourself to drink. You may become dehydrated without feeling it.

Suggested Resources: Water

Braun, Ernest and David Cavagnaro. *Living Water*. Palo Alto, CA: American West Publishing Company, 1971. The authors follow a typical Sierra stream along its course from timberline to the sea, freely digressing into storms and snowbanks, soil and seeds.

Brickson, Betty, J. K. Hartshorn, and Elizabeth McCarthy. *Layperson's Guide to California Water*. Sacramento, CA: Water Education Foundation, 2000. Combining historical and current information, this booklet gives a brief overview of the development and allocation of water resources in California.

Center for Environmental Education. *The Ocean Book: Aquarium and Seaside Activities and Ideas for All Ages*. New York: Dodd, Mead, 1988.

Pielou, E. C. *Fresh Water*. Chicago: University of Chicago Press, 1998. This source provides useful insights into the remarkable ways of water, such as the behavior of currents in a stream, the movement of pollutants through an aquifer, or the differences between a reservoir and a natural lake.

Reisner, Marc. *Cadillac Desert: the American West and Its Disappearing Water*. New York: Viking Penguin Inc., 1986. The author weaves history, biography, engineering, politics and economics into a fascinating story—a story of the quest to control and allocate the West's precious supply of water.

Project WET Curriculum and Activity Guide. Bozeman, MT: Project WET, 1995. Project WET ("Water Education for Teachers") is a water education program designed to promote awareness, appreciation, knowledge, and stewardship of water resources. This guide is only available through training workshops.

The No Waste Anthology: A Teacher's Guide to Environmental Activities K-12. Sacramento: Department of Toxic Substances Control, 2003.

WOW!: The Wonder of Wetlands. St. Michaels, MD: Environmental Concern Inc./Bozeman, MT: The watercourse, 1995. Exploring the potential of wetlands as an educational tool, this guidebook combines useful background material with more than forty wetland-related activities for kindergarten-through-twelfth-grade youths. www.wetland.org/wowteacher.html.

Other Sources of Information

California Coastal Commission. "Public Education Program." Offers a variety of conservation, education and community involvement programs. www.coastal.ca.gov/publiced/pendx.html.

Department of Conservation. "Kids & Educators." This website is full of fun facts and interesting information that students and teachers can use for school projects and learning. www.consrv.ca.gov/index/qh_kidsEducators.htm.

Department of Water Resources. A good source of information on a variety of water-related topics. www.water.ca.gov.

National Oceanic and Atmospheric Administration, National Ocean Service. "NOS Education Discovery Kits: Nonpoint Source Pollution." www.oceanservice.noaa.gov/education/kits/pollution/03pointsource.html.

U.S. Environmental Protection Agency. "Educational Resources." www.epa.gov/epahome/educational.htm.

U.S. Environmental Protection Agency. "Polluted Runoff (Nonpoint Source Pollution)." www.epa.gov/owow/nps/qa.html.

Watersheds.org. "Polluted Runoff, Nonpoint Source Pollution: What Can You Do." www.watersheds.org/earth/nps2.htm

Water Education Foundation. An informative and educational website from the creators of Project WET. www.water-ed.org.

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