Welcome to Headwaters to Ocean's Student Field Trip Program

Welcome! It's good to have you on board our program this year. It promises to be a fun and challenging season full of smiling faces and we look forward to sharing them with you.

What you have in your hands is the curriculum that we have created for teachers to use in preparation for their class' field trip with H2O. We have tried to offer a comprehensive and interesting packet that will be easy to add to existing classroom plans. Please take a moment to page through this to get an idea of what is in store for you and your class.

If you have any questions, comments, or concerns about the program, please call our office at 228-9600. We will be glad to assist you.

H2O would like to take this opportunity to extend acknowledgments to the people whose help was critical in completing this project. Our Education Committee included Celina Fisher, Del Gray, Angela Jackson, Ted Paige, Andy Reichert, Peter Ritson, Steve Robertson, Heather Stevens, Lynn Vanderkamp, Sue Webb, and Pat Willis. The Committee helped steer this project and offered much needed ideas and advice on its presentation. Special thanks to Steve and Peter for taking the extra time to discuss specific ideas, to Celina for offering meeting space and refreshments, and to Del for the layout.

Again, welcome aboard!

How to use this Curriculum

The first section, *Watersheds and Pollution: An Introduction*, is a fairly involved discussion of two major elements of our field trip program. It is designed to bring teachers up to the same starting point concerning watershed and river quality issues. It may be more information than you will need to know for your particular class, but we hope to improve your own understanding of these issues as well. It should help you to answer any basic questions that your students will have. We hope it will also offer a few leads in other related areas you may want to study as a class.

The second section includes the three lesson plans which are critical to your class' preparation. In them, we begin the discussion and thought process on a number of activities that we will continue, first-hand on the boat. They also include suggestions for additional activities and discussions you could have with your students. Each one is laid out simply with the following information included:

- objective
- cross-curriculum subjects
- skills used
- preparation
- procedure
- time frame
- grade level
- materials needed
- additional background
- further resources

The worksheets have been designed to help your students get the most out of the educational aspect of our field trip. One of the completed worksheets (Watershed Address) will serve as the actual ticket-to-board and a second (Chemicals Survey) will be discussed on the field trip; please ensure that your students bring them on the date of your field trip.

The third section is a listing of additional resources, both for teachers and students, in learning more about the importance of water and its myriad uses. These include: organizations to contact for other environmental education programs; other environmental curriculum; and books and magazines that discuss rivers and water quality issues.

The final piece is our evaluation form. We ask that you take the time to sit down and share your comments, concerns, and questions with us after using this curriculum. Your input is integral to improving and expanding our program for the seasons to come. At the end of the boat ride, we will also ask you to distribute surveys to the students to have them share their experiences with us.

Watersheds and Pollution:
An Introduction

The world around us presents many mysteries and wonders of how natural processes work and why. Headwaters to Ocean has chosen to focus on the domain of Rivers for many reasons ranging from the aesthetic to the philosophical to the scientific. This section will give you the necessary information to facilitate the activities included in this packet, and to continue with other activities and discussions for your students in the future. In it we discuss the two main top-ics that will remain consistent throughout the H2O program: watersheds and nonpoint source pollution.

Water And Watersheds

Water, along with the particular mix of our atmosphere, is what enables life to continue in such wealth on planet Earth. Roughly 71% of Earth's surface is water, whether in the oceans or landlocked seas and lakes. (For scale, *all* of the land surface on our planet would fit in the sur-face area of the Pacific Ocean with six million square miles left, an area almost double the size of the U.S.!) Very few, if any, activities and events on this planet happen without water playing an integral, if not leading, role. Life as we know it, would not be possible without a consistent and clean supply of water. As one environmental chemistry text writes, "All living things depend absolutely on a supply of water. The biochemical reactions of every living cell take place in aque-ous solution, and water is the transport medium for the nutrients a cell requires and for the waste products it excretes."[1] And, much like the planet on which we live, the human body itself is mostly water , an analogy we would be well served to remember.

Even with the wealth of water on the planet, we have come to recognize and understand that only a very small portion of it is usable by terrestrial organisms, including humans. Only 3% of the global water supply is fresh water (97% is saline); of that 3%, two-thirds is locked up in the polar ice caps and glaciers (2% of the total). Of the remaining fresh water (1% of the total), two-thirds remains in groundwater supplies and one-third is surface water (.66% and .33%, respec-tively). For perspective, if we represent global water supply as a one gallon jug, the amount of surface fresh water would not quite fill a tablespoon. These figures, however, do not tell us how much of that small supply is still safe and clean, a difficult task at best.

All this water (fresh and saline) plays a role in the water cycle that drives weather and sup-ports life around the globe. The water cycle, of course, is the process by which water molecules move within the natural environment, changing continually from liquid to vapor and back to liq-uid, and sometimes solid, again. Precipitation falling on the surface of the Earth plays any num-ber of roles. It may: sink into groundwater supplies to replenish aquifers; flow into streams which return it to the oceans to eventually evaporate; collect in other lakes and seas to evaporate or eventually flow into the oceans; evaporate directly into the atmosphere again to collect and fall as precipitation again; or fall as snow or ice onto glaciers to be stored until the next warming period comes. Through this process the water on this planet has worked to clean itself of impurities over the millennia. In fact, the water we drink today is as old as the planet itself—we never add any new water but just keep recycling the supply through different uses over time.

Within the water cycle, watersheds remain a useful framework for viewing the health and quality of fresh water and its waterways. Quite simply, a watershed is a longer word for a catchment or basin—it is an area of land within which all the water will flow toward the same point or exit through the same path. Watersheds can range in size from a few square feet around a puddle after a rain storm, to the quarter million square miles of the Columbia Watershed, to the Pacific Ocean, or even the World. Each watershed has unique aspects that influence the variety of plant and animal life and the health and quantity of its water supply.

As humans, we frequently identify with the neighborhood, the city, the state, and the country in which we live to locate our existence in a place others will recognize. Water, however, doesn't listen to the political boundaries we like to place on the landscape, nor does most, if not all, of the entire natural world. In the form of rivers, water can and often does flow through numerous political entities (the Columbia Watershed includes portions of two nations, two provinces, and three states), and Oceans, Seas, and some Lakes have many cities, countries, and even continents along their shorelines. To better understand, and correct, the problems we face with clean and safe water supplies, it's helpful to look at watersheds as whole and distinct entities apart from political boundaries. To that end, one of our first activities is to have the classroom identify its watershed address and recognize its location within that watershed.

All of us living in the Portland metropolitan area are in the Columbia Watershed and most of the metropolitan area also lies in the Willamette Watershed. The Willamette Watershed is an 11,500 square mile piece of land bordered by the Cascades on the East, the Calapooya Mountains on the South, the Coast Range to the West, and the Columbia River to the North. Ranging from the steep wooded slopes near its headwaters in Lake Waldo, down through the lazy curves in the central valley, to the hills near its confluence with the Columbia, the Willamette travels a variety of landscapes in its short journey. The Watershed itself is not very large, covering about one-eighth (1/8) of the state of Oregon, but it receives double the annual precipitation of Oregon east of the Cascades and is home to 70% of its population.

Watersheds are very dynamic systems with many different factors affecting its normal functioning. There are four general components of a watershed that determine its particular traits: climate, geography, geology, and biology.

Climate

Climate is probably the most distinctive component of watersheds; it includes the amount and type of precipitation, temperature and length of season, wind and evaporation, and transpiration—the absorption of water by plant life. Often, we identify climate with certain environments or ecosystems, and for good reason: dry and windy climates result in deserts or grasslands, while damp and mild climates foster temperate and tropical rainforests. Also, we can distinguish between the larger climate and the various microclimates that occur within it. The Redwoods in Northern California are a good example—in a relatively dry coastal climate, the Redwoods have turned their microclimate into one that is significantly wetter than bare slopes. By collecting and condensing the coastal fogs on their branches and needles, these tallest of trees nearly double the amount of precipitation through creating this "tree-rain."

Geography

Geography is simply the size, location, and orientation of a given watershed. Larger watersheds have the capacity to gather more precipitation dependent on the climate. Slope profiles determine how surface water flows behave: steep and hilly slopes tend to increase the volume and velocity of flows and their sediment loads, whereas shallow and flat areas encourage pooling into wetlands, lakes, and slow meanders where the water can deposit the sediment it carries. Location refers to general climactic regions as well as orientation to the predominant weather flow. The Willamette River runs parallel with the west slope of the Cascades which lies perpendicular to the prevailing westerlies. This combination of factors traps water-bearing clouds in the valley, leading to your high levels of precipitation in this Watershed. The Columbia Gorge, by contrast, lies parallel to the westerlies, fostering windy and generally colder weather as if funnels through this narrow cut in the Cascades. Orientation to sunlight (the relative amounts of direct and indirect sunlight) will influence rates of evaporation and the type and abundance of vegetation through the watershed.

Geology

Geology describes the porosity (how porous) of the surfaces and soils of the watershed. Ranging from sheer rock faces to rich loamy soils to sands, these all affect the rate and amount of runoff or seepage. Rocky and clay-like surfaces (nonporous) promote faster runoff and inhibit seepage into the ground; sandy or loamy soils, conversely, allow for seepage and can prevent runoff except in extreme rainfall. Different types of bedrock can also affect groundwater recharge with porous sandstone and limestone allowing more seepage than nonporous granite and gneiss.

Biology

Biology refers to the living (biotic) aspects of a watershed—plant and animal populations. The biotic is probably the most memorable feature of a watershed: we expect to see a cactus in a desert and would be surprised to see a flamingo along the Willamette. Plant and animal species have adapted to their particular watersheds with varying levels of specialization; different runs of the same species of salmon can have critically different adaptations. Chinook in the Sandy River differ from Chinook in the Deschutes in ways that enable each run to be the more viable stock in its home river. In many cases, too, the plants and animals affect and alter the watershed in which they live; as mentioned above, the Redwoods have subtly created their own ideal habitat, much as beavers actively do the same by building dams to pool streams.

As you can well see, watersheds are complex systems, although we have come a long way in understanding how they work. With programs such as the Governor's Watershed Enhancement Board (GWEB), the Willamette River Basin Task Force, and the Lower Columbia River Estuary Program, we are starting to look at natural systems in ways that bring once separate entities together to the same table. It is hoped that a larger view of watersheds will foster and encourage cooperation in addressing water quality issues and improve stewardship of our rivers.

Nonpoint Source Pollution

One issue where a watershed outlook is becoming more central to finding solutions is water pollution. In 1972, Congress passed the Clean Water Act, which aimed to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Its goal was to return all bodies of water to a swimmable and fishable condition. At that time, the most blatant cause of water pollution was easy to identify—it was flowing from pipes that were the direct drainage systems for industry along our rivers and lakes. We could isolate and identify a point where the pollution was being created and introduced to the waterway. At these pipes, one could watch noxious looking and foul smelling liquids draining into the water. From the Hudson of New York to the Willamette of Oregon, Rivers had become flowing cesspools of industrial waste, displaying all colors of the rainbow and killing most, if not all, of the plant and animal life in those waters. The people of this country in general and certain watersheds in particular could see the horrible condition that afflicted these rivers.

Through a series of regulations, the Clean Water Act began to clean up our waterways. Factories were required to clean up or stop the many different types of waste that were being dumped indiscriminately into the waters. Municipalities were required to treat their raw sewage before returning it to natural systems. From 1972 through 1985, $310 billion was spent to clean up water, with the resulting 90% reduction of raw sewage in the country's rivers since the early 1970s. The results, although gradual, were impressive—many rivers started to look like rivers again and still do today. It is much less common to see a factory dumping waste directly into a body of water today than it was 25 years ago, but we still have not met all the goals of the Clean Water Act even today, thirteen years past the target date.[2]

The main reason for this failure is that the Clean Water Act did not specifically address pollution from nonpoint sources, although it encouraged state and local governments to do so. Nonpoint source pollution comes from a variety of points that make it difficult to identify a precise geographic source such as a factory outflow pipe. We also call this runoff pollution because basic runoff (pollution that is somehow on the landscape and runs off into rivers, lakes, and seas) is a very large parcel of nonpoint source pollution. It drips, trickles, and seeps from large areas, affecting even more miles of rivers than all point sources combined affect.

Most runoff can be grouped into three loose categories, based on their effect: chemical poisons; over-nutrifiers; and clouding agents. Each of these categories is necessarily broad; they serve only to allow you to understand how each general type can and does affect our aquatic world. As such, they are not mutually exclusive and many substances will fit in more than one category.

Chemical poisons include any of the variety of synthetic substances that find their way into the water. These substances include: petroleum products (oil, gas, kerosene, etc.); anti-freeze; cleaners (soaps, astringents, degreasers, bleach); pesticides and herbicides; paints and varnishes; and products containing lead or other heavy metals. All of these substances are available to the public and are used in the home, garage, or on the lawn and garden. When introduced to aquatic realms, they show any number of effects that we know and many that we don't. Some undergo chemical conversions to create an entirely new chemical: using chlorine in the paper bleaching process leads to the creation of dioxin, a very potent poison. DDT, a common ingredient in pesticides in the 1970s, causes soft, thin eggshells in fish-eating birds, reducing reproductive rates. DDT poisoning led to plummeting Bald Eagle and Pelican populations before DDT was banned from use in the United States. Petroleum products, especially oil and gasoline, are more well-known culprits in water pollution owing to tanker spills all over the world. Many of us have seen photos from these spills, but few of us realize it happens on much smaller, but equally damaging, scales on inland waters as well. Due to its chemistry, one drop of gasoline can foul thousands of gallons of water.

Over-nutrifiers have three main sources: manufactured fertilizers, organic matter, and sewage overflow. They all have one main effect in common, though: by adding two many nutrients to the ecosystem, they encourage algal blooms in slow-moving waters. These algal blooms grow extremely fast and after they die, they fall to the bottom and decompose. Decomposing bacteria consumes the dissolved oxygen (DO) from the water; as bacteria populations grow, DO levels plummet, suffocating fish populations. Until oxygen levels recover, fish will not recover in that locale. Other effects include disease outbreaks from raw sewage in the water supply, leading to public attention when they affect the human population.

Clouding agents are any sediments that degrade the clarity of the water, with two major consequences: the sediment blocks light transmission and it chokes fish gills. While some streams are naturally full of sediment and murky, many others are not. Organisms in these "clear" environments depend on that clarity to survive. Underwater plants need sunlight for photosynthesis—without it, their populations decline. Fish that depend on their sight for feeding and nesting—salmon and trout are two—no longer can find enough food or proper nest sites.

With this knowledge of general consequences of runoff, we can look at some of the many sources. Again, we can group these into three distinguishable geographic areas—urban, suburban, and rural.—and look at some specific origins and avenues of runoff pollution. In urban areas, one large source lies in our street system because it serves as a large collection area for all kinds of chemicals, debris, and litter. With rain and snowmelt, whatever is on the streets is washed down storm drains into a sewer system. Few cities in the U.S. have treatment systems for this storm drain runoff, sending it directly to the nearest body of water instead. Any motorized vehicle will leak a mixture of oil, gasoline, and anti-freeze that remains on the roadway until the next rain washes it down the storm dray. The friction between the moving parts of an engine creates a very fine metallic dust and the exhaust itself has particulates that collect on roadways and surrounding surfaces; tires and braking systems also leave residue on the pavement. This road grit coats the surfaces of our streets and highways, waiting for the next rain to wash it down the storm drain.

Other, more direct human actions send assorted substances into storm drain systems. Drivers and passengers of these vehicles also leave litter, much of which will not break down before being washed into a river or lake. An assortment of used motor oil, paints, varnishes, and other chemicals sometimes gets dumped down a sewer grate rather than receiving the proper disposal each of these substances requires. On top of all this, whatever organic matter and debris (leaves, pine needles, soil, lawn fertilizers, etc.) is left or put on the roadways will also get mixed into the sludge-like urban runoff.

Suburban problems are much the same, with one notable difference. In contrast to the urban core of pavement and concrete, many suburbs tend to have more and larger grassy areas (parks, golf courses, property landscaping, etc.) that are kept that way through a combination of fertilizers, pesticides, and herbicides. Expanding suburban areas may also have many construction projects in progress which can leave soil exposed to washing away with the rain, creating cloudy rivers and lakes.

Rural problems include all of the above on a smaller scale, but the larger problems in rural areas come from agricultural applications of fertilizers, pesticides, and herbicides and from loose soil exposed on fallow fields and through intense logging practices or road building. Here is a prime example of a problem that is hard to pinpoint. With modern farming techniques (non-organic), fields see numerous applications of these chemicals spread over vast areas, frequently by airplane. There is no sure-fire method to apply the exact amount necessary or to spray it on only the crops that need it. Consequently, larger doses are used, usually overlapping the surrounding vegetation, even unintentionally. Forest practices, whether by over-harvesting a stand or building roads, can remove too much of the root structure of the trees that serves to both hold the soil in place and to store a significant amount of water. The result is faster runoff from the landscape that carries more sediment and silt into the water; sometimes, landslides can outright clog a stream. The same can happen from fields that lie fallow (unplanted), whether seasonally or for the full year.

One final source of nonpoint pollution comes from anyplace there is a drain—bathrooms, kitchens, garages, laundry rooms. At issue here are the contents of the cleaning agents, soaps, disinfectants, shampoos, and laundry supplies that drain out of our households, businesses, and schools. Many soaps use phosphates as one of the cleaning agents—it serves to soften the water to improve effectiveness of the detergent molecules. Phosphates also act as fertilizer, which poses a problem in water ecosystems when it becomes too concentrated as we saw above. Many of these products also have numerous additional chemicals added to them. Look at a bottle of toilet cleaner, or bath and tile spray, or even shampoo, and you will find a cornucopia of chemicals whose names are not familiar, if you can pronounce them at all. In many urban areas, significant rainfall or spring snow melt can overwhelm the sewer system, causing both raw sewage and storm drain runoff to flow untreated into the aquatic environment. Here in Portland, such an event is called a Combined Sewer Overflow (CSO) and can go into either the Willamette River or the Columbia Slough.

The key with nonpoint source pollution at this point lies in understanding the problem and its many facets. Just like the process of understanding point source pollution, we are coming to better knowledge of what is already polluting our waters and what we are still adding to them. Through increased education and public awareness of the problem, we can begin to see improvements in the quality of our natural aquatic environments.

Notes

1. *Chemistry of the Environment*. Spiro, Thomas G. and Stigliani, William M.; Prentice-Hall, Upper Saddle River, NJ. © 1996. p.191.

2. Information on the Clean Water Act of 1972 is taken from *Lifelines: The Case for River Conservation* (Island Press, 1994) by Tim Palmer. His discussion is on pages 100-103.

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H2O

Watershed Address

Adapted from the Ecological Address activity from NSTW 1992-93 Curricula, National Science Foundation

Objective: To have students understand the basic concept of a watershed and to determine their watershed address.

Subjects: Geography, Earth Science, Basic Water Physics

Grades: 4-12

Skills: Map Reading, Inferring

Time: 40-50 minutes (dependent on skill levels)

Materials: World Globe, Maps (relief best but any map that shows rivers will work) of North America, Oregon, Portland, and the Metro Watershed Map.

Preparation: Obtain above maps and make copies of Coastal Drainage Map and Watershed Address worksheets for each student.

Background

Watersheds are nature's way of organizing and drawing boundaries. Put simply, a **watershed** is *all the land area that drains into a particular body of water*. Ridge lines, or the high points of a landscape, separate one watershed from the next, although many smaller watersheds are in a larger watershed with others. Watersheds can be any shape or size and can carry varying amounts of water depending on their location—desert watersheds, although much larger, may carry much less water than a coastal watershed due to prcipitation patterns.

Here in Portland, we have numerous watersheds ranging from the small creeks that snake their way through the city to the **Willamette** and up to the **Columbia**. From a few square miles of the Balch Creek Watershed up to the 258,000 square miles of the Columbia Watershed, these all eventually drain water to the Pacific Ocean where it continues along through the water cycle.

We all locate where we live by street names and cities and states to help others find us. While these street addresses are useful to other humans, they tend to overlook the features and boundaries of our natural world. A **watershed address** serves to redirect our attention to recognize *the watershed in which we live, which is usually named after the nearest stream or lake*. We look at watershed addresses to better understand natural processes, like the water cycle, and our effects on them. This watershed address is also home to many other people and many different plant and animal species. By getting to know our watershed address, we can begin to understand the connections we have with all these other plants, animals, and people.

Finally, each watershed is unique and we need to look at these differences when we make laws or plans to clean or protect them. What works in one watershed may not be as successful in another watershed. By learning more about our own watershed and watershed address, we can begin to solve the problems it has and prevent future ones.

Procedure

1. Begin by taking a sample (6-10) of street addresses from the students and writing them on the board. Have these same students come up and find their address on a city map and identify any nearby parks, streams,

or other "green spaces." Ask them what they think a watershed is and how it might relate to their street address. Make certain that they understand the basic definition of a watershed before going on.

2. Using the Oregon Coastal Drainage Map (included) and colored pencils or markers, have students trace out the boundaries of the watershed of Lobster Creek. Then have them find the Crab Creek Watershed and trace it with a different color. What towns are included in each of the above watersheds? (Denzer and Fisher) Finally, have them trace the watershed of Five Rivers in a third color. What is different about this last watershed? Finally, what river does Five Rivers flow into?

3. Next, bring out the globe and have them locate North America and Oregon. Ask them what watershed North America is in? (There is no right answer as North America has various watersheds—thousands of rivers and the three oceans that they drain into—although it is part of the global watershed.) The point here is that a continent can affect whatever oceans surround it, in our case the Pacific, Atlantic, and the Arctic.

4. On the map of North America, have the students find the Columbia River where it meets the Pacific and then trace it up to its headwaters in the Canadian Rockies. What other rivers flow into it along the way (Willamette, Deschutes, Snake, Yakima, and Okanogon are some major ones). Have students trace out the Columbia Watershed on the map to get a sense of its size (258,000 square miles). Have them locate Portland and the Willamette River and compare its size to the Columbia. (Fun facts: the Columbia is 1200 miles long and is the most powerful river in North America. The Willamette is 250 miles long, with a watershed of 11,500 square miles. It is the 10th largest river in the United States by volume of flow—how much water it carries)

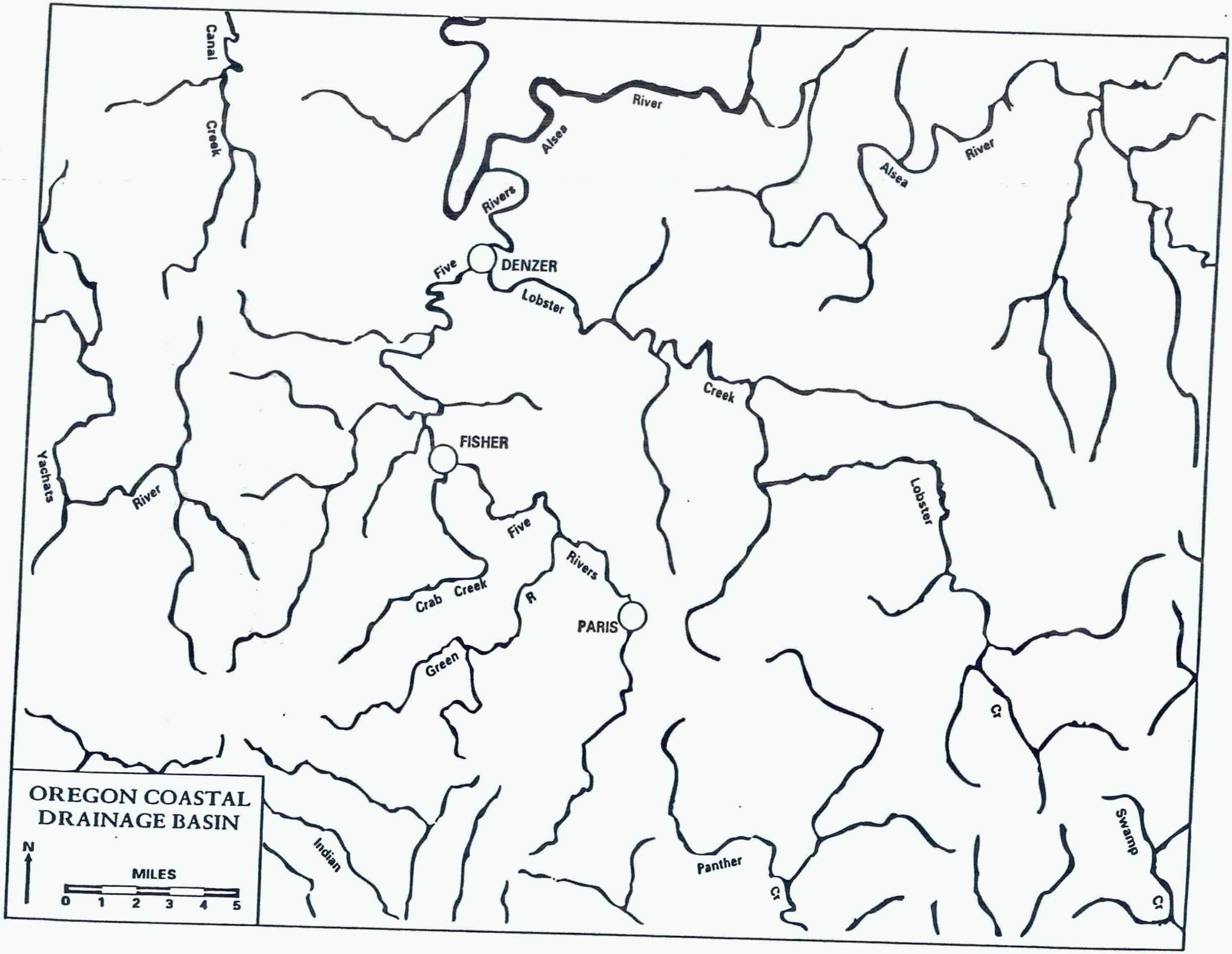
5. With the Oregon map, have them look at the Willamette watershed more closely. How many Rivers flow into it? (There are 10 major tributaries) How many cities are along its banks (Eugene, Corvallis, Salem, and Portland are the four major cities of the Willamette) Have them guess how many people live in the Willamette watershed. (70% of Oregon's population or roughly two million people) Have them trace the watershed, naming the mountain ranges that form its boundaries. (Cascades on the East, Calapooyas on the South, Coast Range on the West, and the Columbia on the North)

6. Moving to the map of Metro Area Watersheds, have the students locate their school. For those who offered their addresses earlier, have them find their homes as well. What is the name of their watershed address? What is the relative size of their watershed and how many people do they think live in it? (No figures available on this yet, we just want to get them to consider the human impact on their watershed) Are there major businesses in their watershed and if so, where are they? (More than likely, if you are on the Willamette or Columbia Slough watersheds, you will have quite a bit of industry right along the water) What other watersheds are near to the school? Finally, have them trace their local stream until it meets the Columbia River.

Further Activities:

Project WET has a number of watershed related activities: *Branching Out* (p. 129); *Rainy Day Hike* (p. 186); and *Color Me a Watershed* (p. 223). If you would like a copy of any of these, contact H2O's office at 228-9600.

Aquatic Project WILD also has some watershed activities: *Where Does Water Go After School?* (p. 75); *To Dam or Not to Dam* (p. 125); and Watershed (p. 163)



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Name________________ School________________ Teacher________________

Watershed Address

1. What is your mailing address? What is the nearest stream? The nearest park?

2. What is a Watershed and why do we care?

3. What watershed is North America in?

4. What countries, states, and provinces does the Columbia River flow through? What are some of its major tributaries (other rivers that flow into it)?

5. How does the Willamette Watershed compare to the Columbia Watershed? How many major tributaries does it include? How many cities are right next to it?

6. Share some interesting facts you learned about the Willamette River.

7. What is your school's Watershed Address? Is that watershed a part of another Watershed? If so, which one(s)? Is your watershed a small, medium, or large one when compared to others in the Portland area?

Bring this with you on the field trip--it is your ticket aboard the boat!

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H2O

Runoff Pollution

Background

Runoff pollution, known formally as nonpoint source pollution, is one of the largest threats to clean water in the U.S. today. The Clean Water Act made significant strides in cleaning up the easily identified sources of water pollution, known as point source pollution, but it has fallen short in reducing or preventing the "invisible" nonpoint sources. This runoff comes from any kind of surface that is near water or a storm drain: parking lots, streets, farm fields, open spaces like parks, and forests that have been logged bare. In urban and agricultural areas, whatever is spread on the ground, intentionally or not, can end up in a stream or lake. Even in urban areas, storm drain systems frequently dump their flows straight into the nearest body of water untreated.

The culprits of runoff pollution are varied and make this issue more difficult to address than point source pollution. Our industrial and technological era has led to the creation and production of thousands of chemicals, many whose long-term effects we do not know. From the agricultural use of chemical fertilizers, pesticides, and herbicides to household cleaners to our love for cars, runoff pollution sources range from large scale industry-wide practices to societal and personal behaviors.

Runoff pollution affects aquatic ecosystems in a variety of ways. Phosphates found in soaps and nitrates from fertilizers serve to over-nutrify algae which leads to a depletion of oxygen as the algae then decomposes. In this oxygen poor environment, fish suffocate even if only passing through. Gasoline and oil—leaks from automobile engines in addition to tank spills—can foul miles and miles of habitat, often killing large percentages of plant and animal life. Lead and other heavy metal residues from engines, buckshot, and fishing weights prove poisonous all the way through the food web. Soil and silt washed into rivers cloud out light, limit vision, and choke fish gills. Untold numbers of new chemicals appear to be causing birth defects, mutations, and lesions in aquatic organisms all over the country.

The list of culprits is lengthy, but the good news is that many of the solutions begin with simple steps. We can inspect the ingredients of many products and only purchase those that are bio-degradable. We can limit or stop our personal use of fertilizers, pesticides, and lead-based products. We can dispose of harmful substances in the proper ways rather than dump them down a drain or in the trash. And we can reduce the amount of driving we do, opting for walking or bicycling or the bus instead. This process begins with education and understanding the scope of the problem and having workable solutions ready to implement.

Objective: To explore the connection between our personal behaviors and water pollution.

Subjects: Earth Science, Biology, Some Chemistry

Grades: 4-12

Skills: Inferring, Analysis

Time: 75-90 minutes (may be split into two sessions)

Materials: Copy of Chemicals Survey worksheet for each student.

Preparation: Arrange to have access to a selection of cleaning supplies and other chemicals from each of the following areas: Kitchen & Cafeteria, Janitor Closets, and Maintenance & Grounds. If possible, have a school employee who is familiar with the use of these products join the class to assist with completing the worksheet..

Procedure

1. On a chalkboard, write the word pollution. Have students offer their definitions of pollution. Direct them to a definition that the whole class can agree with that is useful and reasonably accurate. A dictionary defines **pollution** as *the introduction of harmful substances or products into the environment; the act of making foul or unclean or dirty.*

2. Next, ask them to identify some categories of pollution. Examples include: air, noise, light, and water pollution. When they have listed as many as they can think of, inform them that we will concentrate on water pollution today. Ask them why we might care so much about water pollution. The reason is rather simple: clean water is absolutely necessary for every kind of life on this planet; without it, life as we know it would end. Share with them the fact that our very own bodies are about 75% water. When our bodies don't get enough water, we can dehydrate, which can lead to some serious health problems.

3. Ask them to identify some causes of water pollution. They will likely come up with the visible ones—factory pipes, people dumping garbage in rivers and lakes—but see if they identify some not-so-obvious sources. When they've completed their list, ask their opinion of the following activities: fertilizing your lawn or a park; dumping oil or paint down a storm drain; doing laundry; driving a car; littering on the street or a sidewalk. Let them know that all of these can (and most do) lead to water pollution.

4. Explain to them that all of the above activities are a part of **runoff pollution**. Solicit definitions of **runoff** from the class. The key is to have them understand that **runoff** *is the process by which substances on the ground trickle, seep, or flow into a body of water*. Rain, snowmelt, and watering a lawn or garden can all supply the water necessary to wash these substances away. Ask them to explain runoff pollution based on what they just learned. Explain that, while some of these pollution-causing substances are visible and obvious, many of them are invisible and hard to find and track.

5. Explain that there are many sources of runoff pollution, but that we are going to concentrate on one aspect today—chemicals that we use everyday that go down our drains. We often believe that what goes down our drains gets treated before it goes into the river. Here in Portland (and many other cities), when it rains, what goes down our drains and toilets gets mixed with the storm drain runoff from the streets and heads straight to the river because the sewer pipes can't divert the whole volume to the treatment plant.

6. Many of the harmful substances in runoff pollution are found in everyday products—dish and laundry soaps, bleach, all kinds of bathroom cleaners, motor oil, anti-freeze, paint—but many of them have safer alternatives and all have prevention strategies so that they don't get into our Rivers. What are these substances? Phosphates (found in soaps), chlorine (bleach), lead (paint and batteries), and a wide array of known and unknown chemicals whose effects we don't fully understand yet. Some of these substances are outright deadly while others alter the habitat in ways that make it more difficult for species to survive and reproduce. The H2O classroom visit will talk some more about these chemicals and their effects.

[If you are splitting this into two sessions, make that break here, leaving the survey for the final session.]

7. Pass out the Chemicals Survey worksheet to each student. Explain that they are going to take a survey of the chemicals that their school uses.

The purpose is not to have them find every chemical, but to look in a few important areas (janitor closets, kitchen & cafeteria, and maintenance & grounds) to get a general idea about what is being used overall. You may decide, if you have the people necessary to lead your students, to split them into three separate teams with each concentrating on one of the above areas. If you can't bring your students into these areas of your school, bring a sample of the chemicals to your classroom for the students to explore. Let them know that the last column (Alternative Products) will be filled in on the vessel.

8. When finished, pull the class back together and create a class-wide list of what they found. Discuss the amounts used of each product to determine which ones are used most and give them an informal ranking from highest use to lowest. Tell your students that they will learn more about these substances and how to reduce our uses of them on the field trip on the Willamette (Alternative Products). Have every student complete the entire worksheet if you split them into teams earlier.

9. Have them bring this worksheet with them on the field trip so that they can fill in the Alternative Products column.

Further Activities:

Project WET has some additional activities that touch on pollution issues: *A-maze-ing Water* (p. 219); *Sum of the Parts* (p. 267); and *Where Are the Frogs?* (p. 279). If you would like a copy of any of these, contact H2O's office at 228-9600.

Name____________________Teacher__________________________School________________

Chemicals Survey Worksheet

Location	What is it?	For what is it used?	How much is used per month?	Potential Hazard (1-10)	Alternative Products
Kitchen and Cafeteria					
Janitor Closets					
Maintenance and Grounds					

Headwaters To Ocean P.O. Box 745 Portland, Oregon 97207
(503) 228.9600

H2O

Open Your Senses

Objective: To learn basic quiet observation skills and discover more about the natural world.

Subjects: Earth Science

Grades: 4-12

Skills: Quietness, Watching, Listening

Time: 50 minutes (25 minutes outside making observations)

Materials: Copies of Greenspace Observations Worksheet for each student; a tape player with a numbered or marked volume dial and a tape with quiet music or animal calls on it.

Preparation: If possible, plan this lesson for a day when you stand a good chance for dry weather.

Background

All of science depends on observations. In a lab, technicians watch their experiments dutifully, waiting for results they can quantify. In the field, biologists spend hours watching individual animals or populations looking for more information about their subjects. In both cases, observations play a primary role in the scientific process. Without the abilities to watch, listen, and in many cases, smell, scientists would not be successful in their research and search for knowledge.

A second important aspect of observations, though, has to do with recording those observations. In more formal environments like a lab, the write up can be very specific and structured. In field research, certain structures still apply, but there is some room for more freedom in descriptions. In general, though, keeping a journal in some form, whether a journal of data sheets or a journal of blank writing sheets, becomes useful.

Even for non-scientists, the skills of observation are important and useful. We use basic observation skills when crossing the street or biking around town or when walking through Forest Park or along a river. Most of us just need to concentrate more on watching, listening to, and smelling the world around us. We also need to practice doing so while being quiet so as not to disturb wildlife that we might otherwise see. We can't forget, either, the benefits of writing down what we see, as much to remember it better as to keep a paper record of what we saw on one particular outing.

The following activity will introduce some basic observation skills and urge students to open their senses to the outside world. They can prove to be wonderful skills that will reveal to them many of the marvels of our world.

Procedure

1. Ask your students to share some of the things they have seen and heard in the natural world around them: parks, backyards, on picnics, or even walks down their street.

2. Tell them that today, they are going to learn a few things to help them observe even more. Ask them if they have some ideas that will help them do this. A few suggestions might be: keeping quiet, looking in the distance, cupping their ears, using binoculars or a telescope, etc.

3. This next section will require students to have some room to move—have them stand more than arm's length apart. Tell them this is a skill called "splatter vision." It allows your eyes to see much more than if you focus only on one spot. Have them spread their arms straight out from their sides. At the same time, have them face the front wall without focusing on anything in particular. Next, have them wiggle their fingers and ask them if they can see this without moving their heads or their eyes. Tell them to slowly bring their hands forward, still wiggling their fingers, until they can see both hands in the corners of their eyes. Have them stop and hold their arms right there. Once everyone has come to this point, tell them to look at how wide their arms are spread. The area between them is the zone of splatter vision. So long as they don't focus on any one spot, they will be able to see any movement inside this zone. Spotting animals and birds usually happens this way as we typically only see them when they move. Encourage them to practice their splatter vision as they walk through their neighborhoods or sit in a park.

4. Next, they will work on listening carefully. After everyone has quieted down, bring out the tape player and with the volume all the way off, begin playing the tape. Tell the students that you will slowly turn up the volume and that they should raise their hand, quietly, when they can hear what the tape is playing. When the whole class can hear it, write on the board where the volume dial is. Prompt them to think of ways in which they might be able to hear the tape better. Ask them what is different about a dog's or a cat's ears than theirs. (Both can swivel their outer ears to "cup" and focus the sound to their inner ear.) Suggest that they try to cup their ears and repeat the tape exercise. Again, note the volume level when the whole class can hear it. If all goes well, this number should be less than the previous figure. Encourage your students to use this ear cupping to better hear specific sounds when they spend time outdoors.

5. Ask your students what senses are left. (Smell, Taste, Touch) Ask them if any of the three can be used, or should be used, in observations. Unless they are talking about plants, touch really doesn't come into play and some plants you definitely don't want to touch. Taste is not a recommended method since some plants are poisonous. That leaves smell, a sense that we often ignore as an observation tool even though many of us are aware of scents from flowers and trees. Ask your students to list some scents that they smell everyday. Ask them how they would go about identifying more smells. The solution is simple: sniff more, just like animals do. Although our sense of smell doesn't compare to a dog's or a cat's, we can get to a point of identifying many things by their scents.

6. Now, tell your class that they will get to combine all three of these skills as they head outside to spend some time observing their school grounds/park and recording what they see, hear, and smell. Hand out the enclosed worksheet to each student and explain the directions if necessary. Encourage them to remain quiet as they explore the area—we recommend keeping them in groups of three or less. We encourage at least 25 minutes for this exercise. Remind them to draw a map of the greenspace on the back of the sheet.

7. When they are all done with the observations, have students share some of what they found out there. You may wish to draw a larger scale map on a piece of paperboard to display in the classroom. Have the class decide what goes on it and where it should go.

Further Activities:

Project WET has some observation oriented activities: *Water Log* (p. 19) and *Stream Sense* (p. 191). If you would like a copy of any of these, contact H2O's office at 228-9600.

e____________________________Teacher___________________________School___________________________

Greenspace Observations Worksheet

1. Spend the first ten minutes quietly standing or sitting still in one spot. Just listen and watch and sniff. Answer the following questions, giving descriptions that include colors, sizes, how loud or quiet, rhythm (fast or slow), and sweetness (sweet or sour smells): What do you see? What do you hear? What do you smell? If you know the name of the plants or animals that you observe, write them down as well.

2. Make a count of the number of animals you observe and why you say there are that many (i.e. I heard two different whistles so I think there are at least two different birds plus I saw three more for a total of five birds).

3. Make a count of the different kinds of plants, bushes, and trees that you see. How many of each kind are there? (i.e. Six trees total, 2 maples, 1 oak, and three firs) If you don't know the names of them, describe the differences in their leaves or needles or flowers.

4. On the back of this sheet, draw a map of the area you are observing. Include buildings and playgrounds and plant life.

Greenspace Map

Additional Resources

Organizations

Oregon Trout
117 SW Front Avenue
221-9091

Wolftree, Inc.
3735 SE Clay
239-1820

Portland Audubon
5151 NW Cornell
292-6855

Jackson Bottom Wetlands
123 W Main Hillsboro
681-6206

Publications

Cascadia Times
25-6 NW 23rd Place, No. 406 Portland, OR 97210

Sierra
Sierra Club
730 Polk St. San Francisco, CA 94109

E Magazine
P.O. Box 699 Mt. Morris, IL 61054

National Geographic
National Geographic Society
1145 17th Street NW Washington, DC 20036-4688

High Country News
P.O. Box 1090 Paonia, CO 81428

Earth Island Journal
Earth Island Institute
300 Broadway, Suite 28 San Francisco, CA 94133

Books
(all available through the Multnomah County Library)

Non-fiction

Water: A Natural History
Alice Outwater

Lifelines: The Case for River Conservation
Tim Palmer

This is a River: Exploring an Ecosystem
Laurence Pringle

The State of the Northwest
John C. Ryan

Adopting A Stream: A Northwest Handbook
Steve Yates

Mountain in the Clouds: A Search for Wild Salmon
Bruce Brown

River Notes: The Dance of the Herons
Barry Lopez

Down the River
Edward Abbey

Reach of Tide, Ring of History: A Columbia River Voyage
Sam McKinney

Fiction

Winterkill and *Riversong*
Craig Lesley

The River Why
David James Duncan

Curricula

Project WET
Published by The Watercourse and The Council for Environmental Education
Bozeman, MT

Aquatic Project Wild
Published by Project Wild
Boulder, CO

Investigating Your Environment
Published by the US Forest Service
Portland, OR

The Comprehensive Water Education Book, Grades K-6
Published by Utah State University
Logan, UT

The Kid's Guide to Social Action
Published by Free Spirit Publishing
Minneapolis, MN

Headwaters to Ocean
Field Trip Curriculum Evaluations

Please share your general thoughts about the curriculum.

Were you able to incorporate this curriculum into your classroom with relative ease? If not, is there something we could do to help?

Did you find the Watershed and Pollution section helpful? Please explain? How could it be improved?

Watershed Address

Was the lesson plan easy to follow? How would you describe your students' prior knowledge and understanding of this subject? How would you describe their knowledge and understanding now?

Did the coastal map exercise work for your class? Please explain.

Did the watershed address exercise work? Please explain.

Runoff Pollution

Was the lesson plan easy to follow? How would you describe your students' prior knowledge and understanding of this subject? How would you describe their knowledge and understanding now?

Did the chemicals survey work for your class? Please explain.

Open Your Senses

Was the lesson plan easy to follow? How would you describe your students' prior knowledge and understanding of this subject? How would you describe their knowledge and understanding now?

Did the greenspace observations work for you class? Please explain.

Did we provide enough additional resources with each lesson plan? What other resources would you like to see?

Overall, was the curriculum: too short / just right / too long? Please explain.

Do you have any further suggestions for us to improve the curriculum?

Please grade the curriculum using the following scale:

1	2	3	4	5	6	7	8	9	10
Very Poor		Needs Work		Met Expectations			Above Average		Excellent