RE Sources for Sustainable Communities

YOUNG **WATER STEWARDS**

Middle School Curriculum

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All the World's Water

In-Class Activity #1

RE Sources Staff-Led

Objectives

The students will learn:

1. That the Earth has a finite amount of fresh water.
2. Ways to conserve fresh water and brainstorm ideas to increase usage of untapped water resources in their local area.

Materials

- a vessel capable of measuring 1 liter of water (beaker, graduated container, etc.)
- 5 see-through containers
- scale that can measure grams
- water
- marker & labels to label each container
- Image of the world

Duration

Half of one 55-60 minute class period

Background Information

Our planet's surface may be mostly covered in water, but how much of that can we use? In this activity, students will see how water is distributed across different sources, how much can be used by humans, and will brainstorm ways to decrease their usage of fresh water.

Vocabulary

- **resource:** a natural, economic, or political asset that can be drawn upon when needed
- **desalination:** a process that removes salt from seawater to produce drinkable water
- **fresh water:** water that contains minimal amounts of salt (as opposed to saltwater in the oceans)

- **Tare:** to set the scale to zero when a container is already on the scale, this allows you to measure the contents of a container rather than the container plus the contents

Procedures

1. Introduction
   - Brainstorm with your students about how people use water. We need to drink water in order to survive. We also use water in many other ways, such as bathing, swimming, watering the lawn, doing the laundry, etc.

   - Ask your students where we get the water we need. Have them brainstorm natural sources of water.

   - For this activity, we will be looking at how water is distributed across these sources:

     - oceans
     - groundwater
     - lakes
     - ice
     - swamps
     - rivers

List these sources on the board so they will be visible throughout the activity. Discuss them with your students, making sure they understand what each one means.

2. Have a student fill the large container with 1000 grams of water, 1 g of water is equal to 1 mL.

3. Have a second student come up and measure off 30 g into new container, ask the students to do the math, what percentage of water is in the new container. The two containers now represent salt water (larger container with 97% of the water) and fresh water (3% in the small container).

4. Show an image of the world and ask what all the white stuff is. They will respond with "ice". Ask how thick they think the polar caps are. The ice cap over the north

pole is on average 3-4 meters thick with ridges that are 20 meters thick. Antarctica has ice that is over 4000 meters thick! Have a new student pour out of the 3% “fresh water” jar 20.6 grams of water into a new container. This 20.6 represents the fresh water that is frozen primarily at the north and south poles. Have the student label this container “ice”

5. We now have remaining less than 1% (about 10 g of water) of our total water in our “fresh water” container. Have a new student pour 9 grams into a new container and label the container “groundwater”. Groundwater is also known as aquafers, humans access groundwater through wells. Groundwater is slow to recharge and can be very expensive and sometimes not possible to clean the water if it becomes contaminated.

6. The remainder of our “fresh water” container represents the fresh water that is in lakes, rivers and swamps. Re-label the container “rivers, lakes, & swamps”. If you have a scale that can do small enough measurements you can divide these three sources out.

Measurements of Water:

- ocean: 970 mL
- ice: 20.6 mL
- groundwater: 9.0 mL
- lakes: 0.08 mL
- swamps: 0.01 mL (roughly 5 drops)
- rivers: 0.002 mL (roughly 1 drop)

6. Refer back to the numbers written on the board. Point out that while there is a large amount of water on the planet, only 3% of that is fresh water. 97% is found in the oceans. That limited amount of fresh water must support a growing population of humans in addition to plant and animal life and agriculture.

7. Tell the students they can drink the liquid if they want to, but must first decide how to divide it among the group members. (Remind the ocean group not to drink their salty water.) Have the groups discuss how they might share their portion of water,

considering that the water has to accommodate the needs of plants and animals as well as humans.

8. If desired, you can extend the discussion to consider how water might be distributed equitably. Some groups of students have more water than others. Is this fair? What could be done about it?

Lesson adapted from California Academy of Science https://www.calacademy.org/educators/lesson-plans/earths-water-a-drop-in-your-cup

Getting to Know Nonpoint Water Pollution

In-Class, Activity #2

RE Sources Staff-Led

Objectives

The students will learn:

- The difference between point and nonpoint sources of pollution
- The 4 major sources of nonpoint water pollution
- The major concerns with each source of nonpoint water pollution

Materials

- Nonpoint Water Pollution Fact Sheets- (print in advance, based on how many small groups you plan to have, one factsheet per student)
- Pollutants Worksheet, provided at the end of this document- 1 per student (found in the Appendix, pg 21)

Duration

Half of one 50-60-minute class session

Background Information

There are two ways pollutants enter our waterways and affect the health of the watershed:

- **Point Source Pollution** comes from a single, identifiable source, such as a pipe, ditch, ship or industrial factory. Point source pollution is easier to control because the source is identifiable, therefore regulations can be developed to limit pollutants.
- **Nonpoint Source Pollution** comes from many sources and is thus more difficult to control. Nonpoint sources of water pollution are the number one contributor to water quality issues in our local watershed. Nonpoint source pollution is generated in rural, urban and sub-urban areas and impacts the health of our watershed. Understanding the sources of nonpoint water pollution is essential in understanding how we can keep our watershed healthy.

Lesson Plan:

1. Tell your students that you are starting a program called Young Water Stewards and that in order to prepare for the guest presenters and upcoming fieldtrip, you are going to do an introductory activity to prepare them with some basic knowledge about water pollution.
2. Divide your classroom into 4-8 small groups, assign each group a category of pollutant and give them each a copy of the corresponding fact sheet: 1) Nutrients, 2) Suspended Sediments, 3) Pesticides and Toxic Chemicals and 4) Bacteria, Viruses and Trash.
3. Have students read their fact sheets as a group and then discuss it. Next, have them answer questions 1-3 on the worksheet, and then the first set of questions for their type of pollutant.
4. Ask each group to select 1 or more students to share the answers for their pollutants with the rest of the class.
5. As a class, discuss the answers to questions 1-3.
6. Give each group time to share their answers for the pollutant categories with the class. Students from other groups should take notes to fill out the pollutant worksheets for each category, so that by the time each group has shared, all the students will have the answers for each of the four major

categories of pollutants. Give students time to ask questions and thoroughly describe what they learned in their reading.

7. As a class or back in small groups, answer the final question.

Conclusion

Non-point source pollution is entering our waterways through surface runoff. The contamination is happening on land within the watershed and then storm water carries the non-point source pollution into the water. Pollution changes water quality which can harm aquatic animals, humans, and the overall health of a watershed.

Make Your Own Watershed (MYOW)

In-Class Activity #3

RE Sources Staff-Led

Learning Objectives
Students will learn

· Why we need clean water
· Review major types and sources of pollution
· The major functions and systems in a watershed
· How pollution moves through a watershed

Materials

- Student Pre-Survey: What is a Watershed?
- Student worksheet: Label the Parts, to be completed alongside the PowerPoint Presentation
- PowerPoint # 2: Watersheds
- Build a watershed materials:
  - Model pieces (farm animals, buildings, cars)
  - Contaminants (food coloring, chocolate sprinkles, glitter)
  - Spray bottles
  - Tarp
  - Newspaper
  - If repeating for multiple classes you will need a way to clean off the tarp in between classes

Lesson Plan

Introduction and Pre-Survey (12 min)

If I started by saying, I'm here to talk about THE most important thing in the world- what would you guess I was going to talk about? Water, that's right, and not just any water, but CLEAN WATER.

2. To understand the importance of clean water, first we need to get a few other concepts straight. First off, we need to all be on the same page about this: A Watershed. I want you to take a couple minutes and tell me on this sheet of paper, everything you already know about a watershed.

3. Have students complete pre-survey: What is a Watershed? Draw a picture of one and label as many parts as you can (distribute worksheet)- assure them there's no grade and they should just put what they know.

4. Collect worksheets and ask students how they felt about their answers. If they didn't feel good, assure them that's what we're here to learn! If they did pretty well, tell them that this week is all about deepening their knowledge of a watershed and learning about how we can take actions in keep our water clean.

SPLIT CLASS IN HALF - some stay in class and some go "build a watershed" (3 min)

In Class (20 min):
Review the concept of a watershed and the various components with PowerPoint #2

Have students follow along on the second worksheet: Label the Parts. This will get them acquainted with the different parts of a watershed, which will be the basis of this program.

Build a Watershed (20 min.):

This is basically a review of point and non-point source pollution that they learned in the pre lesson.
Using newspaper to build the topography and laying a tarp over it creates your base for the model.

1. Develop Land: Create your landscape using crumpled up newspapers. There should be some topography - high and low places to create creeks, streams, rivers, lakes, mountains.
2. Cover Ground: Cover the entire landscape a blue tarp. Ensure that the topography is representative of a watershed - again high and low places to create creeks, streams, rivers, lakes, mountains.
3. Establish verbally where all the water would drain to or the common outlet. Demonstrate by making it rain.
4. Put in land-use areas by placing
    - Homes, barns, factories,
    - Animals and farms
    - Cars and roads tieing the community together
    - Riparian Zones and wetlands
5. Pollute:
    - Suspended sediments (dirt) , nutrients (food coloring), bacteria (sprinkles) near Homes, barns, factories,
    - Bacteria (sprinkles), pesticides (food coloring) near Animals and farms
    - Toxic chemicals (food coloring), heavy metals (glitter) near Cars and roads

6. Rain! Use the spray bottle or watering can to start a rain shower in the mountains. The "pollution"wash down through the watershed, ending with very dirty water in the lake, streams, rivers and finally to the outlet in this case, Drayton Harbor.

Points to talk about:

- Without human land use, there wouldn't be much pollution
- What did the wetland/sponge do to the pollutants and/or the water?
- Is there a better way to lay this out? Should all the farms be in one place and all the people live in another?
- Lastly, if there's time you can talk about remediation - covering dirt piles during construction, lining manure lagoons, using fertilizer and pesticides sparingly (or not at all)

Field Trip — Local Watershed Observations, Activity #4

Teacher Participation, RE Sources Staff-Led

Water Quality Background
(source: NSEA Swimming Upstream Program)

Three-quarters of the earth is covered by water. A small quantity of this water is regarded as fresh water, and only a small amount of the fresh water is usable by humans. The water cycle is an endless process of water being exchanged among clouds, land, plants, and oceans; the water cycle recycles all the water that covers the earth.

In Whatcom County, water comes from moisture-rich clouds that form over the Pacific Ocean and attempt to rise over the Cascade Mountains. The water vapor cools as it rises, condenses, and falls (precipitates) as rain in our watersheds. The water can precipitate as snow and become trapped in glaciers or the mountains, or it can form as rain and fill our lakes and streams.

A Watershed Approach

A watershed is all of the land from which rain, snow and underground springs drain into a stream or other water body. Land uses in the watershed affect the water quality of streams because any pollution on the land washes into the stream when it rains or snows. Stream systems are powerful, yet delicate forces of nature. Poor land management and development practices can cause detrimental impacts to the quality of life for both salmon and people. In Whatcom County, our watershed is made up of hundreds of tributary streams, many of which are home to salmon. These tributaries most often lead to larger water bodies including the Nooksack and Red/Lummi River, which then flow out to the ocean. Our everyday actions have a direct impact on the health of our waters.

Biological Stream Monitoring

Monitoring is an essential first step in the process of conserving and restoring our waterways. In addition to understanding the way stream systems work, monitoring can be used to assess the health of local waterways. Monitoring data can be used to document changes in stream or wetland health over time or to detect stress on the system.

Some government agencies and water resources biologists welcome the assistance of volunteer monitors. Only 19 percent of waterways in the United States are professionally monitored today (EPA 1996). Data collected by volunteers is used by government agencies to assess long-term trends in water quality. Volunteer monitors also help local governments by discovering acute pollution problems on streams, such as sewer leaks or chemical spills that require immediate attention.

Whether or not data is submitted to a government agency or university, water quality monitoring can help communities achieve stream restoration goals. Monitoring can help identify water bodies in need of restoration and prioritize water bodies for restoration. Monitoring on a regular basis is essential before, during and after stream restoration. Monitoring before a restoration project helps to assess the need for restoration and can reveal pollution problems that require immediate attention. Continued monitoring after restoration helps to document the benefits of the restoration and can alert your community to additional restoration. In addition, data that documents the positive effects of restoration on a waterway may help you obtain funds and government support for future restoration efforts.

There are many methods available to monitor the condition of waterways. Monitoring includes collecting data on the physical characteristics of the stream, water chemistry and the organisms living in the water.

Station 1: Water Quality Sampling Activity

Objective: Explain the scientific importance of determining the stream's health as an indicator of the health of the watershed. By identifying water quality problems, we can better understand what improvements we need to make in the watershed. Indicators include: temperature, pH, dissolved oxygen, and turbidity.

Background Information:

Temperature:

Temperature directly affects the survival of plants and animals, but it also affects many of the physical, biological, and chemical characteristics of a stream, such as:

- The amount of oxygen that can be dissolved in the water
- The rate of photosynthesis by algae and other aquatic plants
- The metabolic rates of aquatic organisms
- The sensitivity of organisms to toxic wastes, parasites, and diseases

Cold water holds more oxygen than warm water because the solubility of gases increases in cold water. Most aquatic organisms become the temperature of the water that surrounds them. Their metabolic rates are controlled by temperature, and they are most efficient within a limited range of temperatures.

If temperatures are too high or too low, the metabolic functions of the organism can slow or stop, causing the organism to die. These extremes, or lethal limits, vary among different species of fish. Salmon have the highest chance of survival in water that is between 5-20^{O}C (40-68^{O}F). Temperatures higher or lower can kill fish.

When water temperature increases, naturally or artificially, algal blooms can occur. Algae growing in abundance creates loads of decaying algae that sinks to the bottom referred to as detritus (decaying organic matter). The detritus allows large populations of bacteria to become established, as they feed off the decaying plant material. The increased bacteria populations consume oxygen as they work, thereby using up critical oxygen supplies that would normally support salmon and other aquatic organisms.

Temperature is most commonly reported in degrees Celsius or degrees Fahrenheit. In environmental science and ecology, Celsius is generally used.

Causes of Temperature Fluctuations:

- Loss of shading in the riparian zone (the area between the stream or river and the land) can allow temperature to increase due to sunlight directly hitting the water.
- In summer, passage through shaded areas can lead to cooling. This occurs because soils are cooler than air during much of the summer.
- Release of water from ponds or other exposed standing water sources can increase temperatures.

- Municipal wastewater and many industrial sources can elevate temperatures.

pH:
Water ($H2O$) contains both hydrogen ions ($H+$) and hydroxide ions ($OH-$). The relative concentration of these ions determines whether a solution is acidic or basic. In pure water at $20^{O}C$ the concentrations of hydrogen and hydroxide ions are equal. This is referred to as a neutral solution. In an acidic solution, the concentration of hydrogen ions is greater than the concentration of hydroxide ions. In a basic solution, the concentration of hydrogen ions is less than the concentration of hydroxide ions.

The relative proportion of hydrogen ions (H+) and hydroxide ions (OH-) is expressed in pH units (pH= power of hydrogen). In most cases the concentration of hydrogen ions (H+) can be used as a very close estimate of pH. pH is a measure of the intensity of the acidic or basic character of a solution at a given temperature. The pH scale ranges from 1 (extremly acidic) to 14 (extremely basic), with pH 7 being neutral. For example, if the sample solution has more H+ ions than OH-ions, it is acidic and has a pH of less than 7. If the sample contains more OH- ions than H+ ions, it is considered basic with a pH greater than 7. It is important to remember that pH is measured on a logarithmic scale, so a change of one pH unit means a ten-fold change in concentration of (H+) and (OH-). The logarithmic scale is the same principle used in the Richter scale for rating earthquake intensity.

pH is an important measure of water quality because many plants and animals, especially macroinvertebrates, are sensitive to slight changes in pH. There are many natural variables that can affect pH including water temperature, oxygen, and carbon dioxide levels. Waters with higher temperatures have slightly lower pH values. The presence of CO2 affects pH by creating waters that are more acidic. Salmon have a limited pH range in which they can live. A pH of 7 is neutral which is best for salmon. However, salmon will survive in a pH range of 6.5-8.5.

Dissolved Oxygen:
Oxygen is as important to life in the water as it is to life on the land. Most aquatic plants and animals require oxygen for survival and the availability of oxygen affects their growth and development. The amount of oxygen found in water is referred to as the dissolved oxygen concentration (DO). DO is a very important measure of the health of a stream - the presence of too much or too little oxygen in the water is often a sign that the stream is stressed and not able to support aquatic organisms. Dissolved oxygen levels vary from stream to stream, as do aquatic organisms' tolerance for low dissolved oxygen levels.
DO is also affected by:

- Temperature (oxygen, like all gases, is more soluble at lower temperatures)
- Altitude/atmospheric pressure
- Water turbulence
- The growth of plants
- The amount of decaying organic matter in the water
- Physical, biochemical, and chemical, activity in the water

Two important pieces of information are required for meaningful interpretation of DO. The first is the amount of oxygen dissolved in a water sample (measured in mg/L) and the second is the temperature of the stream at the time DO was measured. As water is warmed, less oxygen is able to remain dissolved; warmer waters cannot hold as much oxygen. With these two pieces of information one is able to determine the percent of DO held in the water relative to the maximum amount of oxygen that can be held in water at that particular temperature. For short periods of time water may become supersaturated, holding more oxygen or other gases than it would naturally. Super saturation can be harmful to aquatic organisms, causing a condition called gas bubble disease, which is similar to the bends sickness that deep sea divers may get if they surface too fast. Below is a summary of dissolved oxygen levels.

General Water Quality Standards	
Type of Water	Standard DO (mg/L)
Salmonid Spawning	>11.0
Cold Water Fish Habitat	>8.0
Cool Water Fish Habitat	>6.5
Warm Water Fish Habitat	>5.5

Turbidity:
Turbidity refers to the cloudiness of water in a sample from a stream, lake or marine environment. Turbidity is caused by materials suspended in the water scattering and absorbing light rather than allowing it to be transmitted in a straight line. Clay, silt, fine organic and inorganic material, plankton, and other microscopic organisms all contribute to the turbidity of the water. The direction and intensity of the scattered light depends on the size, shape, and composition of the suspended particles.

Turbidity is important because light affects the biological growth and chemical reactions in the stream. If a stream is very turbid (has high amount of suspended material) then light will not reach very deep down and many natural processes cannot proceed below that depth. High turbidity can be an indication of natural and manmade disturbances in the stream system.

Turbidity Tubes can be used for a more scientific measurement. Turbidity Tubes are long and cylindrical, and are marked with measurements in Nephelometric turbidity units (NTU's) on the side. The tube is filled with a sample of water and a reading is taken when the secchi disk at the bottom of the tube can no longer be read.

Salmon need reasonably clear water and do best in water where you can see the bottom of the stream. The water quality standard expressed in NTU's is based on the amount of increase compared to measurements of background conditions.

Materials

- DO Kits (with thermometer), procedure listed in Appendix
- pH Kits
- Turbidity Tube
- YSI meter
- Plastic containers (for temp)

- Waste water containers
- Goggles
- Gloves
- Hand sanitizer
- Data factsheets- laminated
- Trash bag for used gloves, etc.
- Data recording sheets for students, on the last page of this description

Lesson Plan:

1. Head down to the creek with students and have any antsy students assist you in collecting water samples to be tested back at stations. If students are too out of control, collect the sample on your own.
2. Once back at the water quality station, demonstrate testing methods as students perform measurements along with you. Be sure students wear proper safety equipment (gloves, goggles).
3. Discuss the ecological requirements of freshwater species in relation to each parameter as you go. Students will record their results on worksheets.
4. Using thermometers, HACH testing kits, and turbidity tubes, students will measure water temperature, dissolved oxygen, pH, and turbidity of the stream.
5. Have students analyze their results in comparison to habitat requirements for freshwater organisms to determine if the stream is healthy enough to support organisms.

Station 2: Macroinvertebrate Sampling Activity

Objectives: To identify and characterize stream health by observing macroinvertebrate types.

Background information:
(source: NSEA Swimming Upstream Program)

Macroinvertebrates are an important link in the stream's food web. Some macroinvertebrates are predators that feed on other macroinvertebrates and even small fish, and others are herbivores that feed on plants, plankton, or detritus (organic nutrients in the form of decaying native plants or carcasses of spawned salmon). Many macroinvertebrates have an early life stage that precedes a metamorphism to adults. At this larva life stage they are called 'nymphs' and can live in a stream for up to two years before becoming adults. Juvenile salmonids feed on eggs, larval and adult macroinvertebrates during the fry and smolt stages of their lifecycle. Fish populations depend on healthy macroinvertebrate populations to survive. The ability of macroinvertebrates to act as food is determined by the condition of the stream.

The insects and crustaceans that live in a waterway are indicators of water quality because all organisms require specific conditions to live. We can use the presence of benthic macroinvertebrates to measure water quality. Macroinvertebrates are large enough to see with the naked eye (macro) and have no backbone (invertebrate). Benthic macroinvertebrates live in the benthos, or stream bottom, and include insect larvae, adult insects and crustaceans.

Stream-bottom macroinvertebrates are good indicators of water quality because they differ in their sensitivity to stress in the waterway. Some benthic macroinvertebrates are very sensitive to pollutants in the water. Others are less sensitive to pollution and can be found in almost any stream. Benthic macroinvertebrates usually live in the same area of a stream for most of their lives. Sampling these macroinvertebrates in a stream is a good indication of what the water quality has been for the past few months. If the water quality is generally poor, or if a polluting event occurred within the past several months, it will be reflected in the macroinvertebrate population.

NSEA's macro sampling method identifies three groups of macroinvertebrate taxa based on their sensitivity to pollution: pollution sensitive, somewhat pollution tolerant and pollution tolerant. We collect a sample of macroinvertebrates from the stream, identify the organisms and rate the water quality. Water quality ratings of excellent, good, fair and poor are based on the tolerance levels of the organisms found and the diversity of organisms in the sample. A stream with excellent water quality should support organisms from all three pollution tolerance groups.

Water quality can be inferred via macroinvertebrate assemblages because they have a wide variety of tolerances to pollutants and are easy to catch. Different species and their relative concentrations are used to assess the quality of the stream. Some macroinvertebrates are very tolerant of polluted conditions and some are not. If a stream has a high occurrence of those species which cannot tolerate the presence of pollution (or pollution-intolerant species), it indicates that the water quality is good. Conversely, if a stream lacks pollution-intolerant macroinvertebrates and has a high occurrence of pollution-tolerant macroinvertebrates (species which can live and thrive even in polluted water), it indicates poor water quality. Many macroinvertebrates have the same requirements for life that salmon do (high water quality standards), such as cool, clear water with a neutral pH and a high level of DO.

Materials

- Macroinvertebrates Dichotomous keys (laminated x 5)
- Nets (at least 5)
- Collection trays (at least 5)
- Plastic spoons (at least 5)
- Ice cube trays (at least 5)
- Magnifying glasses (one per student)
- Data reporting worksheet
- Pencils
- Clip boards

Lesson Plan:

1. Head down to the stream with or without students. Be sure to wear boots, and bring the nets.
2. Have students help by dredging up bottom sediments with feet.
3. After sediments become loose, drag net through water, allowing most of the water to drain.
4. Place the contents of the net into a collection tray, making sure it is not too full of sediment; add water to tray as needed.
5. Repeat steps 2-4 with as many trays as you need.
6. After collecting enough samples, head to the table where students will begin looking for macros with magnifying glasses.
7. Have students separate the macroinvertebrates by type in the ice cube trays.
8. Students should then try to use the dichotomous key to determine macro species:
   On the Dichotomous key, all the invertebrates are marked with a "T", "F", or "S"

- **"T"**=**"tolerant,"** meaning they are not very sensitive to pollution and usually don't require a lot of dissolved oxygen. Each taxon (each kind, *not* each individual) you find in the "T" group scores 1 point.
- **"F"**= "**facultative,"** meaning that they are somewhat sensitive to pollution and require water of good quality. Each kind you find with an "F" rating scores 2 points.
- **"S"**=**"sensitive,"** meaning these macroinvertebrate organisms are very sensitive and require water of very good quality. These organisms are often referred to as "indicator organisms," because their presence indicates good water quality that is probably not polluted with organic wastes. Each kind you find in this group scores 3 points.

9. Once students have recorded their macroinvertebrate species, have them tally the score with the above criteria, and share results with the rest of the group.

10. Have students rate the health of the stream based off of the scores they recorded.

Optional Bus Tour

RE Sources staff and teacher led

Learning Objectives

Students will learn

- How certain land uses impact water quality
- Strategies that are used to mitigate land use impacts
- Information about locally relevant land uses

Duration

One 50-60 minute class period, need a district bus

*This portion can be added to the first hour of the field trip if there is enough time

Background Information

Impervious Surfaces: Artificial structures like pavements (roads, parking lots, sidewalks, etc.) that do not allow fluid to pass through.

Turbidity: The cloudiness of a fluid, usually due to large numbers of suspended solids. High turbidity can be caused by flooding, storm surges, and increased sediment load to a water body, and usually indicates poor water quality.

Riparian Buffer Zone: Areas (usually between agriculture fields and streams) that act to reduce erosion and filter pollutants leaving fields. These zones use native vegetation to shade streams and absorb water flow and energy. Riparian buffers utilize a variety of trees, shrubs, and grasses to improve water quality.

Lesson Plan:

1. First, students will meet in the classroom. There, you will start by introducing both where the bus tour will be going, and why students are going on the field trip. Be sure to go over bus safety and etiquette before heading out. This could be done in the classroom or once students are on the bus.
2. As you drive through the watershed area, point out different land use practices you see, like neighborhoods and industrial sites. Discuss water quality impacts of these locations, and discuss pollution issues associated with storm water runoff and impervious surfaces.
3. If available, try to stop by an agricultural area with a nearby stream or water source. Discuss potential impacts from agriculture and dairies, including manure applications. Observe what the

water in the nearby stream looks like, talk about whether it is clear or turbid, and briefly discuss what that could imply about the water quality.

4. While continuing on the bus tour, observe agricultural fields (if possible), stream buffers, forested areas, and explain what impacts these have on water quality.
5. If you can, find a riparian buffer zone that students can stop to observe. Explain the importance and benefit of shade, native species, width, and sediment type to water quality.

Data and Stewardship

In-Class, Activity #5

RE Sources Staff-Led

Learning Objectives
Students will learn

- To identify trends and correlations in data
- Nonpoint pollution best management practices for urban and rural settings
- Get an introduction to stewardship and the stewardship project

Materials

- PowerPoint #4: Data and Stewardship

Duration

One 50 to 60-minute class period

Background Information:

Watershed health indicators: Temperature, dissolved oxygen, macroinvertebrates (type and amount), pH, and turbidity. These indicators are explained in the field trip lesson plan.

Water quality issues:

- <u>Nutrients</u>: the most harmful nutrients to water quality are phosphorus and nitrogen in excess. When too much nitrogen and phosphorus gets into the water system, it can cause harmful algal blooms that decrease oxygen available to other organisms, causing massive die-offs.
- <u>Pesticides and Toxic Chemicals:</u> Too many pesticides applied to crops can wash into nearby streams, creating toxic environments for many aquatic species like fish and frogs. The EPA defines a toxic chemical as a substance that may be harmful to the environment, or hazardous to your health if inhaled, ingested or absorbed through the skin.
- <u>Trash</u>: Degrades habitat, aids disease spreading, and can disturb or kill many aquatic species. The Great Pacific Garbage Patch is one such area that contains 7 million tons of garbage. If time permits, you can show the Pacific Garbage Patch video, which is about 10 minutes long.
- <u>Bacteria and viruses:</u> The presence of bacteria and/ or viruses in water can kill aquatic animals and cause humans to get sick. Pathogens can be ingested accidently, and can have severe side effects. For example, fecal coliform is one of the biggest problems locally, which has caused shellfish beds to close.
- <u>Fecal Coliform:</u> A bacteria found in warm-blooded mammal feces. The amount of fecal coliform increases with increased sewage waste and manure.

Other things to know:

- <u>Best Management Practices</u>: Defined as a practice, or combination of practices that is determined to be effective and practicable at preventing or reducing the amount of pollution generated. These practices are developed with water quality in mind, and aim to reduce nonpoint source pollution.
- <u>Stewardship:</u> Responsible use and protection of natural resources by those that use said resources. Maintaining sites so they can live up to their environmental potential.

Lesson Plan

1. Introduction: Start by asking students what they learned on the field trip to the chosen watershed location. What do they remember the dissolved oxygen level to be? How clear was the water? What was the temperature? Do they remember the invertebrates and organisms they saw? What were they? What does this data tell us about the quality of the water?
2. To further understand the importance of clean water, we need to talk about the different ways water quality can be affected. Use PowerPoint 4: Data and Stewardship to go through the different water quality problems we are facing today.
3. The second half of the Data and Stewardship presentation is a move around activity focusing on Best Management Practices. Introduce the concept of Best Management Practice, that they are scientifically tested, designed by engineers, and constantly changing as new and improved methods are being designed. Instructor will present a situation on non-point source pollution and students will move around the room to the corner that represents what they think the Best Management Practice is.
4. Next, explain the word 'stewardship', and let the students know that they will be completing a stewardship project on campus (or wherever the project will be completed). Include pictures of the site the project is taking place, and explain why stewardship is important in that area.

Stewardship Project

Outside, Activity #5

RE Sources Staff and Teacher-Led

Learning Objectives
Students will learn

- What a stewardship activity entails
- The importance of stewardship activities on both local, and global scales
- How to get involved in more stewardship activities around their community

Materials

- Shovels (for blackberry removal)
- Rakes (for blackberry removal)
- Buckets
- Gloves
- Litter Grabbers
- Garbage Bags
- Truck for hauling

*Dependent on weather: Students are expected to bring jackets, long pants, and boots for themselves

Duration

One 50 to 60-minute class period

Background Information

- Invasive species: A plant, animal, or fungus that is not native to a specific location, which has a tendency to spread to a degree that can cause harm to an environment or species. Himalayan Blackberry is one invasive species in Washington. These are harmful because they out-compete native trees that require sun to grow, and can inhibit wildlife from accessing resources.

Lesson Plan

1. In-class before heading outside: Start by asking students if they remember what 'Stewardship' means.
2. Next, explain the word stewardship if you need to, and let the students know that they will be completing a stewardship project on campus (or wherever the project will be completed). Show them the image of the area they will be working in, and explain the importance of stewardship in that area.
3. Take students to the destination, and explain the project more thoroughly. If they are doing both blackberry removal and litter clean-up, split the group in half or let them chose what they want to do.
4. The goal is to pick up as much litter and/or remove as much blackberry as they can. If multiple classes are participating in this activity, make it a competition to see which class can collect/remove the most.

Optional Culminating Project

*See research guide

Appendix

Worksheets and Factsheets

Alignments with Next Generation Science Standards:
Disciplinary Core Ideas
ESS3.C: Human impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
    - This DCI is present throughout the entirety of the program, and much of the material has been structured to incorporate this core idea. Students will learn about how natural resources, like our watershed, must be managed responsibly for the benefit of everyone in the community.
    - Students will gain an understanding of how to responsibly manage natural resources themselves by learning about Best Management Practices in activity #4, and will then apply those practices to a hands-on activity in class.
    - Students will also learn how water quality sampling and macroinvertebrate populations are indicative of responsible resource management efforts in the field trip activity.

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- …Extreme fluctuations in conditions or the size of any population, however, can challenge functioning of ecosystems in terms of resources and habitat availability.
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species.
    - This core idea is the basis for the Young Water Stewards program, and students will learn about pollution sources in the first activity, and will continue to learn about them throughout the program.
    - This DCI will also be addressed in the Data and Stewardship worksheet and PowerPoint (activity #3), where students will learn to think about how water quality issues affects the health of different organisms, including humans. Students will get to learn about a wide range of pollutants, and will then be able to apply that knowledge to an in-class activity and the stewardship project.
    - If teachers decide to incorporate a culminating project, students will get the chance to apply what

Crosscutting Concepts

- Cause and Effect: Empirical evidence is required to differentiate between cause and correlation and to make claims about specific causes and effects.

- Systems and System Models: When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.
- Stability and Change: Much of science deals with constructing explanations of how things change and how they remain stable.
    - Students will be exposed to these crosscutting concepts during their first RE Sources Staff-led activity when they get to draw and label a watershed, and investigate the Whatcom Explorer watershed model.
    - Students will learn a wide range of concepts regarding watersheds, and will be able to predict and determine the health of a stream based on what they've discovered.
    - Furthermore, students will have the ability to share their experience with the community if the class decides to take on the culminating project.

Scientific and Engineering Practices:

- Using mathematics and Computation Thinking: Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.
- Constructing Explanations and Designing Solutions: Design or refine a solution to a complex, real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritize criteria, and tradeoff considerations.
- Scientific Investigations Use a Variety of Methods: Science investigations use diverse methods and do not always use the same set of procedures to obtain data.
    - These scientific and engineering practices will be addressed throughout the program, but will be especially addressed if students complete the culminating project. Students will research and investigate important water quality problems, and try to come up with solutions to mitigate those issues.

Connections to Nature of Science:

- Science is a Human Endeavor: Scientific knowledge is a result of human endeavors, imagination, and creativity.
- Science Addresses Questions about the Natural and Material World: Science knowledge indicates what can happen in natural systems—not what should happen.

Getting to Know Nonpoint Water Pollution
In-Class Activity #1—Worksheet

What is the difference between Point Source and Nonpoint Source water pollution?

Why do we care about water pollution?

What are the four major categories of nonpoint water pollution?

1) Nonpoint Source Water Pollution Category:

____

(*write name of category*)

- How does this type of nonpoint source pollution end up in the water? Describe the process.
- What are the harmful effects of this pollutant for humans and/or aquatic species?
- Can you think of ways you directly or indirectly contribute to this type of nonpoint source pollution?

2) Nonpoint Source Water Pollution Category:

____

(*write name of category*)

- How does this type of nonpoint source pollution end up in the water? Describe the process.

- What are the harmful effects of this pollutant for humans and/or aquatic species?
- Can you think of ways you directly or indirectly contribute to this type of nonpoint source pollution?

3) Nonpoint Source Water Pollution Category:

____

(*write name of category*)

- How does this type of nonpoint source pollution end up in the water? Describe the process.

- What are the harmful effects of this pollutant for humans and/or aquatic species?

- Can you think of ways you directly or indirectly contribute to this type of nonpoint source pollution?

4) Nonpoint Source Water Pollution Category:

____

(*write name of category*)

- How does this type of nonpoint source pollution end up in the water? Describe the process.

- What are the harmful effects of this pollutant for humans and/or aquatic species?

- Can you think of ways you directly or indirectly contribute to this type of nonpoint source pollution?

Thinking Ahead:

Have you seen or heard about any solutions in our community to deal with nonpoint source pollution?

Pre-Survey: What is a Watershed?
In-Class, Activity #2

1.) What is a watershed? Briefly define the term. If you are unsure, you can write, “I don’t know.”

2.) In the box below, draw a watershed and label as many parts as you can.

3.) List two ways that human land uses impact water quality. If you are unsure, you can write, “I don’t know.”

4.) Label the following water pollutants as either nonpoint source or point source pollution.
Write “NP” for Nonpoint source and “P” for Point source. If you are unsure, write “IDK”

_______ Industrial facility waste

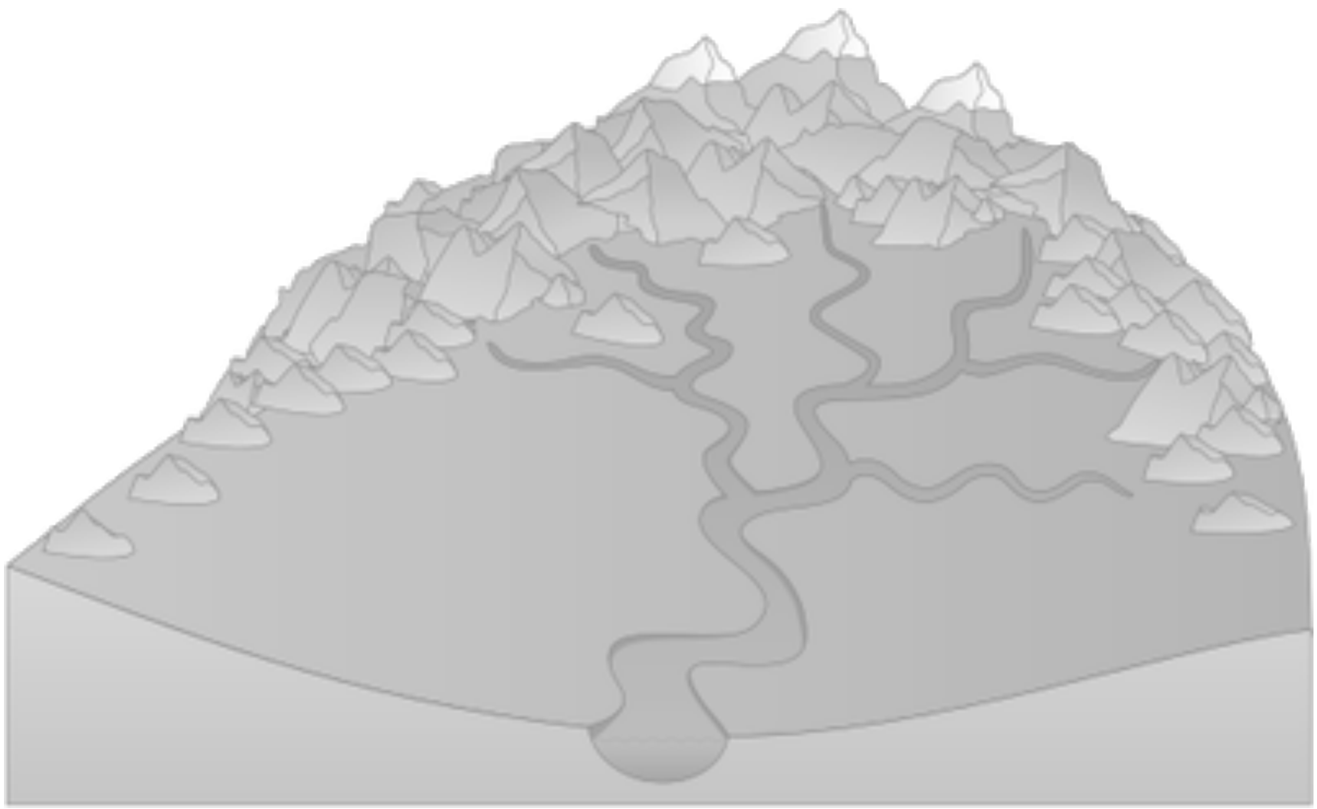
_______ Stormwater runoff

_______ Excess nutrients from a farm

_______ Garbage/ Litter

Label the Parts

In-Class, Activity #2



Student Name:	Location:	Date:	Time:

Site Observations

Weather:

Healthy elements of the stream and riparian ecosystem:

Unhealthy elements of the stream and riparian ecosystem:

Water quality prediction:

Water Quality Measurement Results				
Parameters	**Results**	**Analyze Results**		
Temperature		Between 5-13° C	Between 13-20° C	Above 20° C
Dissolved Oxygen		Between 6.5-8.5	Between 4.5-6.5 or 8.5-10	<4.5 or >10
pH		More than 9 ppm	Between 6-8 ppm	Less than 6 ppm
Turbidity		Less than 10 NTUs	Between 10-20 NTUs	More than 20 NTUs
		Excellent	**Medium**	**Poor**

Based on your data, what do you think the water quality at this creek is? Explain your conclusion.

What is one way we could help improve this creek?

Macroinvertebrate Study

Group	**How many kinds of each group did you find?**	**Multiply Times**	**Equals (score each row)**
T= Tolerant		**x 1**	
F= Facultative		**x 2**	
S= Sensitive		**x 3**	
		Total (add all three scores)	

Water Quality Rating:

___ Excellent (score of > 22)

___ Good (score of 17 – 22)
___ Fair (score of 11 – 16)
___ Poor (score of <11)

Data and Stewardship Worksheet

In-Class, Activity #4

Benefits of a Healthy Watershed

#1 ____

#2 ____

#3 ____

Water Quality Issues

1. ____
   How does it influence water quality?

2. ____
   How does it influence water quality?

3. ____
   How does it influence water quality?

4. ____
   How does it influence water quality?

What is a Best Management Practice (Best Management Practice)?

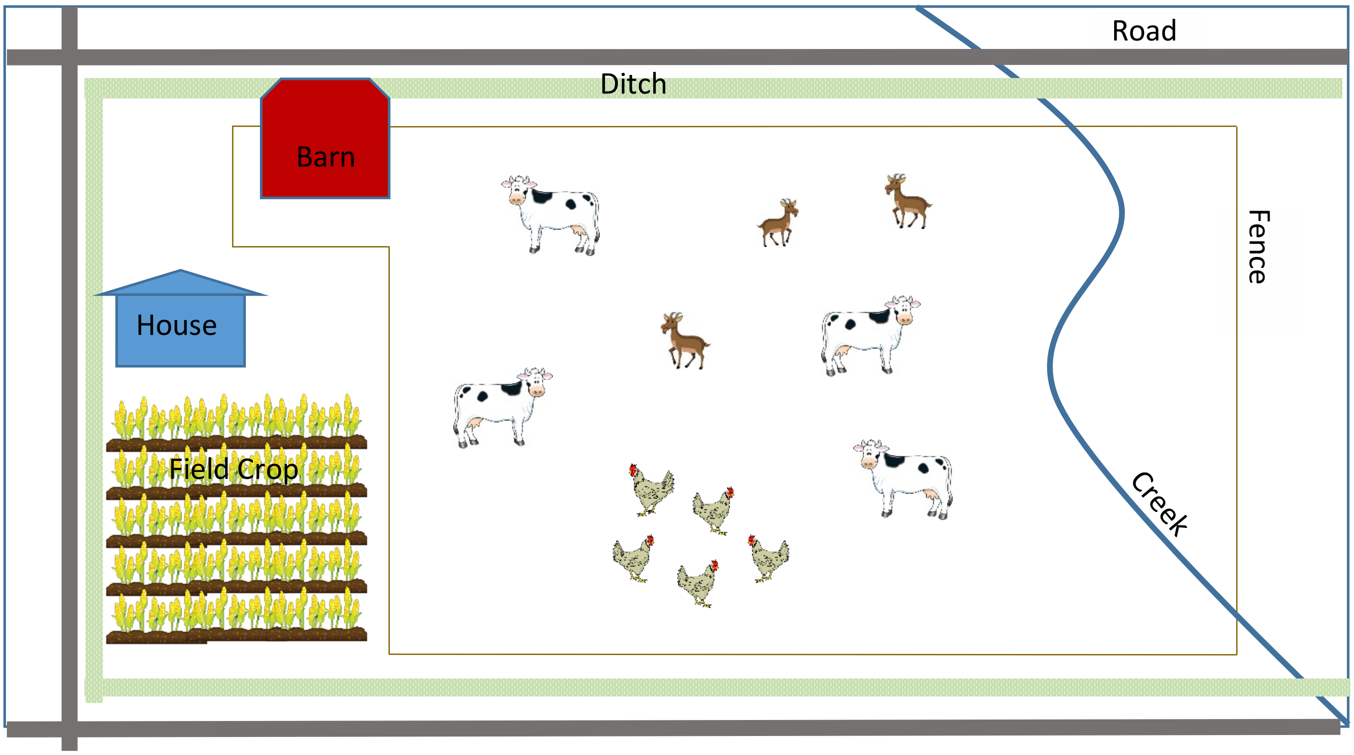
Urban BMPs

- ____
- ____
- ____
- ____
- ____
- ____

Rural BMPs

- ____
- ____
- ____
- ____

Scenario #1

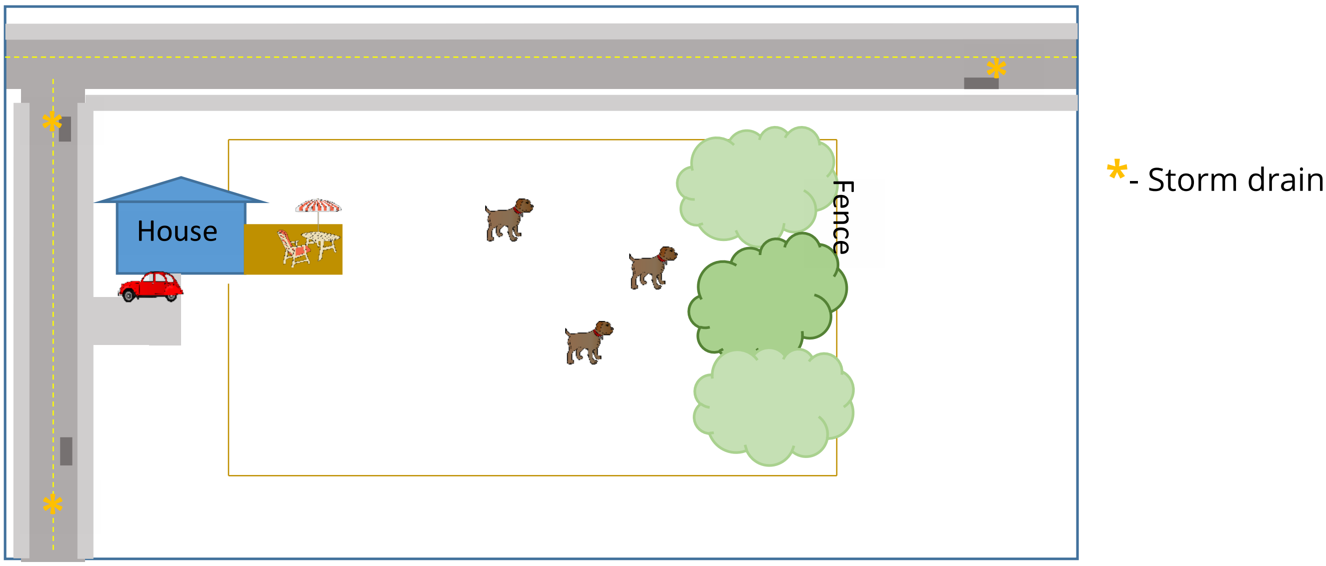


You are a hobby farmer and have a creek meandering through your grazing field. You have a few cows, goats, horses and chickens that range freely through your field, with open access to the creek. There are a few trees near the creek but very few shrubs and the area around the creek gets very muddy in the wet months from your animals accessing the creek.

What are some best management practices you could implement to help protect the watershed?

What type of pollutant is each BMP helping with?

Scenario #2



You live in a small town and have 3 dogs. They spend much of their days in your large fenced backyard. You clean up the dog poop that accumulates near your home, because you use the space often, but you rarely head out the further reaches of your yard. You have a paved drive-way and one of your favorite possession is your car, so you wash it every Sunday to keep it in tip-top condition, but it's an older model and probably needs some repairs.

What are some best management practices you could implement to help protect the watershed?

What type of pollutant is each BMP helping with?

RE SOURCES FOR SUSTAINABLE COMMUNITIES

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