SUSTAINABLE SCHOOLS

RE SOURCES FOR SUSTAINABLE COMMUNITIES

YOUNG WATER STEWARDS

2017 — 2018 Curriculum

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Young Water Stewards is a project of Sustainable Schools at RE Sources for Sustainable Communities, supported by a grant from Bay Watershed Education and Training (B-WET) at NOAA.

YOUNG **WATER STEWARDS**

Curriculum
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YOUNG **WATER STEWARDS**

Watersheds & Pollution Movement

Issue Definition & Background Research, Activity #1

Pre-Lesson, Teacher-Led

Overview:
Students build a watershed model to define what a watershed is, identify the different parts within a watershed, and discover how water moves within a watershed.

Time:
One 50-60 minute period

Objective:
- Students will be able to define what a watershed is and natural elements that are within a watershed.
- Students will be able to identify human land-uses that impact the watershed by adding pollution or creating impervious surfaces that cause run-off.
- Students will understand that pollution is carried from the land into waterways through surface runoff.

Materials:
- Student worksheet: Label the parts of a watershed, to be completed alongside the PowerPoint presentation
- PowerPoint #1: Watershed
- Watershed Kit:
    - Bag of news paper
    - 1 – 8x10 tarp
    - Watershed features laminated cards
    - 8 houses
    - 4 farm animals
    - 3 cars
    - 4 sponges
    - 3 spray bottles (filled with water)
    - food coloring (represents oil, fuel, fertilizer, grease, antifreeze, etc.)
    - chocolate sprinkles (represents poop)
    - silver glitter (represents heavy metals)

Procedures:
- Tell the students they are about to start a program called Young Water Stewards. The Young Water Stewards is an education program that identifies how human behaviors within a watershed impact the health of an ecosystem and water quality. Before starting the program, they must first learn/review what a watershed is, the natural and human made elements of a watershed, and how water flows within a watershed.
- Hand out worksheets and go through the Watershed PowerPoint presentation. Students should fill out the worksheets along with the presentation.
    - For an extension, you can have the students use three different colors to represent movement of water, natural elements within a watershed, and human developed elements in a watershed.

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- Once through with the Watershed PowerPoint presentation, the class will work together to build a watershed model with the kit provided:

Step 1: Create the topography:
- Dump out the crumpled-up newspaper and create a mountain and some hills.
- Lay the tarp over the elevation you created with the newspaper.
- Shape the tarp and newspaper as needed to ensure a mountain and a valley

Talking points:
1. all watersheds have topography, what's the biggest watershed you can think of? (I'm thinking the Earth) What's the common outlet? the oceans

Step 2: Label the parts:
- Hand the watershed element cards out to students, have them read the cards out loud and then place the card where they think that element is within the watershed.
- Add sponges to the watershed to represent how marshes, wetlands, swamps, forests, and lakes slow down and filter out the water.

Talking points:
1. Have students make predictions of what will happen when it rains. what will the happen in the area labeled lakes? wetland? etc.

Step 3: Rain:
- Have students spray down the watershed representing precipitation. The water that hits the land should flow downhill and collect in rivers, lakes, and the outlet: Puget Sound/Salish Sea.
- If areas of the watershed were mislabeled, have students move the labels to where the features actually are within their model. (e.g. If water collects in a lake and the lake card is where no water collected, have a student move the label.)

Talking points:
1. Is this what a watershed looks like? What's missing? Human impact, wildlife, etc.
2. If there were holes in the tarp to let the water run through, what would that be more representative of a watershed? What's that called? Discuss infiltration: groundwater/aquifers

Step 4: Human Impact:
Now you have the watershed properly labeled with natural features, next the class will add in human land-uses and the pollution associated with those land-use practices.
- Add cars, ask the students what type of pollution might come from cars, if they give you a valid answer they can add the "pollution" - glitter and food coloring (a little goes a long way!)
    i. Antifreeze
    ii. Heavy metals from brake pads
    iii. Oil
    iv. Fuel
- Add houses, ask the students what type of pollution might come from houses, if they give you a valid answer they can add the "pollution" - chocolate sprinkles and food coloring (a little goes a long way!)
    i. Fertilizer
    ii. Dog poop
    iii. Soap from washing windows/cars
    iv. Pesticides
    v. Herbicides
- Add farms, ask students what type of pollution might come from a farm, if they give you a valid answer they can add the "pollution" - chocolate sprinkles and food coloring (a little goes a long way!)
    i. Pesticides

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ii. Herbicides
iii. Fecal coliform bacteria
iv. Suspended sediments

Talking points:

1. Have students make predictions what will happen when it rains? pollution runs into the water and streams
2. Talk about developing in areas that were once wetlands, pervious surfaces. What happens now to the water? You can remove sponges and explain that in order to have housing developments, roads, cities, and farms; humans have logged forests, filled in swamps, and removed marshes to make way. In replacement, we have created an infrastructure of impervious surfaces where water cannot flow through. Instead the water runs off these impervious surfaces and flows directly into our creeks, rivers, and oceans. And moves faster!

Step 5: Rain again:

- Have students spray down the watershed model. “Pollution” will flow from the source into the common waterways.

Talking Points:

1. Ask the students what this water model is representing? What impacts they think we might be doing to the environment through pollution.
2. Allow students to offer solutions on how to fix the problems. Prompt with what if housing was all in one area? How about no one was allowed a dog? etc.

Conclusion:

Tell the students that next week members of the RE Sources Sustainable Schools education team will be here to talk more about pollution, the effects pollution has on our watershed, and how we can become stewards of our watershed.

Students should leave the lesson knowing the definition of a watershed, the natural elements of a watershed, and that human behavior is impacting the watershed. Students should be prepared to further discuss the problem and solutions with RE Sources educators at the next lesson.

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YOUNG **WATER STEWARDS**

Where Does Non-Point Source Pollution Come From?

Issue Definition & Background Research, Activity #2

Teacher Participation, RE Sources Staff-Led

Overview:
Students will organize cards by type of non-point source pollution, where the pollution is coming from, and the effect the pollutant has on water quality while critically thinking and discussing with peers. In three steps, students will identify the pollutant category, then what human behaviors within a watershed cause the non-point source pollution, followed by identifying the effects the non-point source pollutants have on water quality and the health of the ecosystem.

Time:
Half of one 50-60 minute period

Objective:
Students apply critical thinking about where specific non-point source pollutants come from, the effects each non-point source pollutant has on water quality, and their role in contributing to non-point source pollutants within their watershed.

Materials:
- Non-point source pollution cards
- Causes of non-point source pollution cards
- Effects of non-point source pollution cards

Procedures:
1. Tell the students that you are representing RE Sources and the students are participating in a program called Young Water Stewards. Ask the students what they think the health of their local streams and rivers are in and why. The Young Water Stewards program they are now participating in focuses on water quality, the health of the watershed, and how we can lessen our impacts and restore the watershed through stewardship.
2. Help the students differentiate point source pollution vs. non-point source pollution. Point source comes from identified factories and industries, pollution is not allowed to be discharged into the water and factories and industries must have permits and implemented cleaning or containing of pollutants to ensure they do not get into the water or on the land. You can point your finger at where this type of pollution can come from. All the rest of the pollution is grouped into non-point source pollution. Non-point source pollution is from all the activities humans and human behaviors create. We all have a part in contributing to non-point source pollution and most of us are unaware of the problem, the effect non-point source pollution has on the environment, or how to reduce our impacts. The Young Water Stewards program is designed to educate all of the participant on what non-point source pollution is, our role in contributing non-point source pollution within our watershed, and how to become stewards of the watershed by reducing the overall volume of non-point source pollution and restoring the watershed to a healthy functioning system.
3. Have the student divide into small groups of two or three people to work on the activity together.
4. In groups, students will pull out the main categories of non-point source pollution and lay them out from right to left. (see “Step 1” below)
5. Next, students will pull out the causes of the pollution and lay them out in columns below the pollution categories they are associated with. Some causes may fall under more than one category and that is OK, students can discuss how they want to deal with this by either placing the card under

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what they think is the main pollution or by putting the card in between the two categories. (see "Step 2" below)

6. Once the causes of non-point source are organized, each group should have just the effect cards remaining. Lay the effect below the type of pollution cards and the causes of pollution cards. (see "Step 3" below)
7. After all cards are laid out into a grid, have students think about the causes and identify any they might contribute to as an individual, within their house household, and their school as a collective.
8. Have students share with the class one or two non-point source pollutants they might be adding to the watershed.

Conclusion:
Emphasize that we all play a role in contributing non-point source pollution within a watershed, through the Young Water Stewards program they will learn ways to reduce their contribution of non-point source pollution, how scientists and engineers are developing ways to remove or mitigate non-point source pollutants such as rain gardens, and how they can become stewards and educate people about non-point source pollution and mitigate it through stewardship projects.

Step 1: Lay out the "Categories of Non-point Source Pollution" cards:

Chemicals & Pesticides	Trash	Grease, Oil, & Fuel	Bacteria & Viruses	Suspended Sediments	Excess Nutrients

Step 2: Lay out the "Causes of Non-point Source Pollution" cards in columns below the categories:

Chemicals & Pesticides	Trash	Grease, Oil, & Fuel	Bacteria & Viruses	Suspended Sediments	Excess Nutrients
Spray Roundup weed control	Unsecure load in truck bed	Driving with an oil leak	Livestock	Increase in impervious surfaces	Applying fertilizer to lawn
Apply slug control to garden		Dripping fuel when fueling up car	Not picking up dog poop	High stream flow	Livestock
Soapy water from washing car			Leaky Septic Tank	Logging	Not picking up dog poop
					Leaky Septic Tank

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Step 3: Place the effect cards below the cause cards in the columns associated with the types of pollutants.

Chemicals & Pesticides	Trash	Grease, Oil, & Fuel	Bacteria & Viruses	Suspended Sediments	Excess Nutrients
Spray Roundup weed control…	Unsecure load in truck bed …	Driving with an oil leak…	Livestock…	Increase in impervious surfaces…	Applying fertilizer to lawn…
Death of aquatic animals	malnutrition	Death of aquatic animals	Human illness	Smothering of eggs	Decrease in dissolved oxygen
	Plastics within food web	Smothering of gills		Loss of Habitat	eutrophication

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YOUNG **WATER STEWARDS**

Field Trip

Local Watershed Observations, Activity #3
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

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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°C (40-68°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:

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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°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 (extremely 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. The next page has a summary of dissolved oxygen levels.

General Water Quality Standards

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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 (See Worksheets)

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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 (See Worksheets)
- 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.

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YOUNG **WATER STEWARDS**

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 stormwater 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.

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YOUNG **WATER STEWARDS**

Best Management Practices & Stewardship Lesson

In-Class, Activity #4
RE Sources Staff-Led

Overview:
Students will assess water quality testing from previous class and apply critical thinking on how Best Management Practices could improve the water quality within their watershed.

Time:
One 50-60 minute period

Objectives:
- Students will compare the water quality data with historic data and tolerable parameters for salmon and macroinvertebrate life and identity trends and correlations in data.
- Students will assess the health of their watershed based on the water quality.
- Students will understand what Best Management Practices are and how implementations of Best Management Practices can help water quality.
- Students will discuss what Best Management Practices could be implemented to improve water quality of their watershed.

Materials:
- Best Management Practices & Stewardship PowerPoint presentation

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:
- Nutrients: 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.
- Pesticides and Toxic Chemicals: 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.
- Trash: 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.
- Bacteria and viruses: The presence of bacteria and/ or viruses in water can kill aquatic animals and cause humans to get sick. Pathogens can be ingested accidentally, and can have severe side effects. For example, fecal coliform is one of the biggest problems locally, which has caused shellfish beds to close.
- Fecal Coliform: A bacteria found in warm-blooded mammal feces. The amount of fecal coliform increases with increased sewage waste and manure.

Other things to know:
- Best Management Practices: 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.

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- Stewardship: 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:

1. Follow along with the Best Management Practices PowerPoint presentation which first reviews concepts discussed in the past followed why we should be conference about non-point source pollution.
2. Slides 4-14 cover water quality testing results from the past day's water quality testing compared to tolerable and intolerable levels for salmon and macro invertebrates.
3. Slides 15-24 are Best Management Practices slides, first introduce the concept of Best Management Practices, who should apply Best Management Practices, and how they are working towards solving our non-point source pollution problem.
    a. Activity: When the picture slides appear, have the students move to the corner of the room associated with what they think is the best practice to reduce non-point source pollution entering our water. Each slide, students should move to a different corner. Debrief each slide by asking students why they moved to where they did? What type of non-point source pollution is each scenario tackling? And have them call on someone in a different corner to justify why they went to where they did.
4. Have students return to their seats to watch a quick video about non-point source pollution.
5. End the presentation by talking about what stewardship is, why we should take action, and some details about their stewardship project which will happen the following day.

Conclusion:

Through an analysis of data the students collected, discussion of best management practices, and why it is important to become stewards of the watershed; students should end the class with a sense of civic duty to engage in the problem and work towards the solution of eliminating non-point source pollution from their watershed.

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YOUNG **WATER STEWARDS**

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 choose 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.

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YOUNG **WATER STEWARDS**

Optional Culminating Project

(See research guide)

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Appendix

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.

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- 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 trade-off 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.

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