YOUNG WATER STEWARDS

Extensions & Handbook to Environmental Education

Sustainable Schools
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What is this resource for?

This is a resource for teachers at 21st Century Community Learning Centers, as well as other participants in RE Sources Young Water Stewards program, to continue the Young Water Stewards program beyond the time RE Sources staff and volunteers have with your class. The more lessons catered around a subject, the better chance students will retain the knowledge, apply critical thinking, and develop a sense of place. This document contains reasons why you should supplement the Young Water Stewards program, how to take your students outside for a more inclusive learning space, resources to contact and incorporate partnerships, and lessons you can teach to your students.

Program staff and classroom teachers are in the best position to turn the Young Water Stewards program into a meaningful program. You have the knowledge of past and future lessons to tie the concepts students are learning from the Young Water Stewards into your curriculum. Teachers and program staff also have a developed rapport with students and can serve as remodels for environmental stewardship and civic engagement.[3]

Why Incorporate Environmental Education and Take the Classroom Outside?

School Performance[1]: Documented increase in standardized test scores, enhanced attitudes about school, improved behavior in the classroom, increased attendance, and overall academic achievements due to hands-on experiences, relevance, and outdoor education teaches to multiple ways of learning:

Taking the classroom outside allows for different learning styles to thrive including:[2]

- **Visual learners** – Lessons are hands on and students can see what they are learning about, rather than imagining through a text book.

- **Physical learners** – Students are outside moving around and physically doing the experiment or work.
- **Logical learners** – Students can think deeply about experimental outcomes and why the results were what they were. For stewardship projects, students can put to the test what they have done and revisit the site to see long-term outcomes.
- **Social learners** – Student can work in pairs. Outdoor education allows the space for large and small groups to work together.
- **Solitary learners** – If you have enough equipment, students can opt to work in on their own.

Health: [1] Physical, mental, and social health increases when you take kids outside. Outdoor education is linked to decrease in ADHD symptoms, decrease ins stress of both students and the teacher, and increase in physical activity.

Child Development: [1] Students who spend time outside learning develop a sense of self, independence, confidence, creativity, and increase in problem-solving and decision-making skills, empathy towards other, increase in motor skills, and in increase in self-discipline and initiative.

Sense of Place and Civic Engagement: [1] Understanding local ecology and connecting to it through lessons leads to a sense of place. A sound sense of place can lead to stronger environmental attitudes and civic behaviors.

Family and Community Engagement: [1] An increase in community and parental involvement occurs with outdoor education. Outdoor classrooms provide an entry point for families and the community to become involved in student learning.

More Fun[1]**:** Students are more likely to participate and have an increase in enthusiasm towards learning when the classroom is taken outside.

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Best Practices for Outdoor Education

- **Make Expectations of Behavior and Participation Known** – before venturing outdoors, talk with students about your expectations of their behavior and participation. Expectations can include staying within eyesight, participation is a requirement, and the work that should be completed in the allotted time outside. Set your students up for success by making expectations known. The more time spent outside the more students will understand that rules of the classroom extend outdoors.
- **Behavior Management** – For poor behavior outdoors including not following directions or not participating, follow the same repercussions as instated indoors i.e. sending out into the hall would translate into sitting alone away from where other students are working. Or sending students to the office, if still on school campus you could send the student to the office still.
- **Prepare for the Weather** – Make sure students are comfortable outside. If they are too hot, too cold, or wet their attention span for learning will decrease. Remind students they will be outside the day before and to dress for the weather. If it is hot, recommend shorts, t-shirt, ball cap, and sunglasses. Provide sunscreen to ensure no one gets sunburned. If the weather is predicted to rain, suggest a rain jacket, rain pants and boots are helpful for longer periods outside. For cold weather have students bring layers including a warm jacket, gloves, and a stocking hat.
- **Waterproof Paper** – if the students will be working around water or the forecast is expecting to rain or snow, print any handouts or worksheets on all-weather paper, such as Rite in the Rain paper.
- **Sunny or Hot days** – seek the shade for lessons and if you are going to talk to the group stand facing the sun yourself. This will allow students to stay cool and able to see you while you are presenting the lesson.
- **Hands-on Learning** – promote every student to learn hands on. Break into small enough groups with group work that all students will be active in the project.

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Risk Management

- **Increase supervision to student ratio** – Especially if going off campus, near busy roads, or near water. A good ratio for High School Students to supervision is 10:1
- **Liability Waivers** – Have liability waivers signed when leaving school property or having an outside organization work with your students.
- **First Aid Kit** – have a portable first aid kit to take with you. Include portable eye wash if using chemicals to do testing. Make sure students who use life-saving medications (such as EpiPen) have their medication with them or follow school policy to be able to carry medications with you.
- **Water**- be sure to have students bring drinking water and bring extra for students that forget, especially on warm days.
- **Phone or Radio** – take a phone (or radio if your school monitors 2-way radios) with you outdoors. Have a list of emergency contacts pre-programed in your phone or printed
    - Including:
        - 911
        - Nearest Hospital
        - School Office
- **Notify people you will not be in the classroom** – Let the principal or office know where you will take your class and time range for when you are gone.
- **Walking & Hiking** – Make sure students have proper footwear for where you will be walking and for how long. Have a lead and sweep to make sure students stick together. Avoid busy roads if possible
- **Special Considerations Around Water** – avoid wet feet, falling in, and swimming (make expectations known before reaching water)

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Supplies to Make Outdoor Learning Easier & More Productive

- Clip boards
- All-weather paper
- Laminated sheets & grease pencils
- Printed procedures of activities for each group
  - Have instructions for your activity printed for each group to take, especially if they will be spread out to make sure learning goals are met and to save time in trying to figure/remember what the students are supposed to be doing

Young Water Stewards Curriculum Add-On Lessons

(See Appendix for Lesson Plans)

- **4 rain drops: Forest runoff vs. urban runoff (pg. 14)**
  Learn how precipitation moves through a watershed without human development and then compare how precipitation moves through a watershed that has been impacted by human land-use.
- **All the world's water (pg. 35)**
  Even through 70% of the world is covered in water, clean fresh water is a limited resource, through *All the World's Water* lesson, students get a visual idea of just how limited the fresh water of the world is.
- **Pervious vs. impervious surface testing (pg. 39)**
  By pouring water of different surface types, students can identify if a surface is pervious or impervious. Students can hypothesize beforehand to see if their guess is correct. Then at the end of the testing they can calculate the percent of pervious and impervious surfaces. In urban areas, likely the impervious will be higher than pervious.
- **Calculating impervious surfaces on campus (pg. 42)**
  Students take precise measurements (with tape measure or measuring wheel) of buildings, walkways, basketball courts, parking lots, etc. to map and add up impervious surfaces on campus. Then they will calculate surface area of impervious surfaces. Next students

can find cubic meters of water annually that are runoff rather than soaking in.

- **Continued water quality monitoring (pg. 44)**
  Visit sites where water quality was tested or bring in water from the same spot throughout the year to track how phenology might affect water quality.
- **Test how temperature affects dissolved oxygen (pg. 46)**
  Students scientifically test how the temperature of the water affects the ability to hold dissolved oxygen.
- **Sound mapping (pg. 53)**
  A mindfulness activity students can do while sitting within different areas of their watershed.
- **Homemade water filter (pg. 55)**
  In teams or as individuals, students will create mini water filters using rocks, soil, and sand in plastic water bottles, and then filter dirty water. Students care measure the amount of each type of layer (ricks, soil, and sand), compare whose filter got the water cleaner, and then come up with an ultimate water filter recipe that could be applied in a rain garden.
- **Land-use debate (pg. 58)**
  Students take on the roles of city council and citizens and debate land-use issues. Through a town hall style debate, students will understand that land-use and water quality issues are not always easy to agree upon.
- **Who am I? Using new vocabulary words (pg. 70)**
  Students play a vocabulary guessing game to find out which word is taped to their back. This activity strengthens students' understanding of watershed and non-point source pollution vocabulary.
- **Create your own video (pg. 72)**
  Have students make a video about what a watershed is, their local watershed and what its current problems are, or a capstone of the Young Water Steward program

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Long-Term Service Learning Projects

- Turn an impervious surface into a pervious surface
- Plant native plants
  - Measure erosion over long term?
- Build a Rain Garden
- Build Rain Barrels
- Adopt a garden, stream bank, or public space near your school
  - Preferable within 5-10 minute walk if not on school property
  - Contact school, city, county, or nonprofit about land your class might be able to adopt
    - Local Skagit organizations to work with:
      - **Skagit Land Trust**
http://www.skagitlandtrust.org/
Lisa Miller, Stewardship & Outreach Associate
360-428-787
lisam@skagitlandtrust.org
      - **Skagit Fisheries Enhancement Group**
http://www.skagitfisheries.org/
Lucy DeGrace, Outreach Manager
360-336-0172
ldegrace@skagitfisheries.org
      - **City of Mount Vernon Parks & Enrichment Services**
http://www.mountvernonwa.gov/
William King, Director
(360) 336-6215
mvparks@mountvernonwa.gov
      - **City of Burlington**
http://www.burlingtonwa.gov/
360-755-9649
      - **Skagit Conservation District**
http://www.skagitcd.org/
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360-428-4313

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Kristi@skagitcd.org

- Local Whatcom organizations to work with:
  - **City of Bellingham**
    https://www.cob.org/gov/dept/parks
    Rae Edwards, Volunteer Coordinator
    360-778-7105
    redwards@cob.org
  - **Whatcom Land Trust**
    http://www.whatcomlandtrust.org/
    Eric Carabba, Stewardship Director
    360-650-9470
    eric@whatcomlandtrust.org
  - **Nooksack Salmon Enhancement Group**
    http://www.n-sea.org/
    Kendra Krantz, Program Coordinator
    360-715-0283 Ext 109
    kkrantz@n-sea.org
  - **Whatcom Conservation District**
    http://www.whatcomcd.org/
    Aneka Sweeney, Outreach & Education Coordinator
    360-526-2381 Ext 103
    asweeney@whatcomcd.org

Adapting Lessons for Special Needs of Individuals

Make sure all student's special needs are met when conducting lessons in the field. Disabilities, illnesses/diseases, and learning abilities will need to be accommodated for outdoor education.

- **Wheelchair/ADA accessibility**[5] – If you have student in a wheelchair, using crutches/cane/walking aid, or a student with poor balance; keep in mind the terrain of where you will be outside. Location may need to be modified or your class may need to break into groups where some stay on more even terrain.

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- **Vision impairments**[5] – Be aware of students will vision impairments, if you have a student who has impaired vision have teaching aids they can hold. Also, be conscious of pointing out objects in the distance, if it is not possible to get closer describe what the rest of the class is seeing to students with impaired vision.
- **Fatigue**[5]– If you have student who is easily fatigued, keep in mind the distance you are traveling, how long students will be standing, and the overall energy requirement for the day. If available, shorten distances and durations, bring a chair for student(s) to sit down on, or have a second chaperone escort the student back to campus when they become fatigued.
- **Behavioral**[5] - Have extra supervision for students with behavioral issues or pair student which behavioral issues to students who are excelling. Outdoor settings often have a calming effect on students with behavioral issues; rather than not allowing them to participate give them a chance to show they can behave appropriately for the education setting.
- **Diet**[5] – Make sure proper nutrition is accessible:
    - Diabetic students have access to food.
    - Snacks or sack lunch available for extended periods outside.
    - Frequent water breaks and potable water access.
    - Students understand if you are foraging for food outside the risks associated with eating things you find. Have students agree to only eating things they find when adults who have knowledge of local plants say they are safe to eat.
- **Hearing**[5] – For students that are hard of hearing, have printed procedures/tasks for them to read. If you are talking as a group, make sure they are towards the front and that the speaker is facing them.

Adapting Lessons to be Place-Based

Almost all lessons can be adapted to be place-based by implementing one or more of the following easy changes:

- **Attach place-based names** such as Mount Baker, Skagit River, and Mount Vernon to lessons instead of using generic terms like mountain, river, and town.

- **Utilize current problems & solutions** your school, town, or region is facing as teachable moments and to add context to what the students are learning, that the issues are civic problems that real people and jobs are working towards solutions.
    - Invite local agencies to come share data they are collecting, problems they are working on, and solutions they are implementing. Turn the solution into a service learning project and have your students come up with solution and how to implement it.
- **Use historic problems** your school, town, or region faced and solutions implemented to make changes. Ask students if the problem happened more recently, what different ideas do your students have for a solution?
- **Use native plants and animals** in scenarios and projects to show the importance of the native flora and fauna.
- **Visit walkable attractions** rather than traveling for field trips. This can save time and money; no transportation is required if you are walking to the destination. Also, by focusing on a field trip within walking distance will make it more likely your students will re-visit the site and share what they learned with others.

Resources at You for Youth Website

Online Courses:

- Summer Learning
- Citizen Science
- STEM
- College and Career Readiness
- Literacy
- Family Engagement
- Strengthening Partnerships
- Aligning with the School Day
- Project-Based Learning

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Resources

1. University of Wisconsin Stevens Point, July 3, 2017, https://www.uwsp.edu/cnr-ap/leaf/school-grounds/documents/outdoor%20education%20research%20for%20school%20Grounds.pdf
2. Learning-styles-online.com June 29, 2017, https://www.learning-styles-online.com/overview/index.php
3. Meaningful Watershed Educational Experiences – NOAA, July 3, 2017, http://www.noaa.gov/explainers/noaa-meaningful-watershed-educational-experience
4. You for Youth, July 11, 2017 https://y4y.ed.gov
5. Environmental Education: Guidelines for Success. Ohio EE 2000: A Strategic Plan for Environmental Education in Ohio by Joyce Meredith, Diane Cantrell, Michael Conner, Bruce Evener, Diana Hunn, & Paul Spector.

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Appendix A:
Add-on Lesson Plans

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Four Rain Drops: Forest Runoff vs Urban Runoff

Overview: Students simulate the movement of water droplets in an undeveloped and a developed watershed and graph the results.

Age: Elementary

Time: 45-50 minutes

Common Core ELA Standards:

- R#4: Interpret words and phrases as they are used in text, including determining technical connotative, and figurative meanings, and analyze how specific word choices shape meaning and tone.
- R#7: Integrate and evaluate content presented in diverse media and formats including visually and quantitatively, as well as in words.
- S/L #1: Engage effectively in a range of collaborative discussions (one-on-oe, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others' ideas and expressing their own clearly.
- Vocabulary:
  - Evaporation
  - Transpiration
  - Infiltration
  - Surface Runoff
  - Wetland
  - Watershed

Objective: Students will:

- Compare how water moves through a forested watershed (undeveloped) and an urbanized watershed (developed).
- Learn that an equal amount of rainfall creates very different amounts of stormwater runoff depending on the amount of forest trees vs. urban development
- Explore impacts to land and aquatic habitat caused by increased amounts of runoff.

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- Think of ways to control or reduce the amount of stormwater runoff in urban watersheds.

Materials:

- 28 sheets of green paper
    - 6 Evaporation
    - 6 Transpiration
    - 8 Infiltration
    - 4 Surface Runoff
    - 1 Forest
    - 2 Forested Wetlands
    - 1 Creek
- 28 sheets of yellow paper
    - 3 Evaporation
    - 3 Surface Runoff
    - 2 Transpiration
    - 4 Surface Runoff
    - 3 Infiltration
    - 5 Surface Runoff
    - 4 Surface Runoff
    - 3 Urban/Suburban
    - 1 Creek
- Stopwatch or watch with second hand
- Poker chips/paper slips with pollution labeled on them (dog waste, pesticides, herbicides, fertilizer, dirt)
- Handout or projection of the forest and urban water cycle diagram and hydrograph (optional)
- Soils for salmon reading – http://www.soilsforsalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf

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Preparation:

Card Assembly

The following is a more accurate distribution of cards, but to simplify for younger students you can just do 25% (1/4 of the class) for each Evaporation, Transpiration, Infiltration, and Surface Runoff at the beginning. Tape/Staple two sheets together back to back with words facing out.

Green (for 28 Students*)	**Yellow**	**Number of Cards**
Evaporation	Evaporation	3
Evaporation	Surface Runoff	3
Transpiration	Transpiration	2
Transpiration	Surface Runoff	4
Infiltration	Infiltration	3
Infiltration	Surface Runoff	5
Surface Runoff	Surface Runoff	4
Forest	Urban/Suburban	1
Forested Wetland	Urban/Suburban	2
Creek	Creek	1

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Other Preparation

This lesson can be done in either a classroom (or other indoor space) or outside. If doing this lesson indoors, it is best to clear an aisle way in the room where students can move freely from one side of the room to another.

Figuring out numbers of cards if the class size is different than 28 students.

- If you have just a few (2-4) students more than 28 add additional pairing of cards in this order (yellow/green)
    - 1 – Evaporation/Evaporation
    - 2 – Infiltration/Infiltration
    - 3 – Surface Runoff/Surface Runoff
    - 4 – Transpiration/Transpiration
- If you have a few (2-4) less students, remove cards pairs in the revers of the order listed above (e.g., remove the Transpiration/Transpiration card pairing first, then the Surface Runoff/Surface Runoff)

You will still use one of the forest, wetland, and creek cards; however the ratio of the "rain drop" cards will need to be adjusted with the number of students. Here is how to pair the green cards and yellow cards (green/yellow) if you have a class size that is much different than 28 students.

Here are the percentages needed (round up or down as needed).

Evaporation/Evaporation	10% of raindrop card pairs
Evaporation/Surface Runoff	15% of raindrop card pairs
Transpiration/Transpiration	10% of raindrop card pairs
Transpiration/Surface Runoff	15% of raindrop card pairs
Infiltration/Infiltration	15% of raindrop card pairs
Infiltration/Surface Runoff	15% of raindrop card pairs
Surface Runoff/Surface Runoff	15% of raindrop card pairs

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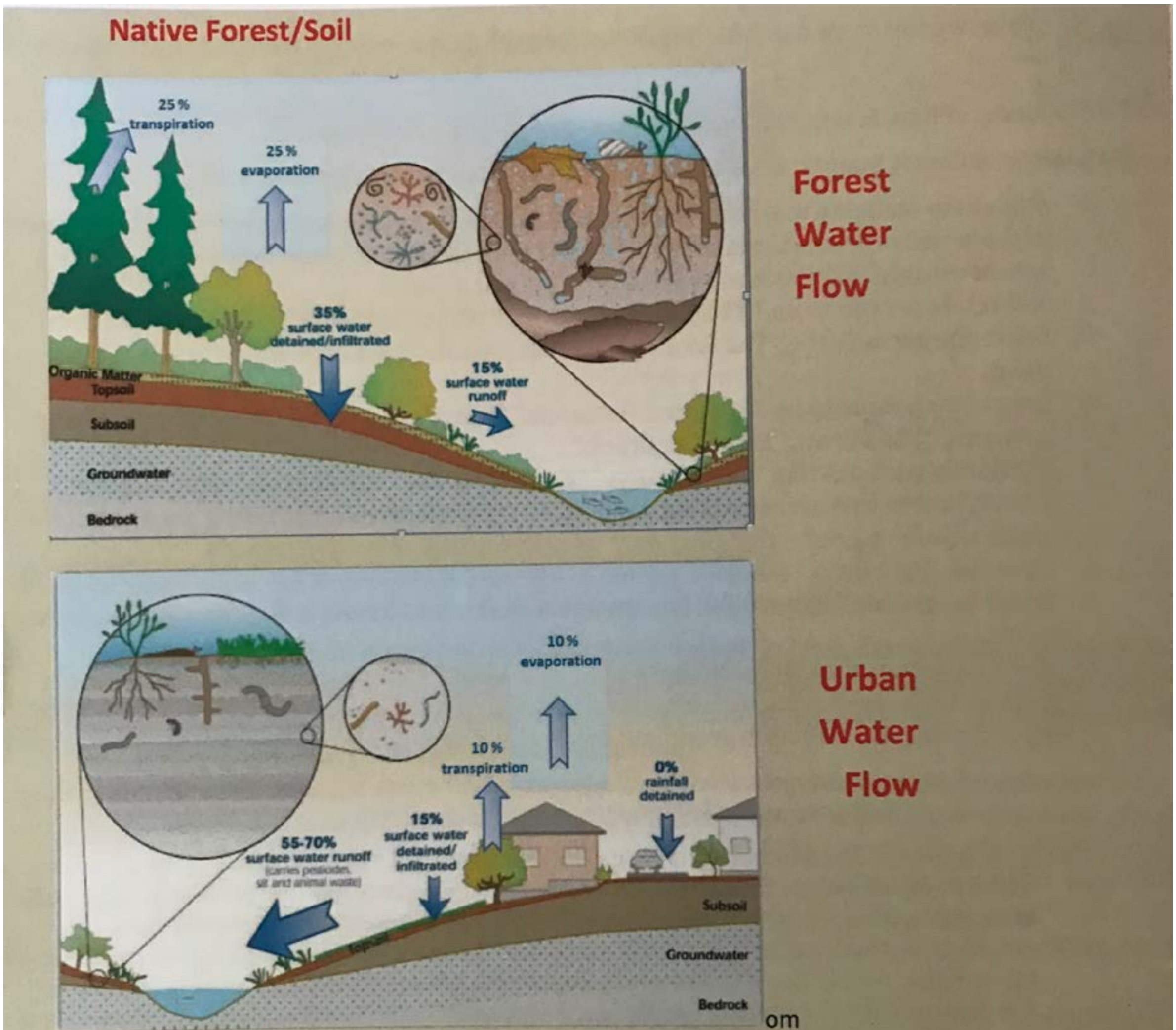
Making Connections

Many people do not realize how much the surface runoff portion of the water cycles is affected by the land use (mature forests or highly urban) or that several hundred stormwater detention ponds (artificial wetlands) have been constructed throughout our community to contain and slow down the flow of stormwater. Modelling water droplets in forests and an urban setting helps students conceptualize the scale of the difference.



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http://www.soilsforsalmon.org/pdf/SoilsforSalmonLIDrev9-16-04.pdf

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Background

4.5 million people live in the Puget Sound region. Before the development of the many cities and towns, where most of these people reside, this region was heavily covered in forests. Large areas of this forest have been replaced with wat is called, "impervious surfaces." These are surfaces such as pavement and concrete where the rain water is not able to soak into the ground.

This combination of less trees and more impervious surfaces creates changes in the way that train water moves through the land, and also how it enters natural waterways such as rivers, lakes, and the Puget Sound. In the forest, about half of the water either evaporates or is absorbed by trees. Another one-third of the rain water is absorbed into the soil ad slowly makes its way downhill, through the soil, to waterways. Un a frosted landscape, only about 15% of rain water flows over the surface of the land to enter a nearby waterway after a rainstorm.

Urban development changes the amount and the speed at which rain water enters natural waterways. Without trees to slow down and absorb the rain water, or easy access to soil, about two-thirds of the rain water flows over the surface of the land to enter nearby rivers or lakes. This, "surface runoff," also reaches these natural waterways much more quickly in an urban landscape. Finally, as the rain washed over streets and lawns, it picks up pollution that is then carried into waterways.

For more information see: http://www.soilsforsalmon.org/why.html

This is a lesson where students contrast the water cycle in a forested landscape versus an urbanized landscape, and how these differences can affect the health of natural water bodies such as lakes, rivers, and the Puget Sound. In the lesson, the students themselves model the process of rain moving through these different landscapes, record data on the amount and rate of water entering a creek, and graph these data to compare the different landscapes. At the end of the lessons, students will be able to explain both why and how urban development can have impacts on waterways like creeks and lakes.

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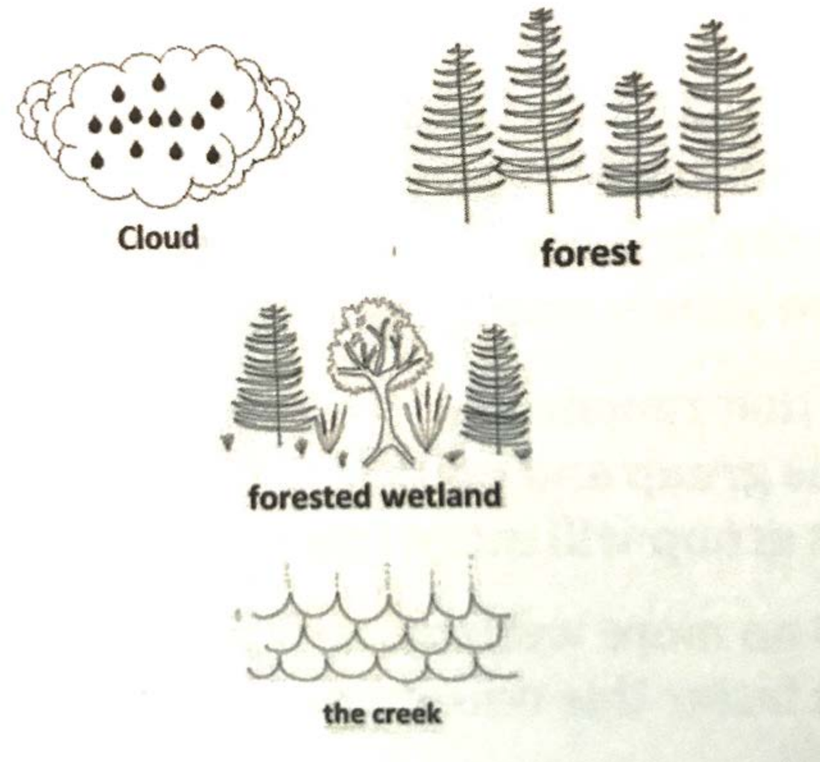

Procedures:

PART ONE: Model of rain moving through a forest – See diagram
Simulation of the Forest Runoff: there is very little surface runoff and it travels very slowly

1. Explain to students that they will be participating in a role-playing activity where most of them will represent rain drops while a few students represent features on the land where the rain falls, such as trees, wetlands, and a creek.
2. Select on person to be, "The Creek." Have that person stand on one side of the room.
3. Select one person to be, "The Forest." Have that person stand on the opposite side of the room.
4. Select two people to be, "Forested Wetlands." Have these people stand about half way between, "The Forest," and, "The Creek."
5. Randomly pass out the, "Evaporation," "Transpiration," "Infiltration," and "Surface Runoff," cards to each remaining student. All students should have

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their cards with green side facing out **– this first part uses the green side of the cards**.

6. Have the, "rain drop," students gather, in a group at the side of the room away from the forest to create a, "cloud." Tell students that they are in a cloud and about to rain on the forest.
7. Then, have the wind blow and have the, "rain drops," rain on the forest. Lead students through the role-playing activity, explaining the movement of each type of raindrop in the order below. Call each group out of the cloud separately as they rain on the forest:
   - Evaporation: Raindrops fall on the tree leaves and are there long enough for the sun to shine on them so they evaporate. Send this group back to the cloud.
   - Transpiration: These raindrops first hit the trees, make it to the ground and soak into the soil. The raindrops are then absorbed by trees and then trees, "sweat," water vapor out through their leaves. When trees, "sweat," it is called transpiration. The water then evaporates off of the leaves. Send this group back to the cloud. Take time to have students think about the amount of time it really might take a drip to get from the tip of a 200 foot tall fir tree to the ground. You want them to think about dripping from branch to branch and it might take a few hours – and there is so much time for evaporation to occur.
   - Infiltration: Raindrops first hit the trees, make it to the ground and soak into the soil. They are not absorbed by trees, but instead flow *slowly through the soil* towards the creek. These raindrops only move an inch or two a day. These students can move towards the creek, but because they are moving slowly through the soil, they can only take on tiny step every 30 seconds (or another way that will have students move very slowly). (Make sure these students move slowly enough that they do not reach the creek during this role play.)
   - Surface Runoff: All that remain are, "Surface Runoff," drips. Explain how these drops do not soak into the soil but have to seep slowly over the forest floor, through lots of dead leaves of twigs. In addition, each rain drip will be trapped in a wetland for a while, so when these drops pass through the wetland they need to stop for a 10 second delay before they can continue flowing to the creek.

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- o BEFORE the, "Surface Runoff," raindrops start moving to the creek, explain to students that we will be measuring how many rain drips reach the creek and how many seconds it takes for those raindrops to reach the creek. Then time how long it takes for all the, "Surface Runoff," drips to reach the stream. Count the number of drips that reach the stream. Record these data on the whiteboard for later use.

Diagram of placement of the cloud, forest, wetland, and creek (not to scale)

PART TWO: Model of rain moving through an urban watershed
Simulation of urban runoff: lots of surface runoff and it travels very quickly

1. Have all the rain drips return to the cloud station. Explain that you have returned to the same watershed and that there have been a few changes in the past five years. Some of "The Forest," has been cleared to build homes and roads. Flip over, "The Forest," card to the yellow side, so it says, "Urban/Suburban."
2. Describe how the wetlands in the middle of the watershed have also been clear for homes and roads. When you flip over the Wetland card, tell students that the wetlands are still there, that there are rules about not building in the middle of most wetlands, but even when the rules are followed, the wetlands don't work quite as well as they used to. Flip over all the, "Forested Wetland," cards so they say, "Urban/Suburban."
3. Point to, "The Creek," which is still at the bottom of the watershed. Flip over the creek's card (it will still be a creek).
4. Go over the difference between the urbanized landscape and the forested landscape. These main differences are less trees and more impervious surfaces where rain cannot soak into the ground.
5. Ask students if they can think of human activities that may introduce some pollution on top of the surfaces of the pavement and the lawns. Scatter the poker chips/slips of paper with different types of pollution around the floor near the house (where the forest and the wetland originally were).
6. Have all the raindrops flip their cards over to the yellow side. Ask students if they notice if some of their cards have changes (some change, some do not).
7. Lead students through another role-playing activity, explaining the movement of each type of raindrop in the order below. This part of the role-play should emphasize the differences in how the raindrops move due to the

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replacement of the trees and wetlands with homes and roads. Call each group out of the cloud separately as they rain on the forest:

- o Evaporation: Use the same roe playing as in the first model, but make note that there are now less trees. Also, make note of how many less students are in this group compared to the forest model. Sending this group back to the cloud.
- o Transpiration: Use the same role playing as in the first model, but make note that now there are less trees AND less soil available into which the rain can soak. Also, make note of how many less students are in this group compared to the first model. Send this group back to the cloud.
- o Infiltration: Use the same role playing as in the first model, but make note that now there is less soil available into which the rain can soak. Also, make note of how many less students are in the group compared to the first model. This group can move slowly towards the creek. (Make sure these students move slowly enough that they do not reach the creek during this role play.)
- o Surface Runoff: All the remaining are "Surface Runoff," drops. Make note of how many more raindrops are in this group and quickly review why (less trees, more impervious surface). Like in the first model, this group will move towards the creek, but with two important differences:
  - Since there is no more wetland, they are not delayed for 10 seconds at the wetland. They can also walk faster this time because there are no dead leaves or twigs in their way.
  - They need to pick up pollution (poker chips/slips of paper) as they travel to the creek.

8. BEFORE the, "Surface Runoff," raindrops start moving to the creek, explain to the students that we will be measuring how many rain drips reach the creek and how many seconds it takes for those raindrops to reach the creek. Have the students walk quickly to the creek picking up poker chips/slips of paper along the way. Point out that the wetlands are no longer able to slow the rain drips (can't give penalties). Time the trip and count the number of rain drips reaching the creek. Record these data on the whiteboard for later use.
9. Have students look at their poker chips/slips of paper. What was on them? How does this simulate what really happens in the urban system?

PART THREE: Graphing and discussing our results

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1. Have students return to their desks.
2. Review what a watershed is and the physical differences between a natural forested watershed and an urban or suburban watershed.
3. Share the data collected and have students graph the results.
   a. Let students choose what style of graph would be best (bar, dot, scatter)
   b. Let students choose what is on x and y axis.
4. Compare graphs with other students graphs and the hydrograph in this lesson.
5. Ask students how does urbanization change the amount of water that reaches the creek, how does it change the timing, how does it change the quality:
   - Quantity: in a mature western Washington forest, about 15% of the drips that fall from the sky will reach the creek. Time to reach creek: In a forest water moves very slowly – several days, weeks, months. In an urban setting, nearly 55-70% of the drips that fall from the sky will reach the creek. Time to reach creek: In an urban setting we have pipes, gutters, downspouts, and other conveyances structures that allow runoff to reach the creek in a matter of minutes or hours.
   - Quality: refer to the various types of pollution that raindrops picked up and brought to the creek
6. Have students think of solutions that engineer could design to help water in an urban watershed flow more like the water in a forested watershed. What could an engineer design to have less water flow into creeks in an urban watershed?
7. Have students think about how natural wetlands tend to trap many pollutants and prevent them from migrating downstream. What happens to pollutants in urban systems? What are ways to prevent pollution from entering wetlands and creeks?

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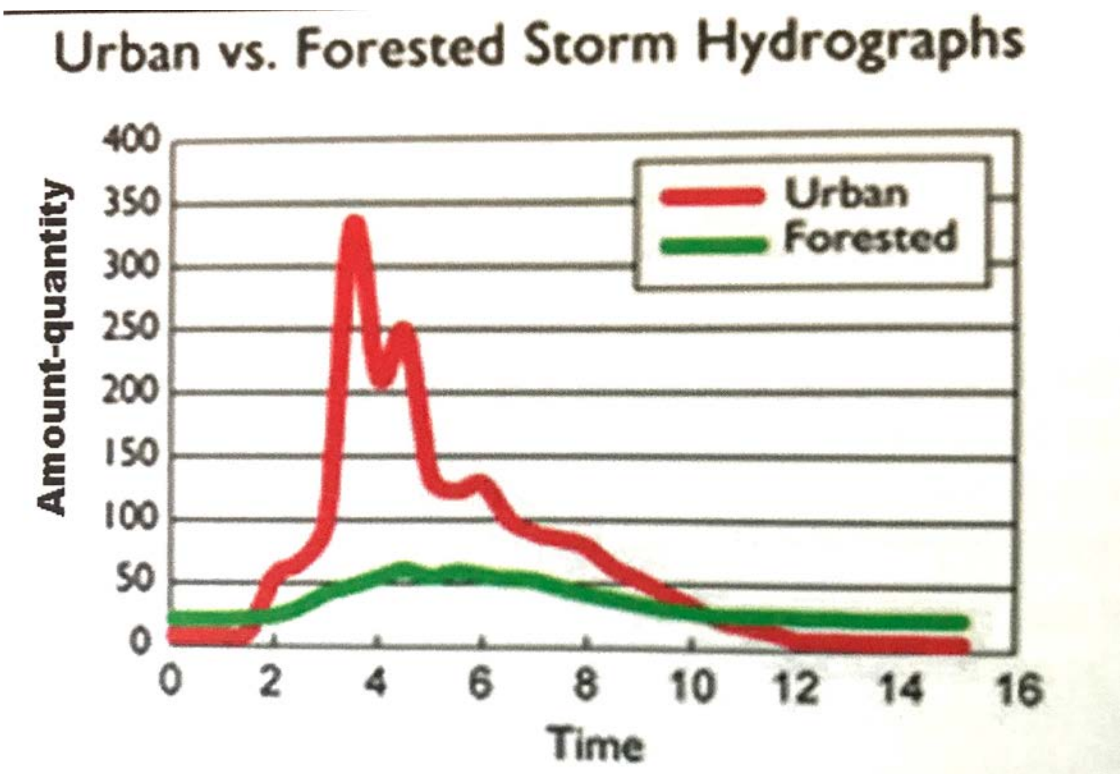

Lesson adapted from Pacific Education Institute: Drain Rangers Program in partnership with Puget Sound Starts Here campaign

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Pet Waste	**Pesticides**
Herbicides	**Fertilizer**
Soil (Dirt)	**Pollution from Cars**

Template of pollution cards to make multiple copies on bright colored paper and cut up.

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The Creek

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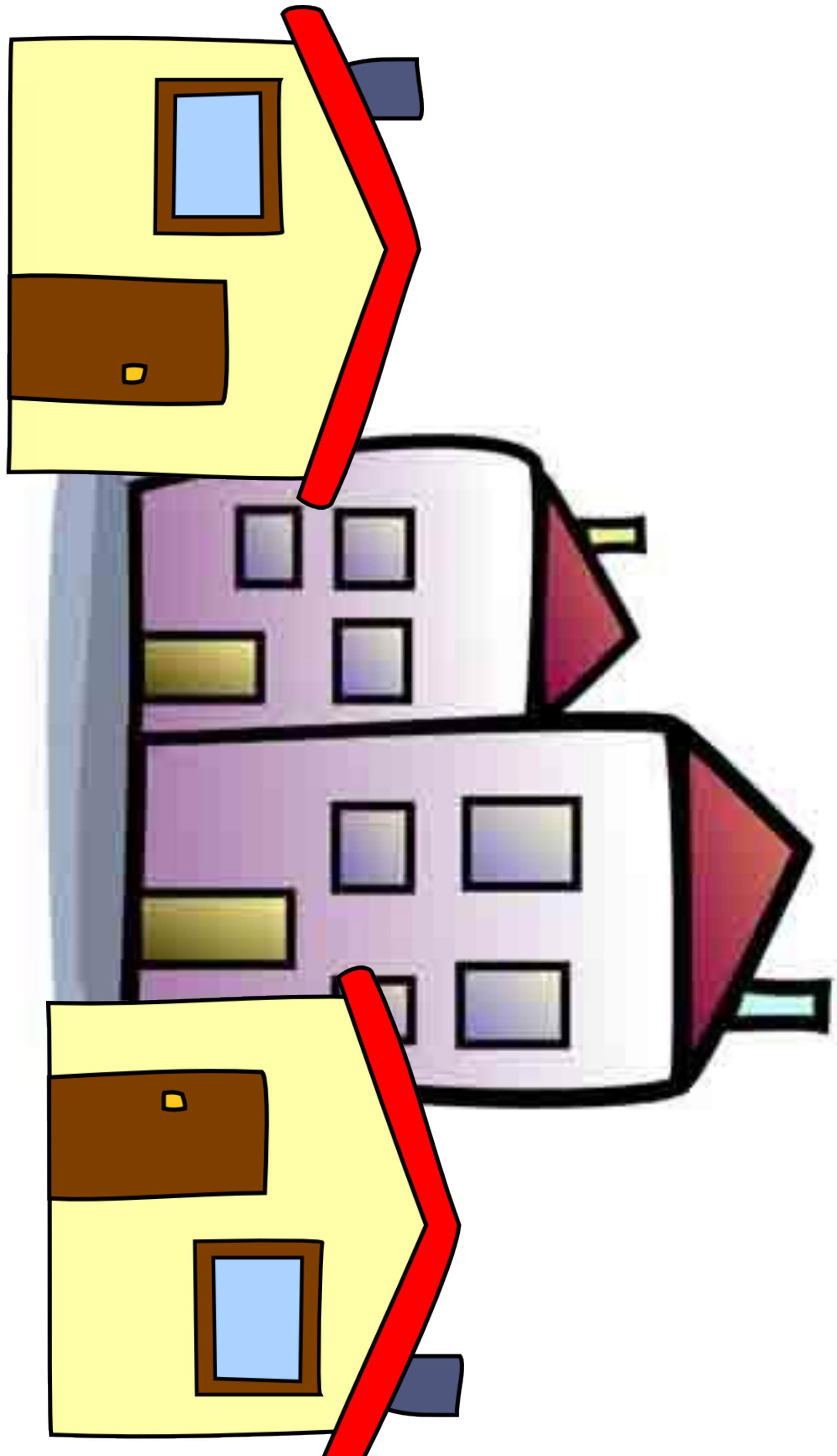
Urban/Suburban



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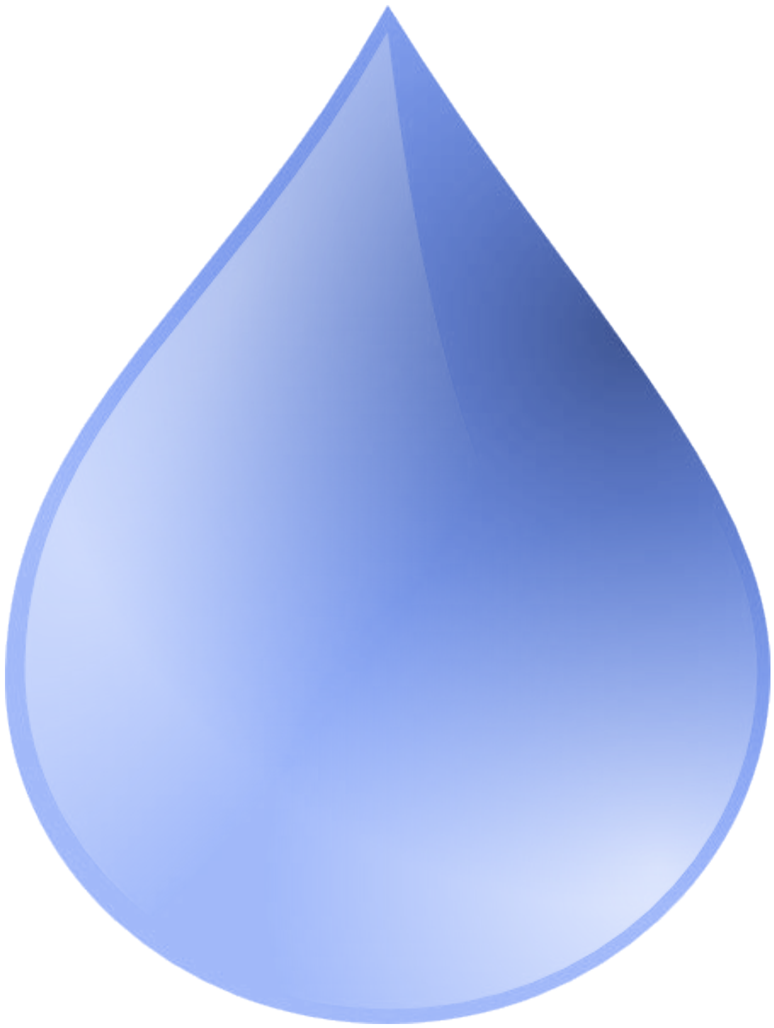
Evaporation



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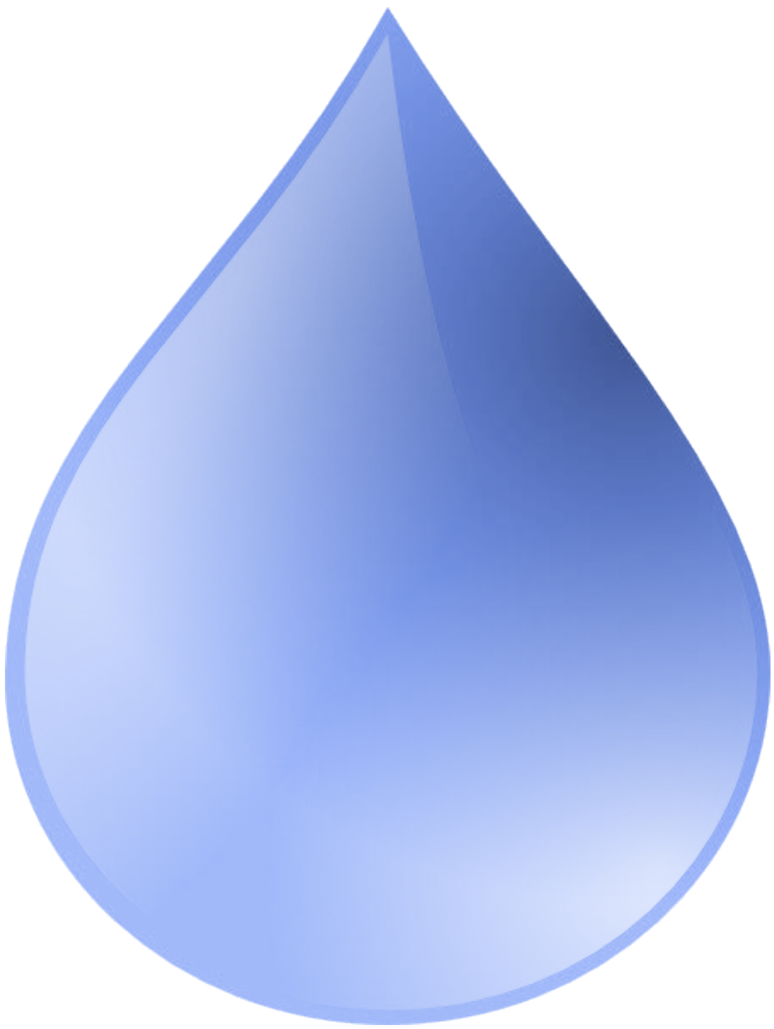
Transpiration



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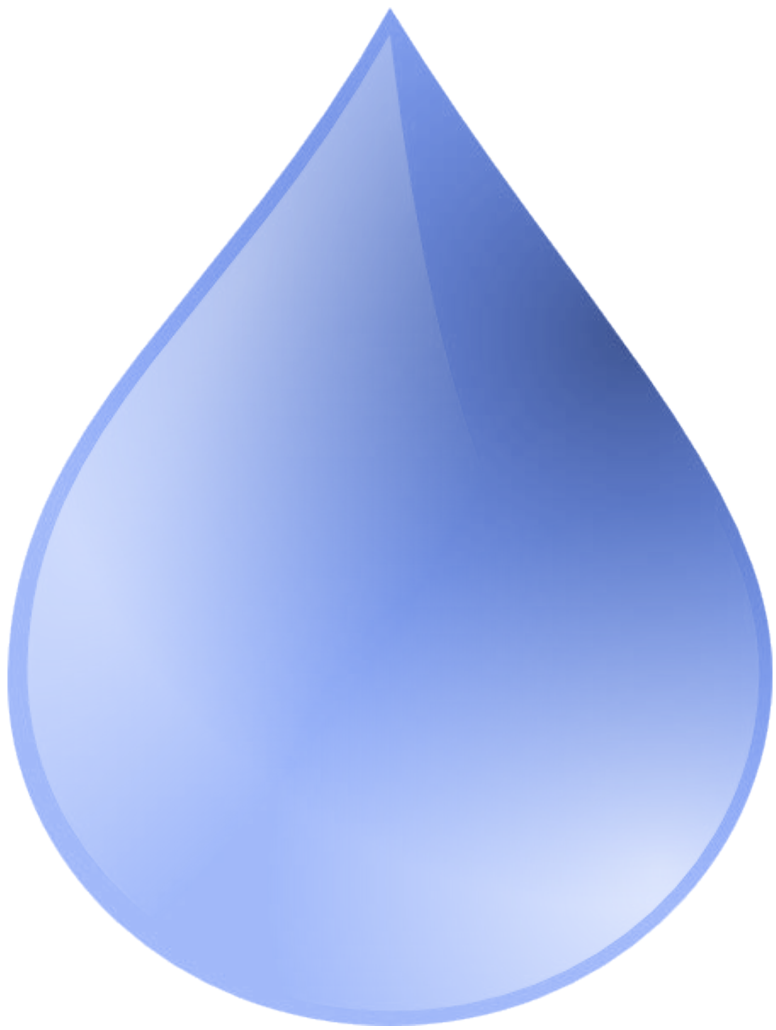
Infiltration



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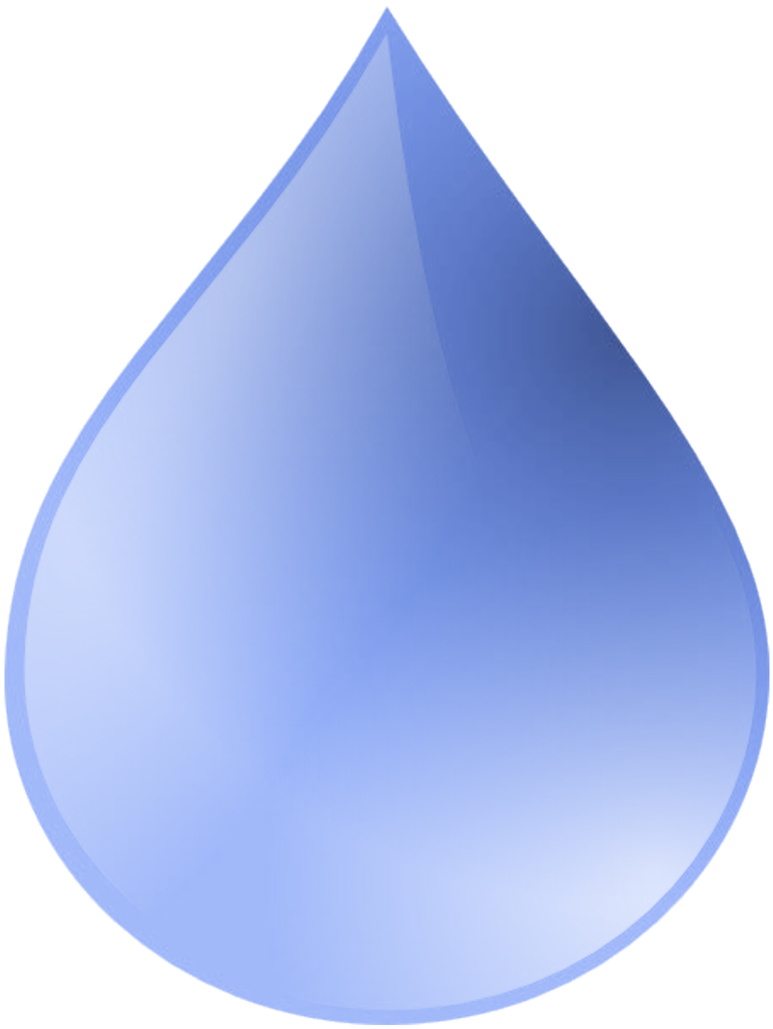
Surface Runoff



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All the World's Water

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
20-30 minutes

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

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- **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).

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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

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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

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Pervious vs. Impervious Surface Testing

Grade Level: 3-7th grade

Time: 30 minutes

Objective: test surfaces near school to determine if they are pervious or impervious. Through hands-on testing, students will understand what pervious and impervious surfaces are.

Materials:

- Water in cups or water bottle
- Data Collection sheet

Vocabulary:

- Pervious: a surface that allows water to flow through the surface such as gravel, sand, and dirt
- Impervious: blocks the flow of water, a surface that is impervious causes water to pool (mud puddle) or run off into a storm drain

Procedures:

1. Introduce the new vocabulary to students: Pervious and Impervious.
2. Tell the students that the class is going to go outside to test multiple surfaces permeability to see whether a surface is pervious or impervious. Before they test a surface, hypothesize if the surface is pervious or impervious.
3. Send students outside to test different surfaces. They will pour a small amount (20 mL) on each surface and observe the water to see if it soaks in, pools, or runs off.
4. Students will record their results.
5. Gather students back up and you can assess the data they collected.

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   a. Create percentages of pervious vs. impervious surfaces of your school yard, have students then average the percentage.
   b. Discuss the concept of a surface being semi-permeable, where some water will soak in, but it takes a long time for the water to enter the ground and if the surface is on a slope, high volumes will likely runoff before it soaks in – an example of this is mowed lawns.

6. Relate this experiment to other concepts students are learning such as watersheds and non-point source pollution
   a. Have students discuss ways cities, towns, or land owners can increase the amount of pervious surfaces and decrease the amount of imperious surfaces and the benefits.

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Pervious vs. Impervious Data Collection Sheet

We are going to test different surfaces throughout the campus to see if they are pervious or impervious by pouring water on them.

Pervious – water can seep into the ground through the top of the surface.
Impervious – water cannot seep into the ground, it either pools up or runs off but does not go into the ground.

For each surface:

1. Write down the type of surface you are testing (ex. Plastic slide, grass, or driveway)
2. Make a hypothesis on whether you think the surface is pervious or impervious
3. Test the surface by slowly pouring a cup of water on it
4. Record the results from each test

Surface Type	Hypothesis	Results from Testing	Was Your Hypothesis Correct?

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Calculating Impervious Surfaces on Campus

Grade Level: 5-9th grade

Time: 60+ minutes

Objective: measure and calculate the impervious surfaces and how much rain water they collect throughout a year.

Materials:

- Tape measure (100+ foot tape)
- Wheel measuring tape (optional for large campuses)
- Graphing paper (optional)
- calculators

Vocabulary:

- Pervious: a surface that allows water to flow through the surface such as gravel, sand, and dirt
- Impervious: blocks the flow of water, a surface that is impervious causes water to pool (mud puddle) or run off into a storm drain
- Area: calculation of a space which is length times width
- Volume: calculation of length times width times height

Procedures:

1. Divide the class into groups of 4 students, smaller groups allow for more hands-on time.
2. Tell the students that they are going to measure the surface area of impervious surfaces on the school campus (you can opt for a specific building if you have less time).
    a. If students are unaware of how to calculate are, guide them in which measurements they need to gather before doing any calculations.

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    b. If students are divided into groups that will be measuring area of different buildings, create a "master" copy where the data is reported to.
3. Send students outside to take measurements of the buildings' length and width. They can also include sidewalks, basketball courts, and any surface that is determined to be impervious.
4. Have students calculate the area of each building and add that up to get total area of impervious surfaces.
5. Students can then research annual rainfall for their area (about 40 inches for Western Washington).
6. Calculate Volume by multiplying annual rainfall by area.
    a. Students can have a rain gauge to calculate volume of rain hitting pervious surfaces throughout a month.
    b. Compare the annual volume of rainfall that is being sent to storm drains to Olympic sized swimming pools (2,500,000 L).
7. Have students discuss ways the school can capture the rainfall and divert it from going straight to the storm drain.
    a. This could turn into a service learning project where students either build rain barrels or install a rain garden.

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Continued Water Quality Monitoring

Grade: 6th – 12th

Time: 30 minutes each data collection series

Overview: Collect water quality data (pH, temperature, dissolved oxygen, and turbidity) over a period of a month or year to compare the data over time and with the seasons. Body of water you are testing should be within a few minutes' walk of campus or you may want to bring in test water on your way to the program/school and test first thing in the morning.

Materials:

- Thermometer
- Dissolved Oxygen test kit
- Secchi disk
- pH test strips or test kit
- data collection sheets & computer for graphing data

Goals & Objectives:

- Students will gain hands-on experience using test kits and following scientific procedures to collect accurate data.
- Students will compare long-term data to trends in phenology and land-use practices to make scientifically backed guesses on why water quality might change throughout the year.

Vocabulary:

- Phenology – the study of the seasons, seasonal changes, and seasonal occurrences such as migration, blooming/fruiting times, and hibernation.

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Procedures:

1. Determine how long you would like to monitor water quality and how frequently to meet the needs of your classroom or program schedule. Here are suggestions:
    - 1 month 3x/week
    - 3 months 1x/week
    - 9 months 2x/month
2. Collect and record data per your decision on how long your class is going to study water quality (step 1). Other things to record: weather, date, & time.
3. Enter data along with date into an Excel spreadsheet.
4. Once your study is complete, analyze the data as a class or share the spreadsheet with students and have teams or students analyze the data individually. Have the data represented in graph(s) for visuals using dates as the x axis to compare with time.
    a. Are there trends in water quality parameters that correspond with seasonal patterns?
        i. Are turbidity levels associated to rainfall?
        ii. Does temperature of water mirror temperature of land fluctuations?
        iii. Does dissolved oxygen match a seasonal change? (Higher rain falls will increase volume of water in creek which speeds up flow, also cooler temperatures have a higher capacity for dissolved oxygen.)
        iv. Can students come up with what phonological changes might affect pH? (pH can change when runoff has increased non-point source pollutants entering the body of water)

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Test How Temperature Affects Dissolved Oxygen

Grade: 8-12th

Time: 60 – 90 minutes

Objective: Students test the correlation between temperature and dissolved oxygen and apply the relationship to local stream ecosystems.

Overview: Students test the dissolved oxygen levels of different temperatures of water from the same water source. Once data is collected, students will graph the results and then apply critical thinking of the relationship between temperature and dissolved oxygen to local aquatic ecosystems and human impacts on the watershed.

Materials:

- Each group will need:
  - Copies of lab sheet
  - Dissolved oxygen test kit
  - Thermometer (up to 100ºC)
  - One jar with water at room temperature
  - One jar with water and ice
  - One jar with water that was boiled for 20 minutes and then cooled (sealed)
  - One jar with water that was heated to 50º C for several hours and then cooled (sealed)

Preparation:
Prepare enough jars of water so that each group will have one at room temperature, one with ice, and one of each boiled sample. Leave the ice water jars open to the air, adding ice to cool them to 5ºC (they can be left open in a refrigerator or ice chest). The jars at room temperature should be left open at least

overnight, since some schools' water tanks have very low levels of dissolved oxygen. Prepare two canned samples: one set of samples should be water that was heated to 50º C and held at that temperature for several hours, then poured carefully into jars and sealed (a coffee maker is an easy way to do this; just fill up with water and leave heated for several hours, then pour into canning jars and seal). The other set of heated samples should be brought to boiling for 20 minutes and then poured into jars and sealed. This preparation can be done anytime ahead of class; the jars will be cooled when the students use them, but the amount of DO inside will have been 'fixed'. You can even do this several weeks ahead of time. Make sure you use jars that can withstand boiling water; if you are unsure, a metal knife in the jar should eliminate the risk of a shattering jar.

Another option would be to boil the samples as a class so that students can see the preparation process and understand that the samples are being heated and then sealed to eliminate air movement while they are being cooled.

Procedures:

1. Ask: what do all living things need in order to survive? Students should eventually answer: oxygen. Ask: Do aquatic animals need oxygen too? How do they get it? Students should e able to think o ways for oxygen to enter into the water: diffusion and plants. Hold up a glass of ice cubes and water and a glass of hot (if possible, steaming) water. Ask: What do you think could live in each of these glasses of water? Allow the students to make some guesses – don't give them answers. Ask: what is necessary for all living things to survive in water? They should be able to remember the field testing where they tested for dissolved oxygen and come up with "oxygen". Ask: do you think there is oxygen in very hot or very cold water? Allow students the time to write down the answers to the predictions.
2. Students will have access to all four water samples. They should test each sample two or three times, depending on the length of time you have in class. A good way to save time is to use the CHEMetrics test kits instead of the kits from Lamotte or HACH. Remind the students that even though all of the water temperatures are "cold" or "cool", to samples were prepared and "fixed" at hot temperatures. Make sure that there are clear labels on the samples themselves or on the table were the samples are located. Do not open the sealed jars until the students are ready to test the water. They

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should create a chart which shows the temperature at which the jars were sealed or tested – 5, 25, 50, & 100^{o}C, and their results for each test.

3. Cold water holds more dissolved oxygen than hot water, because as the temperature increases, the water releases some of the oxygen. The higher the temperature, the less dissolved oxygen. Ask: what do you think happens to the levels of dissolved oxygen in a river in the summer? At night? Students should be able to formulate answers to these questions based on their research. They should also be able to explain the importance of dissolved oxygen and the implications of low dissolved oxygen on aquatic ecosystems.

Conclusion:
Students will understand that when temperatures increase, dissolved oxygen decreases. If you apply this concept to local water, in the summer months the dissolved oxygen levels will be lower than in the winter months because water temperature is warmer. The affect on aquatic animals can be stress, death, or migration.

Lesson Plan from the Cary Institute:
http://www.caryinstitute.org/sites/default/files/public/downloads/lesson-plans/1C4_DO_and_Temp_lab_graph.pdf
Water Quality Historic Data:
Skagit:
https://www.skagitcounty.net/Departments/PublicWorksSurfaceWaterManagement/WQ.htm
Whatcom:
https://www.whatcomcounty.us/2618/Interactive-Water-Quality-Maps

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Name ____________________

Dissolved Oxygen and Temperature Worksheet

Dissolved Oxygen and Temperature Lab
Background: In this experiment, you will try to find out what happens to the amount of dissolved oxygen when the temperature of the water increases or decreases. This will help you understand how seasonal changes as well as long-term changes, such as climate change, might affect aquatic ecosystems.

Before you begin: Make a hypothesis about what you think will happen: Will cold water hold more or less dissolved oxygen? ________________________________
Copy this data table in your lab notebook, and make enough columns for all the groups in your class plus the average:

Temperature (when sealed)	DO in jars when opened: Group 1	DO in jars when opened: Group 2	DO in jars when opened: Group 3	DO in jars when opened: Group 4	DO in jars when opened: Group 5	DO in jars when opened: A average
50o C						
100o C						

Procedure:

1. Obtain a DO test kit from your teacher.
2. Test the temperature of the two samples of unsealed water: ice cold water and room temperature. Record your result and then test the DO of these two samples.
3. Next, carefully obtain a water sample from the water that was heated to 50o C and test the DO level.
4. Obtain a sample from the water that was heated to 100o C, perform the DO test, and record your results.
5. Compare your results with that from the other groups, and find the average.

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Discussion questions:

1. Describe the difference in what happened with your predictions. Why do you think you got your results? Explain in as much detail as you can.

2. Include a line graph of your results showing the result for each temperature from each group. You could add a trend line to your graph.

3. What would you expect the amount of dissolved oxygen to be if you heated a sample of water to 75 C?

4. Based on your results, what can you say about the relationship between dissolved oxygen and water temperature?

5. What kinds of human activities could create a higher water temperature? What kinds of natural events could create a higher water temperature?

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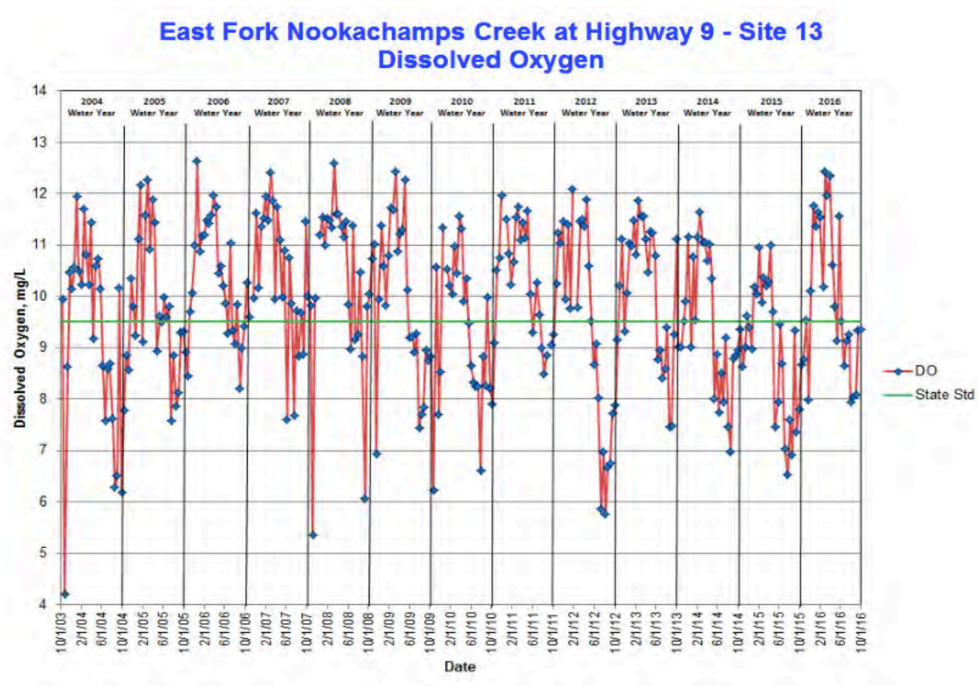
6. When do you expect fish and other aquatic organisms to have the most problems getting enough dissolved oxygen?

Now that you have completed the dissolved oxygen testing, apply what you learned to data collected in your local watershed:

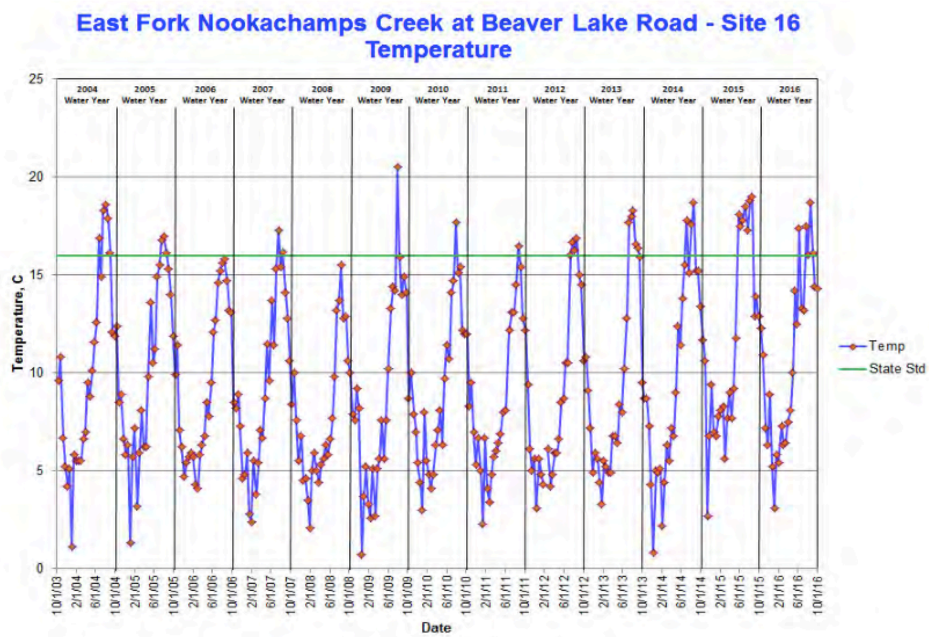


Complete the following sentences:
When the temperature increases, the dissolved oxygen ________________.
When the temperature decreases, the dissolved oxygen _________________.

1. During what time of year did the highest temperatures occur? The lowest?

2. During what time of year did the highest DO levels occur? The lowest?

3. Based on your lab activity and these data, what can you say about the relationship between dissolved oxygen and temperature?



4. During what time of year do you think plants and animals would be under the most stress? Why?

5. Do these data give you enough information about the types of dissolved oxygen stress the aquatic ecosystem might experience?

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Sound Mapping

Taking an inventory of your place in the watershed

Grade Level: 3-6
Time: 5-15 minutes, depending on student's ability to focus

Overview: *What can I learn from the sounds that surround me?*

This activity provides students with a new way to explore and connect with the outdoors. Using just their sense of hearing, students will discover the range of activities and inhabitants that occupy the space around their school grounds.

Required Materials:

A journal and writing utensil for each student

Objectives and Outcomes:

1. Students will practice using just their sense of hearing for discovery 2. Students may determine relative species abundance
3. Students will learn to create a map and legend

Activity:

Prepare students before they head out by telling them:

1. They will need to find a spot within the designated boundaries that is within sight of the teacher but away from other students.
2. Sound maps are a quiet, individual activity. They need to be as quiet as possible and not interact with other students.
3. They can choose to sit however is comfortable for them.
4. They begin by drawing a dot in the center of the paper to represent them. Space at the top of their paper represents space in front of them. Space at

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the bottom of the paper represents space behind them. The right side of the dot represents space to their right and so on.

5. When the teacher gives the signal to start, students record everything they hear using a symbol they create. Students can use letters or shapes to represent sounds. Each time they hear a repeated sound, they record it again using the same symbol. Some students might do better if they close their eyes and wait for a sound, then open their eyes and record the sound on their paper. This activity does not use sight at all.
6. Students keep listening and recording until the time is up.
7. Students will finish by creating a legend to accompany their sound map. They do not need to know what the sound they heard was.

Extension Ideas:

- Students can adopt one specific location on campus as their own unique spot for ongoing study and exploration throughout the year.
- The sound mapping activity can be repeated from different locations or different habitats, during different times of year or different times of day. Students can compare their results and make note of any differences.
- Maps could be used to determine species abundance if wildlife sounds are the focus as in the example (below).
- Students could create a story of events to accompany their sound map.
- Students could create a graph from their sound map to determine the relative frequency of sounds in their location and make comparisons to other locations chosen by their classmates.
- Students could use the sound map data to make predictions about habitat quality of different locations or to determine the various ways their location in the watershed is being used (driving, flying, mowing, playing, dogs etc.).

*Curriculum adapted from Lower Columbia Estuary Partnership: http://www.estuarypartnership.org/sites/default/files/Sound%20Mapping_Watershed%20Focus%20Lesson.pdf

Homemade Water Filter

Grade: 4^{th} – 8^{th}

Time: 45 minutes

Objective: To introduce students to the concept of natural water filtration and how a rain garden can filter non-point source pollutants out of stormwater runoff.

Overview: By building their own water filters, students will learn what water filtration is, mixtures of mulch, gravel and sand can remove non-point source pollutants from stormwater.

Background: Urban and suburban development has reduced pervious surfaces and increase impervious surfaces all around the world. Stormwater is collected through gutters, storm drains, and ditches which are directly piped to streams, creeks, rivers, bays, and the ocean without being filtered. Along the way, stormwater picks up non-point source pollutants such as dirt, chemicals, oil, bacteria, and heavy metals. Without a filtration process, those non-point source pollutants are being piped directly into our waterways. Engineers and scientists are developing ways to filter non-point source pollutants out of stormwater before it enters the waterway. In this activity, students will build their own water purification systems to model how rain gardens filter out pollution from stormwater before it enters the storm drains.

Materials:

- 1-liter soda bottles cut in half
- Napkins, paper towels, coffee filter, or landscaping fabric
- Gravel
- Sand
- Bark or mulch
- Cups or scoops (for gravel and sand)
- Large water container for dirty water (pitchers or gallon jugs)

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- Dirty water (made by adding dirt, twigs, leaves, trash, etc. to water)

Procedures:

1. Divide the class up into groups of 2-4 students, each student will receive a 1-liter soda bottle that is cut in half.
2. Show the student the materials they have to work with:
    a. Filter
    b. Gravel
    c. Sand
    d. Bark/mulch

   *Optional – allow students to research how scientists and engineers layer filtration layers in a rain garden.
3. Students will assemble their containers by turning the top of the 1-liter bottle upside down and inside the bottom of the bottle. Tape is optional to hold the two pieces together.
4. Have the students build their water filtration systems, for older kids, you can have them measure out each material they are using and calculate the percentage of each material (e.g. sand 50%, gravel 30%, mulch 20% by using measuring cups and get volume or by using scales and collecting mass). All students should document the order they layer their filters to share with the class.
5. Once students have completed their filter assembly, pour dirty water through the filter. Cleaner water will collect at the bottom.
6. Have students compare their clean water with other groups to see who got the cleanest water. Students can also share their methods and possibly come up with a "best method" that they can create as a group.
7. Ask the students what type of pollutants they think can be removed from a filtrations system like what they made
    a. Trash
    b. Dirt
    c. Heavy metals
8. Ask students what types of non-point source pollutants might still be in the water
    a. Bacteria & viruses

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    b. Chemicals
9. Optional – watch a YouTube video on how a professional rain garden is constructed and planted. Ask students was is similar to their models, what is different?

Lesson adapted from Utah State University Extension Program: http://extension.usu.edu/waterquality/files-ou/Lesson-Plans/Homemade-water-purifier.pdf

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Land-use Debate

Grade: 8-12th

Overview: In a town-hall setting, students will represent stakeholders in land-use scenarios around water quality issues and solutions. For each scenario, stakeholders will be given the opportunity to share their position followed by a rebuttal from opposing sides. At the end of the debate, city council will share their decision on how to best proceed in the best interest of all stakeholders.

Time: 30-90 minutes (depending on how many scenarios you do)

Objective: Students will represent the positions of different stakeholders in a land use debate surrounding water quality issues to grasp that water quality issues do not have black and white solutions and how Best Management Practices are implemented.

Materials:

- Printed out stakeholder position cards.

Preparation: Cut the Scenario cards up so each stakeholder only sees their position.

Procedures:

1. Divide your class into six groups. These groups will represent the city council and five stakeholder groups for each of the scenarios.
2. Hand out scenario 1 (you can use any scenario you want, choose the most applicable or your watershed's water quality issues) stakeholder cards and allow five minutes for groups to read their stakeholders' position and discuss how to represent their position's interests in the town hall debate.
3. To start the debate, the city council will read the scenario's issue out loud to the stakeholders to start the town hall style debate.
4. Each group will have 2 minutes to represent their position on the issue. Followed by up to three one-minute rebuttals from the other stakeholders.

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5. Once all five stakeholder positions have presented, each stakeholder will have the opportunity to give a final 1 minute closing statement without rebuttal.
6. City council will deliberate for up to 3 minutes before making their decision at the town hall debate.
7. Debrief the debate as a classroom (as a student and a citizen) to talk about how Best Management Practices can be implemented for a city-wide problem. Best Management Practices can be a burden for some industries or residents, but overall their implementation has a positive affect on water quality.
8. With time allowance, repeat steps 1-5 with scenarios #2 and #3.

Conclusion:
Students will understand that land use is complicated and can often lead to heated debates. Though everyone has an idea of how they would like to see the land used or not used, we must come together as a community and compromise, negotiate, and decide what is best for citizens, the environment, and future generation.

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Scenario #1 – City Development

City Council – Issue: A construction company is proposing a 50-home development near a historic salmon spawning stream. Currently the construction company owns the land which is second growth forest, salmon have historically spawned in this stream but have not been seen for the past 45 years since a culvert was installed 2 miles away which currently prohibits fish passage. The city has plans to remove the culvert in the next five years. The 50 new homes plus driveways and a road will increase the impervious surfaces of this particular section of land from 0% to 45%. To deal with the stormwater, the construction company plans to install one retention pond which will slow the water down before it directly enters the creek.

DO NOT READ ALOUD: City council wants to increase housing opportunities for new homeowners which means they want housing costs to be low. In order to keep housing costs low, houses need to be either small or multi-family (duplex, triplex, townhouses). The city is also required to increase salmon spawning habitat due to loss of habitat over the past 100 years. Amongst the city council members, offer a proposed solution to meet the city's obligations. Once you hear everyone's positions, you must decide as a group what the best actions will be, you can include restrictions to what homeowners can do on their property, change the plan for the new housing development to meet your goals, and/or further review the land-use entirely in case the city wants to purchase the land to preserve it due to the importance of the streams health. Or come up with a different solution or plan of action collectively as a council.

Scenario #1 – City Development

Tribe – The tribe is dedicated to restoring salmon runs throughout the region. Your tribe as invested a lot of time and resources to restore land and salmon runs. If the city does not act in the best interest of the salmon, you have the right to take the city to court and fight your position.

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Scenario #1 – City Development

Family Looking to Buy a Home– You represent a family that is looking to buy a home. You have lived in the area for the past 12 months. When you moved to the city, you rented a house to get an idea of which neighborhood you would like to live in. You are ready to purchase a home now but there are very few houses for sale. You want to have a yard and some natural land for your kids to explore. If more homes are not built in the city, house buying will become even harder with more people looking to purchase and not enough houses for sale. This competition might ultimately make your family have to move to a different town; which means the money you put into an economy with rent, groceries, taxes, and recreation would go to a different town.

Scenario #1 – City Development

Construction Company– You are the construction company who will be building the houses. You want to build bigger homes because they will bring you more money in the sale of each house. You are a known construction company in the area and often follow Best Management Practices when it is affordable to your company. In the plans for the housing development, you will spend your own money to put in a retention pond that the stormwater will pass through before entering the creek. You will also leave a 35-foot riparian buffer between the construction sites and the creek which meets the State's minimum set back.

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Scenario #1 – City Development

Department of Natural Resources– Your concern is water quality during and after the construction. The land has already been proposed for development, your issue with the construction is how to reduce impacts on the water quality within the stream. Because the City is proposing a removal of the culverts that is blocking the salmon from spawning in this stream within the next 5 years, you want to see a wider riparian zone of 75 feet. The larger riparian zone will keep suspended sediments out of the water, suspended sediments irritate fish gills, can cover up and kill eggs, and can hide the salmon's fresh water food source: macro invertebrates. In the past, you have also fined this specific construction company for not complying with Best Management Practices.

Scenario #1 – City Development

Water Quality Scientist– You have been testing this stream for years, besides the culvert, the stream is in pristine shape to restore salmon habitat and provide fresh water to the native animals that live near the area. Not only are you concerned about the construction project potentially causing suspended sediments to enter the creek and the increase in impervious surfaces; you are concerned about the impact for the next 10, 20, and 30+ years the homeowners are going to have on the health of the creek. You are concerned about dog poop causing fecal coliform bacteria to increase, trash entering the creek, oil or gas spilling for the homeowner's cars, and excess nutrients due to fertilizers residents often put on their lawns.

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Scenario #2 – Fecal Coliform Polluting Water

City Council: Issue– One stream within your city has been testing too high for fecal coliform bacteria which is causing emergency shutdown of beaches and shellfish harvest to keep citizens safe. To help mitigate this problem, the city has invested in education to have residents pick up dog poop and make sure septic tanks are properly working. This education did not seem to result in a decrease in fecal coliform bacteria so your city opted to test the fecal coliform DNA to see what animal it is coming from. The results show that the bacteria is originating from cows. At the headwaters of this creek, there are only two small farms that have cows. Until the fecal coliform counts get greatly reduced, the beach and shellfish harvest must remain closed for public safety.

DO NOT READ OUT LOUD: It is not illegal to have cows where these farmers live, however farmers must comply with regulations. Regulations include proper manure spreading or disposal to help keep the manure out of the water. Penalties include verbal and written warnings and then fines, but you must catch the farmer in the act to impose these penalties. As a city you want to promote a healthy watershed, industry, and safety of your residents. Historically there have always been small cow farms since settlers arrived. The shellfish industry however cannot harvest and sell when fecal coliform bacteria counts are too high, with sustained no harvest regulations this industry may be forced to move or close down entirely. The city does not offer any education for farmers on how to protect the water, however a local nonprofit does. As a city council, you must put concerned citizens at ease and offer guidance on how to move towards a solution.

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Scenario #2 – Fecal Coliform Polluting Water

Farmer #1– You have over the past several years implemented different Best Management Practices to keep cow manure and fecal coliform bacteria from running off your property and entering the nearby creek. Several years ago, your cows would walk up to the creek to drink, but since then you have learned that cows stomping around the riparian zone causes mud and manure to enter the creek. You have worked with a local nonprofit organization that has helped offset the cost to make the modifications on your property to keep the cows away from the stream. You have a pump that keeps a water trough full of fresh water from the stream so the cows always have water to drink. You also are in the process of planting native plants along the creek bed to restore the riparian zone and reduce erosion. Overall, with a fence to keep the cows out of the water, the water pump and trough, and the replanting of the riparian zone; you have spent $5,000 to keep the water clean.

Scenario #2 – Fecal Coliform Polluting Water

Farmer #2– Your family has lived on the same farm since the city was formed, over 100 years. The reason your family settled where it did was access to the creek for farming. You inherited the farm from your family and work a job that you travel often for. Because you are often gone for work, you want to make sure your cows have access to water, if they are free to walk down to the creek they can get water anytime they want. You are afraid if you fence the cows out of the creek and pump water to them, there might be a pump failure while you are traveling and your cows will die.

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Scenario #2 – Fecal Coliform Polluting Water

Shellfish Farmer–Through a grant, you started a small business growing and harvesting shellfish. The grant was to start a shellfish farm since shellfish clean water. You employ three people and yourself with your small business and sell your shellfish to local restaurants. You have been forced to not harvest shellfish on several occasions because the fecal coliform bacteria is too high and could cause food-born illness to humans that consume the shellfish. Because of the abrupt closures of harvest, you have been unable to supply restaurants on a few occasions. Restaurant owners are getting upset at your unreliability of food and might take their business elsewhere. The current closure to the shellfish harvest is lasting longer than expected and you might have to lay off your three employees.

Scenario #2 – Fecal Coliform Polluting Water

Nonprofit Organization–You work with local landowners to help them implement Best Management Practices to keep water quality good and to help restore our watershed's ecosystem. You worked with farmer #1 to keep his cows away from the water, provide them with fresh drinking water, and to restore the riparian zone. That project alone cost $10,000, through grants your organization helped the farmer pay for half of the cost. Your funding since then has decreased and you cannot offer the same grant to farmer #2. What you can offer is a plan to help reduce fecal coliform bacteria and suspended sediments from leaving the farm, but you would not be able to give financial help.

Scenario #2 – Fecal Coliform Polluting Water

Concerned Resident–You heard the fecal coliform bacteria levels were above the safe level for swimming (100 colonies/Liter) and you want to voice your concern. Your kids like to play near the creek and you are afraid for their health. You believe it is not fair that two farms are polluting the creek so much so that others cannot utilize its natural resource.

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Scenario #2 – Fecal Coliform Polluting Water

Water Quality Scientist–Your organization has been testing the water quality of this creek for several years. Water quality issues you have found are low dissolved oxygen in the summer and fall, warm temperatures in the summer, high turbidity in the fall through spring, and the presence of fecal coliform bacteria. When you compare the data, your organization has collected over this time period, the water quality of the creek has not gotten better. Your concern is that the poor water quality will kill the remaining native animals that live in it. Because there was a constant presence of fecal coliform bacteria, you did DNA testing to see what type of animal poop was in the water and the results were cow. You also test the water to determine if the water quality is good enough to harvest shellfish and you have determined it is not.

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Scenario #3 – Excess Nutrients

City Council Issue–In recent years, excess nutrients have been getting into the lake causing algal blooms in summer and fall months. When the algae blooms, it decreases the amount of sunlight entering the water and native aquatic plants are dying. Then when the algae die, in the fall, it's decaying process uses up the dissolved oxygen within the water decreasing the total dissolved oxygen levels of the lake, low dissolved oxygen levels are stressing and killing native aquatic animals. Not only are excess nutrients within the lake destroying the natural ecosystem, the city is concerned about toxic algae and the harms it can cause to humans and animals that drink the water. The city is contemplating methods to keep excess nutrients out of the water including a ban on fertilizers, increase in riparian buffers, rain gardens, or a regulation on how much impervious surfaces a property can have.

DO NOT READ OUTLOUD: Your primary concern is safe drinking water now and in the future. You cannot force current land owners to decrease their impervious surfaces, only new construction can you put a regulation on how much impervious surfaces are allowed. A ban on fertilizer can be hard to enforce because you would need to catch the land-owner in the act of spreading fertilizer, which means you would need to implement patrols. The city does have the money to offer rewards for compliance with whatever rule you come up with or to help offset the cost of implementing a Best Management Practice, but the funds are limited and may only last a short time if the reward is high for compliance. The city council must decide how to decrease the nutrients reaching the lake to ensure safe drinking water for the citizens.

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Scenario #3 – Excess Nutrients

Landscaping Business Owner –You own a landscaping business that serves the neighborhoods around the lake. Your customers like pristine yards which includes lush green lawns and flowers that produce big blooms. In order to meet you customers' wants, you promote fertilization in the spring and fall as well as water multiple times a week throughout the warm months. Regulation on putting fertilizer onto your customers' yards might result in a yard that does not look "well cared for", you are concerned that people might look for a new landscaper because your work might not look as nice as it used to, or you might not get referrals to new clients. Your landscaping business is how you support your family, it has taken you several years to establish your business. Often, you walk with your family along the trails near the lake and play at the sports complex nearby, you see dog poop that is not being picked up and think that the poop is a bigger contributing factor to the excess nutrients that occasional spreading of fertilizer.

Scenario #3 – Excess Nutrients

City Parks Department –The city Parks Department manages a sports complex that borders the lake. There are two soccer fields and three baseball diamonds. This sports complex gets used throughout the year and heavily in the summer months. To keep the fields healthy, you apply fertilizer twice a year and water and mow twice a week. The short grass makes for great playing fields and allows the water to quickly run off rather than creating a swampy mess. Beautify city parks, such as the one you manage, are one of the big reasons people like to live within your city. You are afraid that if your fields are not cared for in the way you have been doing in the past, the grass will die in places and the fields will become less desirable to play sports on. Because you are a city entity, you think the city council should consider their parks looking nice as a priority.

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Scenario #3 – Excess Nutrients

Concerned Citizen – You walk your dog daily on trails near the lake. After a long walk, you allow your dog to drink from the shore of the lake. You have heard that there might be toxic algae blooming in the lake and are concerned that it could make your dog sick or kill it. As a concerned citizen, you want to ensure there is no toxic algae that can make you or your dog sick, so you are pro ban of all fertilizers in the watershed.

Scenario #3 – Excess Nutrients

Architect – You are an architect and design new modern homes along the lake. Your customers are looking for new homes that are multi-story so they have a nice view of the lake and have a small footprint on the lot. Your customers are looking for energy and water efficient homes as well as zero lawn landscaping because your customers know the impacts single-family homes have on the watershed. You want incentives for not having so much impervious surfaces and yards that do not require fertilizing or watering to offset the cost of new homes, this would make the homes you design more competitive in the housing market if homeowners got money back for the energy and water efficient homes.

Scenario #3 – Excess Nutrients

Home Owner – You have lived along the lake for 30 years. In your 30 years of living there, you have watched as more and more homes are being built along the lake. You do not think what you do on your property is the problem because 30 years ago there were no algal blooms. In recent years, as more and more homes are being built, you started seeing the algae bloom in the summer months, you think that it is the new houses that are creating the problem of excess nutrients. Your position is that the city should put a moratorium on new construction in the watershed to preserve the water.

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Who am I? Using New Vocabulary Words

Grade: 6-9th

Time: 15 minutes

Objective: A fun game for students to practice vocabulary words and their definitions.

Overview: Students ask yes or no questions to discover which vocab word they are. This game reinforces vocabulary words in a fun setting.

Materials:

- Paper with vocabulary words written or printed on them
- Tape

Set Up:

- Print or write Young Water Stewards vocabulary words on paper and cut them out. Font should be big enough to read from a few feet away. Vocabulary words:

Watershed
Wetland
Forest
Estuary
Non-Point Source
Pollution
Dissolved Oxygen
Turbidity
Excess Nutrients
Ground Water
Runoff

Storm Drain
Fecal Coliform
Bacteria
Temperature
Salmon
Macro Invertebrates
Impervious Surface
Pervious Surface
Water Cycle
Infiltration
Snowpack

Urban Development
Heavy Metals
Topography
pH
Water Quality
Stewardship
Best Management
Practices
Nookachams Creek
(or your local
watershed)

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Procedures:

1. Tell students that they are going to play a game, rules are you can only ask yes or no questions and you must find a new person to ask a question to every time. Their goal is to uncover what vocabulary word is taped on their back.
2. Tape vocabulary words onto the backs of students, once everyone has a word, allow them to start asking yes or no questions and mingle.
3. When they have uncovered what vocabulary word is taped on their back they can have a seat, free time, or another appropriate task to keep them occupied while other students finish up.

Conclusion:

Using vocabulary words in a fun game reinforced understanding and utilization.

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Create Your Own Video

Grade: 6-12th

Time: 2 hours +

Objective: Students combine technology with learning objectives of other lessons to create a culminating video about what they learned and the Importance of being a Young Water Steward.

Overview: Students create a video about one aspect of the entirety of the Young Water Stewards program to share with family, friends, and students within their community.

Materials:

- Video recorder, phone, or electronic device capable of recording video
- Computer
- Video editing software such as i-movie

Procedures:

1. Divide the class into groups that will work on a video – this project is best to engage classroom learning at afterschool program or for extra credit.
2. Allow students to come up with a specific aspect, lesson, or the entirety of the Young Water Stewards program that they will create a video for.
    a. Ideas include: watershed model, the difference between point-source and non-point source pollution, stewardship, how to talk to people who are creating non-point source pollution, or water quality testing.
3. Students can take roles within the video production or all help out in all parts. (e.g. videographer, video editing, acting)
4. Shoot the video footage.
5. Edit the footage to create a continuous video displaying the goal of the video.
6. Share the video: online or have a viewing.

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Conclusion:
Students learn and show learning in all different ways. Allowing technology to play a role in learning is a great way to include students who engage best through technology. These videos are a great way to show student progress, learning, and to share with family and friends the experience students had in the Young Water Stewards program.

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