TEACHER OVERVIEW

Ecological Impacts

Grades 9-12

Nature Vision Student Packet

The materials contained within have been created by Nature Vision, an environmental education nonprofit organization that brings programming to schools and local greenspaces for over 70,000 PreK-12th grade students each year in King and Snohomish Counties. This work from home curriculum materials packet is designed to foster an understanding of the importance of water and its integral role in supporting life and shaping our planet. Packets can be completed either independently, or with the help of an adult caregiver. Each day of the week offers materials building on previous days learning, offering a variety of activities including, art, writing, and field exploration.

These materials are provided to you by City of Auburn Utilities, City of Bothell, City of Lynnwood, and grants from King County Flood Control District, and King County Wastewater Treatment Division. Learn more by visiting:

- City of Auburn Utilities: https://www.auburnwa.gov/city_hall/public_works
- City of Bothell: http://www.bothellwa.gov/surfacewater
- City of Lynnwood: https://www.lynnwoodwa.gov
- King County Flood Control District: https://www.kingcounty.gov/services/environment/water-and-land/flooding/flood-control-zone-district.aspx
- King County Wastewater Treatment Division: https://www.kingcounty.gov/depts/dnrp/wtd.aspx

Thanks to Cascade Water Alliance for providing the accompanying series of student packets: Ecosystems, Watersheds, and Humans and Water. To learn more please visit: https://cascadewater.org/.

This unit supports NGSS Performance Expectations across various disciplines, as well as supporting K-12 Integrated Environmental and Sustainability Standards. These are listed at the bottom of this page. Teachers will be supplied with PDF formats of materials to be emailed to families, or teachers may print and send to students to complete at home.

Students begin with an introduction to the concept of stormwater and how it moves through our environment. Next, students explore the impact of stormwater on our streams and rivers and the way that wetlands act to collect and filter our stormwater. Students then explore the impact stormwater toxins can have on our marine environment and orca populations, followed by ways that we can keep our freshwater as clean as possible.

If you have any further questions or concerns regarding this packet, please email our Office Coordinator at info@naturevision.org.

Grades 9-12
Supports NGSS Performance Expectations: HS-LS2-7, HS-LS4-6, HS-ESS2-5, HS-ESS3-4, HS-ETS1-3

Grades 9-12
Day 1 - Stormwater Basics
Day 2 - Rivers, Streams, and Ponds
Day 3 - Wetlands
Day 4 - Puget Sound
Day 5 - Stewardship

Stay connected with Nature Vision! Follow us for updates @naturevisionorg

PARENT/CAREGIVER OVERVIEW

Ecological Impacts
Grades 9-12

Welcome to Nature Vision's student packet for home use. Nature Vision is an environmental education nonprofit organization that brings programming to schools and local greenspaces for over 70,000 PreK-12th grade students each year in King and Snohomish Counties. We are excited to be offering this version of our programming directly to students at home!

This packet is designed to be completed over the course of one week, with each day focusing on a different aspect of environmental science and stewardship. The majority of these materials can be completed independently, but we thought it would be important to provide background information for any adults who may be helping to complete or answer questions. We've included the basic learning objectives for each day along with some vocabulary.

These materials are provided to you by City of Auburn Utilities, City of Bothell, City of Lynnwood, and grants from King County Flood Control District, and King County Wastewater Treatment Division. Learn more about caring for our water by visiting:

- City of Auburn Utilities: https://www.auburnwa.gov/city_hall/public_works
- City of Bothell: http://www.bothellwa.gov/surfacewater
- City of Lynnwood: https://www.lynnwoodwa.gov
- King County Flood Control District: https://www.kingcounty.gov/services/environment/water-and-land/flooding/flood-control-zone-district.aspx
- King County Wastewater Treatment Division: https://www.kingcounty.gov/depts/dnrp/wtd.aspx

Challenge yourself to post all the things you are doing with your friends and family to prevent pollution and protect our water!

- City of Auburn Utilities: Tag @auburnwa and include the hashtag #auburnwa
- City of Bothell: Tag @BothellWaUSA and include the hashtag #PugetSoundStartsHere
- City of Lynnwood: Tag @LynnwoodWA and include the hashtag #Lynnwood
- King County Flood Control District: Tag @KingCountyDNRP
- King County Wastewater Treatment Division: Tag @kingcountywtd

Thanks to Cascade Water Alliance for providing the accompanying series of student packets: Ecosystems, Watersheds, and Humans and Water. To learn more please visit: https://cascadewater.org/.

Please contact info@naturevision.org with any questions or concerns
Stay connected with Nature Vision! Follow us for updates @naturevisionorg

NOTE: Students may require support in reading directions and/or completing some tasks. While many activities in this packet are creatively oriented and open ended, you may consult the answer key located at the back of the packet for additional assistance or guidance.

Unless otherwise noted, images courtesy of freepik.com

PARENT/CAREGIVER OVERVIEW: DAY 1

Stormwater Basics

Background Information: Stormwater is all of the water that moves over our environment as a result of precipitation. Stormwater is the source of water for plants in our soil as well as how our surface water is replenished. The two main issues communities face when managing stormwater are flooding and contamination. Stormwater issues create some of the largest environmental challenges that people deal with in our urban environments.

Learning Objectives: Students will learn the basics of watersheds and model how water flows through the landscape. They will also understand how stormwater carries pollution from one place to another and the effect that has on the environment.

Main Activity: Stormwater Storytelling

- ***Overview****:* Students write a story from the perspective of a water drop moving through our environment. They will focus on both the natural and human elements water interacts with, as well as the benefits and challenges stormwater may cause.
- ***Parent/Caregiver Tasks****:* None

Optional Activity: Runoff Model

- ***Overview****:* Students create a physical model of a watershed using household materials to observe the movement of water and pollution
- ***Parent/Caregiver Tasks****:* Help student gather materials and supervise them running the model

Optional Activity: Stormwater Stewardship Challenge

- ***Overview****:* Students complete a daily stewardship challenge related to pollution prevention
- ***Parent/Caregiver Tasks****:* If needed, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 2

Rivers, Streams, and Ponds

Background Information: Stormwater needs to be controlled and directed as it moves through urban environments. Storm drains are the main piece of infrastructure that we have developed to manage our stormwater, and they do a very good job of directing water and reducing flooding. However, because they send water directly to the closest stream, they also play a role in moving pollution from the urban environment to our freshwater.

Learning Objectives: Students will develop an understanding of how the introduction of excess nutrients to our freshwater from stormwater runoff can have as much of a damaging effect as pesticides and other toxins.

Main Activity: Eutrophication Model

- ***Overview****:* This simple board game activity gives students a chance to explore how excess nutrients such as nitrates from fertilizer impacts freshwater ecosystems
- ***Parent/Caregiver Tasks****:* Help students set up game

Optional Activity: Salmon Streams and Stormwater Study Article

- ***Overview****:* Students read and answer questions from a Washington State University study on the impacts of stormwater runoff on two salmon species
- ***Parent/Caregiver Tasks****:* None

Optional Activity: Stormwater Stewardship Challenge

- ***Overview****:* Students complete a daily stewardship challenge related to pollution prevention
- ***Parent/Caregiver Tasks****:* If needed, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 3

Wetlands

Background Information: Wetlands are areas of land that are wet for majority of the year. Depending on their location and vegetation, a wetland can be a pond, marsh, swamp, fen, bog, slough – to name several. While they are called different names, wetlands all share three characteristics. Wetlands contain water, saturated soil, and water-tolerant plants. A wetland is habitat for a multitude of animal and plant species, and is a vital ecosystem that provides food and nutrients. Wetlands prevent flooding by holding excess rainwater within their soil. The soil dually functions as a filter as it traps pollutants that flow into wetlands through storm drains.

Learning Objectives: Students will learn how wetlands may be known by many names but share three defining characteristics. They will understand how to identify wetlands and their unique traits. Students will discover the various functions of wetlands and the impact of stormwater upon this ecosystem.

Main Activity: Constructed Wetland Investigation

- ***Overview****:* Students interpret the work being done by researchers at the University of Washington who are exploring the impacts of "constructed wetlands" on the Duwamish River
- ***Parent/Caregiver Tasks****:* None

Optional Activity: Wetland Sponge Model

- ***Overview****:* Students use sponges to model how saturated soil more effectively absorbs and filters water in comparison to dry or hard ground
- ***Parent/Caregiver Tasks****:* Provide supervision

Optional Activity: Stormwater Stewardship Challenge

- ***Overview****:* Students complete a daily stewardship challenge related to pollution prevention
- ***Parent/Caregiver Tasks****:* If needed, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 4

Puget Sound

Background Information: Puget Sound is the inland sea of Washington. It is an estuary where freshwater rivers and streams meet saltwater. Our local region surrounding this body of water from the Cascade Mountains in the east, to the Olympic Mountains in the west, to Olympia in the south, and to the Canadian border in the north is also called the Puget Sound region. This land is connected by the various waterways that flow through this watershed and drain into Puget Sound. The land and water surrounding Puget Sound is also habitat to 211 fish species, 100 species of sea birds, and 13 marine mammals species – it is a biodiverse region! Puget Sound is impacted heavily by stormwater runoff pollution. Surrounded by many major cities, storm drains lead polluted stormwater into Puget Sound.

Learning Objectives: Students will explore the impact that toxins from our stormwater can have on Orca through the process of biomagnification.

Main Activity: Ecosystem Interaction

- ***Overview****:* Students analyze a basic marine food web with a focus on the accumulation of toxins and their impact to Orca and other predatory animals
- ***Parent/Caregiver Tasks****:* None

Optional Activity: Biomagnification and Bioaccumulation Calculation

- ***Overview****:* Students calculate the potential for toxins to multiply over time as they move through the food chain
- ***Parent/Caregiver Tasks****:* None

Optional Activity: Stormwater Stewardship Challenge

- ***Overview****:* Students complete a daily stewardship challenge related to pollution prevention
- ***Parent/Caregiver Tasks****:* If needed, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: DAY 5

Stewardship

Background Information: Stewardship is how we care for the natural resources that all living things need to survive – such as water. Stewardship can include conservation of natural resources, thinking and acting carefully about how we interact with the world around us. Humans impact their environment in many ways. A negative impact takes the form of pollution entering our environment. Stewardship remedies this impact and ensures a positive change that will keep our environment clean for all.

Learning Objectives: Students will combine their knowledge gained throughout the week to consider ways they can support the environment. They will learn to focus on pollution prevention through carefully considering daily habits, behaviors, and usage of materials that will contribute to stormwater runoff pollution.

Optional Activity: Stewardship Poster

- ***Overview****:* Students create a poster to remind themselves and their households of best stormwater management practices
- ***Parent/Caregiver Tasks****:* Help brainstorm ideas

Optional Activity: Eco Audit

- ***Overview****:* Students navigate their homes and/or neighborhood in search of environmental challenges and ways these issues are being addressed
- ***Parent/Caregiver Tasks****:* Help students film, if needed, and provide permission to upload to social media

Optional Activity: Stormwater Stewardship Challenge

- ***Overview****:* Students complete a daily stewardship challenge related to pollution prevention
- ***Parent/Caregiver Tasks****:* If needed, help the student share their work on social media

PARENT/CAREGIVER OVERVIEW: VOCABULARY

DAY 1

Contaminated: Made dirty by exposure to pollution
Groundwater: Water held underground in the soil or in pores and crevices in rock
Infiltration: The process of water soaking into the earth
Runoff: Water that moves over the surface of the earth
Storm Drains: Drains in the streets of our cities that send water directly to the nearest stream

DAY 2

Anoxic: Greatly deficient in oxygen
Carcinogenic: Having the potential to cause cancer
Dead Zone: Dead zones are areas in the world's oceans and large lakes where nothing can live, caused by excessive nutrient pollution from human activities
Eutrophication: Excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which cause excess algae growth and death of animal life from lack of oxygen
Hydrocarbons: Chief components of petroleum and natural gas
Hypoxic: A region of the body is deprived of adequate oxygen supply at the tissue level
Lactic Acid: Whenever the body breaks down carbohydrates for energy, this chemical forms faster as the body's oxygen becomes more limited
Nitrates: Chemical compounds which contain nitrogen and oxygen, used as fertilizer
Nutrients: A substance that provides nourishment essential for life.
Phosphates: Used in automatic dishwasher detergents and laundry detergents to help soften water and to remove soil, oil, and grease

DAY 3

Bioswale: Channels designed to concentrate and convey stormwater runoff while removing debris and pollution. They are like vegetated ditches.
Constructed Wetlands: Artificial wetland to treat municipal or industrial wastewater, greywater or stormwater runoff
Estuary: The tidal mouth of a large river, where the tide meets the stream
Saturated: Holding as much water or moisture as can be absorbed; thoroughly soaked
Wetlands: Land consisting of marshes or swamps; saturated land

Continued on following page

PARENT/CAREGIVER OVERVIEW: VOCABULARY (*cont.*)

DAY 4

Bioaccumulation: When a substance is consumed by a consumer and accumulates faster than it is excreted (i.e. toxins can accumulate inside an organism's body)
Biomagnification: When an organism consumes a large number of organisms containing small amounts of substance (refers to the increasing concentration of a toxin in tissues of an organism at successively higher levels of the food chain)
Mercury: Highly toxic chemical, commonly added to our environment by burning fossil fuels
Producers: Organisms that make their own food that get energy from the sun, and with the help of water convert energy into useable energy in the form of sugar or food (e.g. a plant)
Primary consumer: An organism that feeds on primary producers (e.g. an herbivore)
Secondary consumer: Organisms that feed on primary consumers (e.g. an herbivore or a carnivore)
Tertiary consumer: An animal that obtains its nutrition by eating primary consumers and secondary consumers (i.e. a carnivore but can also be an omnivore)
Trophic levels: Any of the sequential stages in a food chain, occupied by producers at the bottom and in turn by primary, secondary and tertiary consumers

DAY 5

Audit: A detailed inspection
Stewardship: The act of caring for and being responsible for something; being a protector

DAY 1

Stormwater Basics

Stormwater is any water that results from a rain event or a snow or ice melt. Stormwater can either be absorbed by the earth in a process called **infiltration**, or move over the surface, called **runoff**. Stormwater infiltration is responsible for replenishing our **groundwater** supplies and making water available for plants while stormwater runoff replenishes our lakes, rivers and fresh surface water. Stormwater is on a constant journey from the highest to lowest point in our watersheds.

In natural and rural areas, most of this water is absorbed by the soil. In more developed areas, there is less opportunity for water to soak into the earth, leading to more runoff which must be managed by **storm drains**. Storm drains send water from our streets to the nearest stream or body of water, along with any pollution it may have picked up along the way. In Washington, nearly all stormwater runs to streams, rivers, and eventually the Salish Sea — or Puget Sound — without any treatment. This runoff causes harmful effects on our ecosystems and communities. **Contaminated** stormwater runoff is one of the primary causes of water pollution throughout the United States today.

For many years, people did not think much about where stormwater came from, where it went, or how other communities could be impacted by it at a later point. People essentially treated our stormwater as an "out of sight, out of mind" issue. However, in recent years, we have found that understanding and managing our stormwater is vitally important for the health of our freshwater and marine environments. Without careful management, stormwater runoff can lead to issues of flooding and pollution that can be harmful to natural and human environments. The negative impact of stormwater runoff can be managed in a variety of ways, with a focus on slowing down our surface water and giving it more chances to soak into the earth.

We will focus more closely on these methods, referred to as Best Management Practices (BMPs), later during this packet.

Vocabulary
Contaminated: Made dirty by exposure to pollution
Groundwater: Water held underground in the soil or in pores and crevices in rock
Infiltration: The process of water soaking into the earth
Runoff: Water that moves over the surface of the earth
Storm Drains: Drains in the streets of our cities that send water directly to the nearest stream

Main Activity

Stormwater Storytelling

One of the important aspects of managing our stormwater is considering the different impacts that it could have on our environment, and then designing solutions to those issues. This activity will be a way for you to consider and think more deeply about the journey water makes, and act as a starting point in our exploration of how stormwater impacts the world.

Materials: Paper, writing utensil

Draw from your real world experiences with stormwater near your home and school as well as your knowledge of the environment to create a narrative in which you are a water drop traveling with a large amount of stormwater from the Cascade Mountains to the Salish Sea.

Your narrative should include:

- 3 different natural environments/habitats (mountains, forests, streams, wetlands, oceans)
- 3 different human environments (farms, gardens, roads, cities, rooftops)
- 5 essential functions of water for different plants or animals, (acting as a home, source of food or drinking water, etc.)
- 3 different negative impacts that can be caused by this water (flooding of animal habitats, creating dangerous situations for people, carrying pollution to negatively impact animal habitat or the water humans use for drinking and/or recreation)

As you complete more of this packet consider how you can add to or adapt this narrative to create an understanding of our stormwater and how it can be managed to minimize negative impact while fulfilling its needed functions for the environment.

Optional Activity

Runoff Model

If you choose to build this model, save it for further work during an optional activity on Wednesday!

Be sure that you have adult permission and supervision. When gathering materials, be sure that they are safe and remember to be careful that these materials are collected and returned outside — <u>DO NOT</u> wash down the drain in your home.

Materials: large aluminum pan or plastic container, aluminum foil, dirt, silt, sand, gravel, food coloring, drink powder, spray bottle

Instructions to build model:

1. Fill one third of a large aluminum pan or plastic container with dirt in an irregular manner to mimic the Earth's surface.
2. Using a spray bottle, spray small amounts of water on the pan and notice how it flows downhill in watersheds. Record what you observe, such as direction of flow, pooling, etc.
3. Press a layer of aluminum foil over the dirt surface.
4. Cover the majority of the foil with a layer of dirt, silt, sand and gravel (in any pattern you like until the pan or container is two thirds full) to simulate various soil textures. Leave areas of the model (at various elevations) with the foil still exposed to simulate paved portions of the watershed.
5. Predict what effect the new soil textures and impervious areas will have on water flow, and effects of the water on the soil.
6. Spray water in increasing amounts onto soil. Does the water move certain areas more than others? Does this depend on the slope of the watershed or the quantity of water? Does more water flow from the foil (paved) area than the soil area?
7. Place small amounts of different colors of powdered dyes around your landscape model to represent solid pollutant sources (e.g., animal waste, fertilizers, and pesticides). Place a few drops of food colorings at other places to represent liquid pollutant sources like soap from a car wash, oil from a leaky car, and animal waste.
8. Predict how the various pollutants will be transported through the watershed.
9. Spray small amounts of water on your "pollutants" and observe results.

Does the water pick up and transport the substances as stormwater pollution (colored water)?

Does sandy soil filter out some pollutants, while gravel did not?

Does more of the pollutant runoff of the paved areas than the soil areas?

Optional Activity

Stormwater Stewardship Challenge for Day 1

There are multiple ways to protect our waterways. At the end of every daily lesson, we will be providing a challenge to highlight what you've learned.

Materials: Writing utensil, computer/phone/tablet, internet connection

The water that flows through our watershed sustains plants and animals while also feeding our rivers, streams, wetlands, and Puget Sound. This water additionally provides humans with not only drinking water but an outlet for recreation and exercise. However, the quality of each of our waterways is impacted by stormwater runoff pollution.

Think about a time you've witnessed a problem with stormwater runoff pollution in your neighborhood. What was the specific issue or pollutant? How do you think the stormwater runoff pollution impacts those that live in our watershed and rely on that water, including the plants and animals as well as humans? What are the simple and possibly complex solutions to this stormwater problem?

Create a piece of writing that documents these ideas for your local city council. Specify the reasons they should consider in remedying the stormwater runoff pollution problem in your city.

To share your work, post your challenge to Facebook and/or Instagram (***with an adult***) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

- If you live in City of Auburn: Tag @auburnwa and include the hashtag #auburnwa
- If you live in City of Bothell: Tag @BothellWaUSA and include the hashtag #PugetSoundStartsHere
- If you live in City of Lynnwood: Tag @LynnwoodWA and include the hashtag #Lynnwood
- If you live in King County: Tag @KingCountyDNRP and @kingcountywtd

Brainstorm Ideas

Letter to City Council

DAY 2

Rivers, Streams, and Ponds

When we consider sources of stormwater pollution, we often think about things like pesticides, oils, and other chemicals which impact the environment by making plants and animals ill. One impact stormwater can have that is more complicated to understand is the impact that excess **nutrients** can have on the environment.

Nutrients are naturally present in our soil and water. They provide materials that plants need for growth while acting as the foundation of both land and water-based food webs. However, too much of a good thing can cause problems, specifically a process called **eutrophication**. Eutrophication occurs when our stormwater runoff has excess nutrients like **phosphates** that are often found in soaps and **nitrates** that are typically found in fertilizers from our lawns, gardens, and farms. This runoff eventually ends up in our ponds, lakes, and streams which can cause algae to reproduce rapidly.

When this increased algae population forms, a thick layer develops on the surface of the water which blocks the sun for the other water plants. Without sunlight, these plants stop photosynthesizing, leading to less oxygen in the water. As the algae uses up the nutrients in the water and eventually dies, it is then broken down by bacteria. This bacteria reproduce quickly as well, using up a vast majority of the remaining oxygen. The water becomes **anoxic**, meaning there is no longer enough oxygen to support plant or animal life. This can lead to a **dead zone,** where no living things can survive.

Excess Nutrients > Algae Bloom > Decomposition/Bacteria > Anoxic Water > Dead Zone

We can help reduce the presence of excessive amounts of nutrients in our freshwater by choosing phosphate-free cleaning materials. We can also practice garden and lawn care that relies on compost rather than chemical nitrogen fertilizers, to name a few examples.

Vocabulary

Anoxic: Greatly deficient in oxygen
Carcinogenic: Having the potential to cause cancer
Dead Zone: Dead zones are areas in the world's oceans and large lakes where nothing can live, caused by excessive nutrient pollution from human activities
Eutrophication: Excessive richness of nutrients in a lake or other body of water, frequently due to runoff from the land, which cause excess algae growth and death of animal life from lack of oxygen
Hydrocarbons: Chief components of petroleum and natural gas
Hypoxic: A region of the body is deprived of adequate oxygen supply at the tissue level
Lactic Acid: Whenever the body breaks down carbohydrates for energy, this chemical forms faster as the body's oxygen becomes more limited
Nitrates: Chemical compounds which contain nitrogen and oxygen, used as fertilizer
Nutrients: A substance that provides nourishment essential for life.
Phosphates: Used in automatic dishwasher detergents and laundry detergents to help soften water and to remove soil, oil, and grease

Main Activity

Eutrophication Model

This activity models the process of eutrophication, and the impact of stormwater on our freshwater environments both with and without the impact of stormwater runoff. You will begin with a healthy pond ecosystem that supports fish and algae with a moderate amount of nutrients. You will then add or remove algae, nutrients, and fish tokens based on an "action step" controlled by rolling a single die.

The first round the model will represent a natural pond ecosystem without impact from the human environment. During the second round, nutrients will be added to the environment from stormwater flowing into the stream. This model helps us to observe the impacts that excess nutrients can have on populations of algae and how that impacts fish populations.

Materials: game board, 10 fish tokens, 20 algae tokens, 20 nutrient tokens, a 6-sided die, or 6 coins

If you are unable to print these materials, you can make a simple drawing of the game board following the example included and use various materials around your home to represent different tokens. These could be paper clips, small pieces of paper, beads, dried beans, etc.

Round 1: Natural Nutrient Cycle

1. Place all fish tokens, 5 algae tokens, and 5 nutrient tokens in the corresponding grid inside the "pond" (*NOTE: grids are designed to help you keep track of the number of tokens*).
2. Roll a 6-sided die for your "action" step. If you do not have any dice, you can flip 6 coins instead, counting the number of 'heads' as your final number. You can also just choose a random number.
    - 1 or 2: add one nutrient and one algae token to the pond to represent natural nutrient addition and algae growth.
    - 3 or 4: remove one nutrient and one algae to represent natural digestion of nutrients.
    - 5 or 6: remove a fish token to represent the natural life cycle.
3. If you have 10 or more nutrient tokens, add 2 algae tokens for each nutrient added to your pond.
4. If you have 10 or more algae tokens, remove 1 fish each round in addition to other action steps.

Continue play until all fish are removed from the pond.

Round 2: Stormwater Impacts

1. Place all fish tokens, 5 algae tokens, and 5 nutrient tokens in the corresponding grid inside the "pond" (*NOTE: grids are designed to help you keep track of the number of tokens*).
2. Roll a 6-sided die (or use 6 coins) for your "action" step.
   Before you roll each turn, move any nutrients downstream one space.
   - 1: add one nutrient and one algae token to the pond to represent natural nutrient addition and algae growth.
   - 2: add one nutrient from the "city" to the stream to represent phosphate cleaning products.
   - 3: add one nutrient from the "lawns & gardens" to the stream to represent fertilizer.
   - 4: add one nutrient from the "farm" to the stream to represent fertilizer.
   - 5: remove one algae and one nutrient to represent natural digestion of nutrients.
   - 6: remove a fish to represent the natural life cycle.
3. If you have 10 or more nutrient tokens, add 2 algae tokens for each nutrient added to your pond.
4. If you have 10 or more algae tokens, remove 1 fish each round in addition to other action steps.

Continue play until all fish are removed from the pond.

Questions:

1. *How many turns were you able to take during Round 1 before the fish population was removed from the pond?*

2. *How many turns were you able to take during Round 2 before the fish population was completely removed from the pond?*

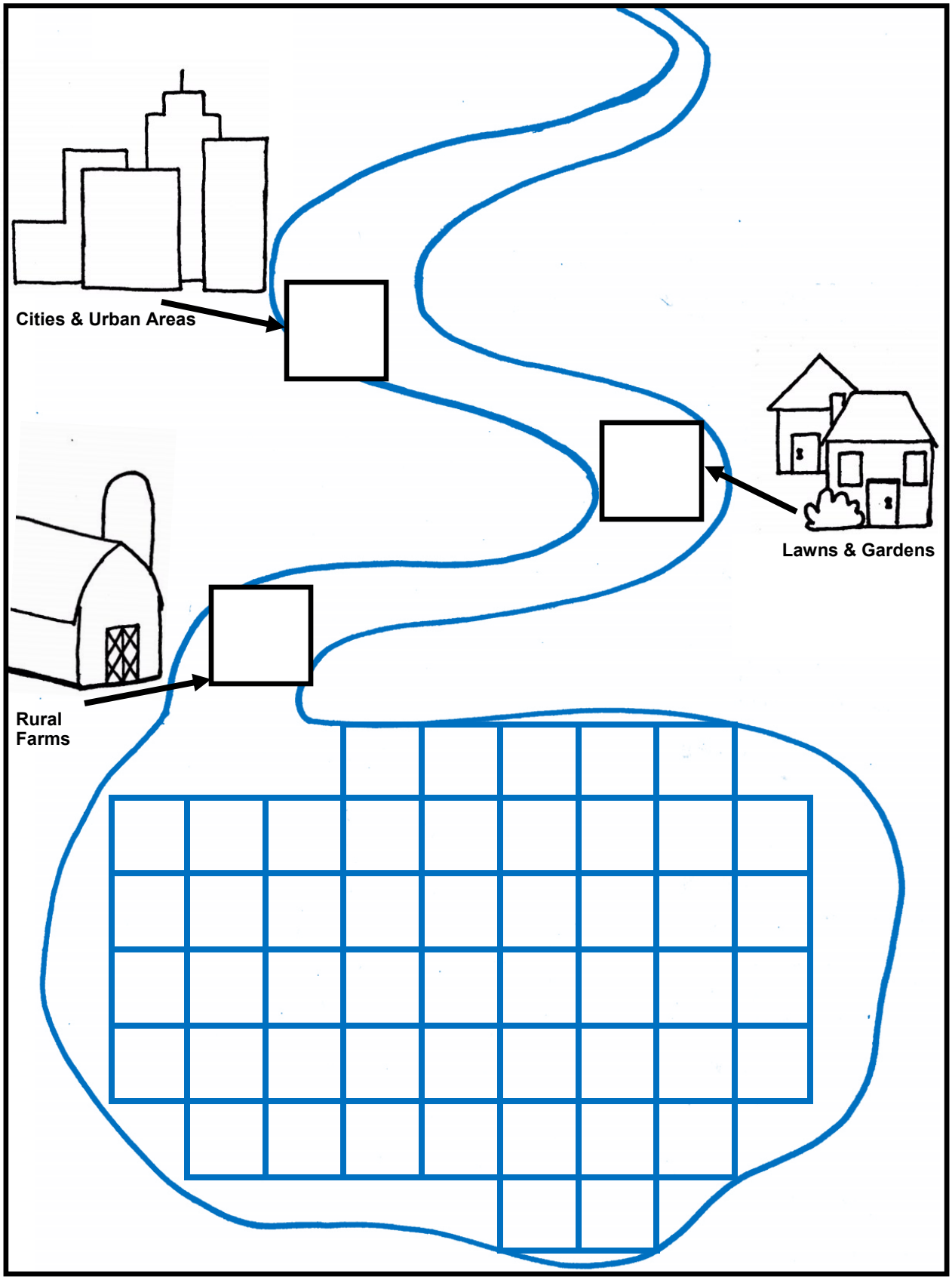
3. *As the concentration of nutrients increased, what happened to the algae population?*

4. *What were the similarities and differences between Round 1 and Round 2?*

5. *Which of these scenarios provided a balanced and working ecosystem?*

6. *What connections can you make between human activities, changes to our freshwater ecosystems, and the survival of animals that rely on that water?*

Game Board:



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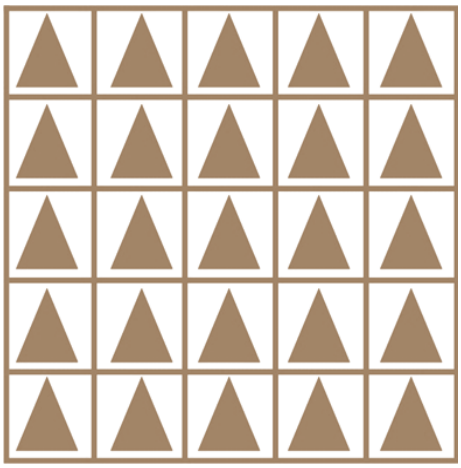
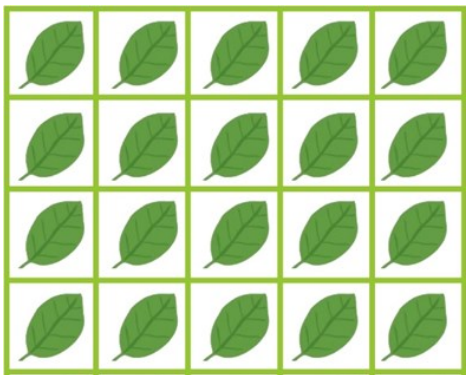
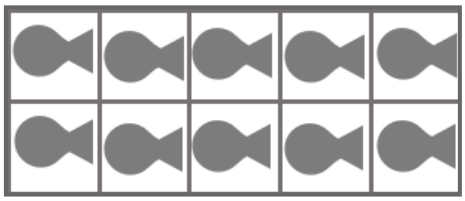


ALGAE TOKENS:



FISH TOKENS:



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Optional Activity

Salmon Streams and Stormwater Study Article

This report from Washington State University details the impacts of various chemicals on different salmon species. Analyze and interpret the article below, paying attention to details of the impact that stormwater pollution can have on salmon populations. After reading, answer the questions that follow.

Ask for an adult's permission before accessing the online story.
Source: https://www.eurekalert.org/pub_releases/2018-04/wsu-csd041718.php

Materials: Writing utensil, phone/computer/tablet, internet connection

"Coho salmon die, chum salmon survive in stormwater runoff research"

WSU scientists have discovered that different species of salmon have varying reactions to polluted stormwater runoff.

In a recent paper published in the journal Environmental Pollution, scientists found that Coho salmon became sick and nearly died, within just a few hours of exposure to polluted stormwater. But Chum salmon showed no signs of ill-effects after prolonged exposure to the same water.

"It really surprised us," said Jen McIntyre, an assistant professor in WSU's School of the Environment. "Not that the Coho were affected so quickly, but how resistant the Chum were. We saw no impact at all in the Chum's post-exposure bloodwork."

Survival in the tank

*Stormwater is toxic to fish because it can include **carcinogenic hydrocarbons**, metals and other organic compounds, most of which have yet to be identified.*

McIntyre and her team collected stormwater runoff in large tanks from roads and highways in western Washington. Then they placed salmon in that water for four hours, or until the fish showed signs of illness. Blood samples were then taken from all of the fish.

*Only a few Coho lasted four hours before having to be removed. In the test afterwards, the team found a significant increase in **lactic acid** concentrations and their blood was thicker and more concentrated. Their blood pH was thrown off and the amount of salt in their plasma decreased significantly.*

The Chum test results showed none of those changes, all these fish lasting the full four hours without showing any signs of distress or sickness.

"These fish are very closely related," said McIntyre, who works at WSU's Puyallup Research and Extension Center. "They're the same genus, but obviously something is significantly different physiologically. We just don't know what that difference is yet."

Collaborative study

The study was done at the Suquamish Tribe Grovers Creek Salmon Hatchery, with fish donated by the Suquamish Tribe.

McIntyre worked on the project with fellow WSU scientists, along with colleagues from the NOAA-National Marine Fisheries Service and the U.S. Fish and Wildlife Service.

Clues for next round

*McIntyre and her team noticed a few clues for where to start their next round of investigations: studying what makes the chum nearly impervious to toxic runoff. One is that the Coho looked **hypoxic**, meaning they weren't getting enough oxygen. But the water had plenty of oxygen, so they'll look at blood circulation issues, how the fish metabolize oxygen in their muscles, and a few other areas.*

"We don't know if the thicker blood is a symptom of the problem, or if that's the initiating event that then causes the oxygen deprivation," McIntyre said. "There's a lot of work still to come, but this really narrows down where we need to look."

They're also hoping that looking further into Chum will turn up clues about how they resist the effects of toxic runoff.

Four days, no symptoms

In a later study, not included in this paper, McIntyre and her team conducted a prolonged exposure test on Chum. Those fish swam in the stormwater runoff for four days and none of them got sick.

"We're still trying to understand how they're unaffected," she said. "It's actually really impressive."

Another problem for the Coho is that scientists don't know what particular contaminants in the runoff are causing the problems.

"There's a whole variety of heavy metals and hydrocarbons in that water," McIntyre said. "And a whole bunch of chemicals we are working to identify so that we can protect more delicate species like Coho salmon from the effects of human pollution."

Questions:

1. *What are the common contaminants that make stormwater toxic?*

2. *Briefly describe how scientists carried out this research.*

3. *Which type of salmon were most impacted by stormwater pollution? Which were mostly unaffected?*

4. *What "clues for the next round" did scientists see in this study?*

5. *How might knowing that one species is more immediately impacted by pollution help scientists while measuring water quality?*

Optional Activity

Stormwater Stewardship Challenge for Day 2

Humans are capable of great change! One of the greatest issues in our watershed is how pollutants enter waterways as stormwater runoff and harm salmon – an essential species to the health of our watershed.

Materials: Writing utensil, computer/phone/tablet, internet connection

Investigate items around your home that contain unnatural ingredients. Identify specific items that could harm salmon if that item ever ended up in a river, stream, wetland, or Puget Sound as stormwater runoff. Would these ingredients decompose, or break down, in the waterways or would these ingredients contaminate the waterway's health?

Write down specific items you've identified as harmful to salmon health. Additionally, explain which ingredients could be toxic to salmon.

1.

2.

3.

4.

5.

Once the list is complete, answer the following questions regarding solutions:

- Which items are absolutely necessary for you and/or your family?
- Are there salmon safe alternatives to these items?
- Would you and/or your family consider using the salmon safe alternatives starting today?

To share your work, post your challenge to Facebook and/or Instagram (with an adult) so other people in your community can learn, too!
Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

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DAY 3

Wetlands

While water flows through our environment, one of the most important areas it moves through is our **wetlands**. Wetlands contain water, **saturated** soil, and water-tolerant plants. Places like swamps, bogs and marshes are all wetlands. In other words, wetlands are places where the land is saturated, or soaked with water, for at least part of the year. Wetlands are crucial because they help to slow water down, are able to absorb a lot of water, and even help clean that water as it makes its way through the watershed. Therefore, when the water reaches the nearest body of water, it is carrying less pollution. They are also very important habitat for many different animals, and so they help to support both natural and human communities.

For many years, people did not understand how important wetlands were, and we did not treat them very carefully. Now that we understand their importance, we continue to help make sure they function to the best of their abilities. One thing that people are doing to help improve and preserve their functionality is creating areas called **bioswales**. Bioswales help to combine the actions of a storm drain and a wetland, acting as ditches of sorts which are filled with native plants. Because these are created to absorb stormwater, bioswales are usually built along the side of roads to help direct and slow the flow of water. Then, this stormwater absorbed into the ground can be naturally cleaned within a city, just like it would in a natural wetland area.

People have also begun building artificial wetland habitats, known as **constructed wetlands**. These aim to supply the same benefits as a natural wetland, providing vital habitat for native plant and animal species and working to clean our water.

Vocabulary

Bioswale: Channels designed to concentrate and convey stormwater runoff while removing debris and pollution. They are like vegetated ditches.
Constructed Wetlands: Artificial wetland to treat municipal or industrial wastewater, greywater or stormwater runoff
Estuary: The tidal mouth of a large river, where the tide meets the stream
Saturated: Holding as much water or moisture as can be absorbed; thoroughly soaked
Wetlands: Land consisting of marshes or swamps; saturated land

Main Activity

Constructed Wetland Investigation

This article comes from “Currents”, a student blog from the University of Washington. It details the work being done to construct wetlands in our environment, specifically along the Duwamish Waterway. Read the article and answer the questions that follow!
Source: https://smea.uw.edu/currents/something-afloat-in-the-duwamish-river-a-look-at-floating-wetlands-in-an-urban-estuary/

Materials: Writing utensils

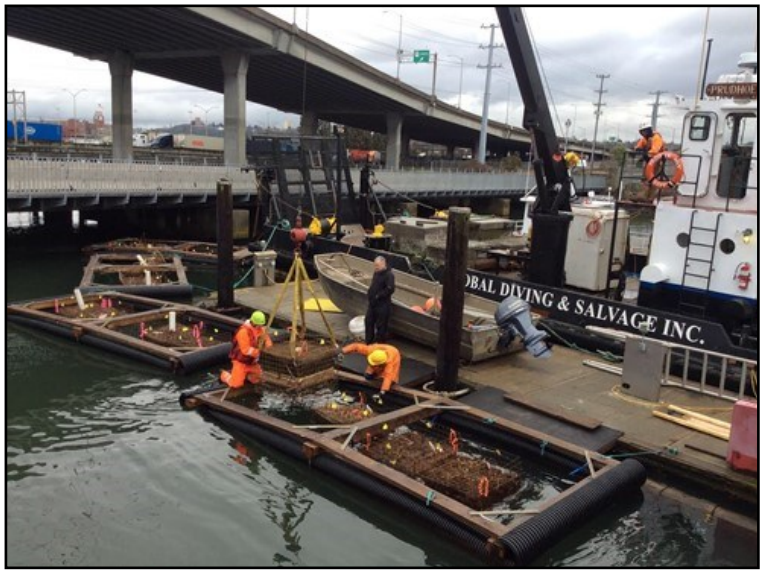
SOMETHING AFLOAT IN THE DUWAMISH RIVER: A LOOK AT FLOATING WETLANDS IN AN URBAN ESTUARY
By: Charlotte Dohrn

Wetland Biofilter

The general design of the floating wetlands, including layers of different organic materials (credit: University of Washington Green Futures Lab)

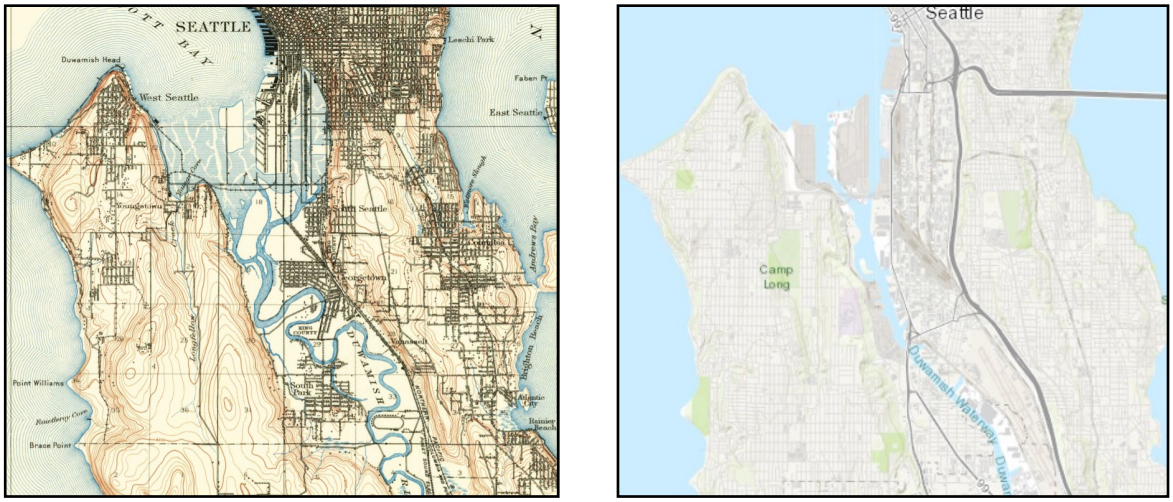
Seattle's Duwamish River estuary has something new afloat along the shorelines. If you have the chance to visit the river this spring, you might see several structures holding large, square mats of wood straw, biodegradable foam, and other natural materials tethered to piles near the river's edge. You might also see me or other team members perched on the wooden frames, counting fish, measuring plants, and sampling water quality. From a distance, these structures may not look like much right now – but if you look closer, you will see that they are holding native wetland bulrush that are just beginning to emerge. Suspended within buoyancy providing bio barges, the floating wetlands are an innovative approach to mimicking natural wetlands that may improve water quality and provide habitat for invertebrates and juvenile fish.

Designed and built by the University of Washington's (UW) Green Futures Research and Design Lab, with support from King County, the Rose Foundation and the Port of Seattle, the team towed the floating wetlands to their primary research sites at two locations in the estuary in mid-April 2019. An interdisciplinary UW team comprised of faculty and students from the Landscape Architecture Department, the School of Marine and Environmental Affairs, the Evans School of Public Administration and Governance, the School of Aquatic and Fishery Sciences, Civil and Environmental Engineering, the School of Environmental and Forest Sciences, the College of Built Environments and the School of Oceanography, is working with experts from King County and the Port of Seattle on the project. Now that the wetlands are built, planted, and afloat in the Duwamish, we are designing and implementing a monitoring program to assess the potential impacts and benefits that the floating wetlands may have on water quality, invertebrates, and juvenile salmon. We hope to learn if the wetlands improve localized water quality, provide habitat for insects that juvenile salmon eat, and how salmon utilize the wetland structures on their way out to sea. The team thinks that the wetlands could provide refuge from predators and additional food in the form of wetland insects that may contribute to marine survival.



Installing the floating wetlands within the biobarges before relocating them to their future sites (credit: University of Washington Green Futures Lab)

Other urbanized waterways – like the Baltimore Harbor – have installed floating wetlands to improve water quality and habitat. The floating wetlands in the Duwamish have been designed with a specific focus on the imperiled and culturally and ecologically significant salmon. In a heavily industrialized area like the lower Duwamish River where shoreline restoration opportunities may be limited, floating wetlands could complement restoration efforts by adding a new type of valuable wetland habitat. The team is actively engaging the social as well as the environmental context of this project, by integrating a community science program that will engage residents of nearby neighborhoods and community groups in environmental monitoring. Community scientists will collaborate with the monitoring team on data collection in the field and other opportunities. We are working to align the project with principles developed by the City of Seattle's Environmental Justice Committee to create opportunities for communities of color to connect to Seattle's waterways.



Historical changes to the Duwamish River estuary from the 1800s to today
Sources: (left) USGS website https://catalog.data.gov/dataset/usgs-1-62500-scale-quadrangle-for-seattle-wa-1908, (right) Google Maps

Once a meandering waterway that drained over million acres of watershed and five major rivers, the Duwamish watershed supported productive and diverse ecosystems and abundant salmon, plants, and other wildlife. The Duwamish Tribe – the host tribe of Seattle and King County – had one of their largest villages along the banks of the lower river, coexisting with the river ecosystem until the village was burned by settlers in 1895. Non-Native settlers violently displaced members of the Duwamish Tribe and other Coast Salish peoples, many of whom relocated to reservations throughout the region. Logging, straightening, large-scale watershed engineering projects conducted by the Army Corps, and other hallmarks of development heavily impacted the watershed and reduced salmon habitat in the Duwamish by over 97 percent by the early 1900s. The city subsequently filled the tidelands to enable industrial use of the area.

In 2001, the EPA listed over five miles of the lower river as a Superfund cleanup site due to legacy sediment contamination from industrial pollution. King County, Boeing, the City of Seattle, and the Port of Seattle have been named responsible parties, and other industries will likely be found responsible for the cleanup. Advocacy efforts led by tribal and non-tribal communities have helped drive initial cleanup and restoration, and the city has implemented programs to control pollution. However, there are still occasional outfalls of untreated stormwater going into the river, along with environmental concerns.

Despite its troubled environmental history, the Duwamish River has seen considerable investment from local community organizations like the Duwamish River Cleanup Coalition – including the Duwamish Tribe as a founding member, the City of Seattle, Port of Seattle, King County, the EPA, corporations, and other groups. The EPA is working with responsible parties and communities to design the specifics of the cleanup plan for the Superfund area. King County has restored over 25 acres of habitat along the river, and there are areas that now mimic natural shoreline conditions and salmon habitat. Every year, groups come together to celebrate ongoing efforts to revitalize the river.

Constructed floating wetlands are in use in other waterways around the state, including these in Redmond, WA (credit: Mason Bowles)

Habitat enhancement projects along the Duwamish River are part of a portfolio of innovative approaches taking place in Seattle to improve the ecological health of the city's urban aquatic environments. The city recently completed an unprecedented redesign of the central waterfront seawall, including habitat benches, texture on the seawall surface, and light penetrating sidewalks to improve habitat for migrating juvenile salmon and other species. The Port of Seattle is in the process of creating an experimental eelgrass and oyster bed restoration area at Smith Cove in Elliot Bay to sequester carbon, mitigate ocean acidification, and improve water quality. The city is aiming to manage 700 million gallons of stormwater runoff using green infrastructure, in part to improve water quality in Puget Sound, the Duwamish, and other waterways.

Many restoration endeavors, like the floating wetlands project currently underway in the Duwamish, began as experiments and pilot studies. In the floating wetlands project, the team is embracing experimentation, acknowledging that the project will generate valuable lessons learned for future efforts. The environmental problems in urban environments can seem intractable, and urban ecological restoration requires creative and innovative approaches to addressing challenges like degraded water quality and fish habitat. Time will tell, but we hope that the new floating wetlands in the Duwamish, along with other restoration and rehabilitation projects small and large, may contribute to incremental changes in the land-sea processes that affect the health of Seattle's urban ecosystem.

Questions:

1. *What are the suspected benefits of these floating wetlands for salmon?*

2. *What are the suspected benefits for water quality?*

3. *Why are floating wetlands being placed in addition to restoring the river banks?*

4. *How many gallons of stormwater runoff is the city hoping to manage with "green infrastructure projects"?*

5. *How would you design a floating wetland?*

Optional Activity

Wetland Sponge Model

This activity can be done in two different ways. First, it can be done as a simplified standalone alone activity. Alternatively, it can be done as an extension of Monday's Optional Activity: "Runoff Model".

Materials: Tray/shallow plastic container, sponge, soil, two cups or jars to hold water, water, small strip of carpet (if possible)

Be sure that you have adult permission and supervision if needed. When gathering materials, be sure that they are safe. Remember to be careful that these materials are collected and returned outside. They are *NOT* to be washed down the drain in your home.

If extending from your "runoff model" from Monday's Optional Activity:

Place various materials downhill from some of the pollutant sources to mimic structural water quality management practices including:

- **Grass buffer strip or bioswale:** Place a small strip of carpet below pollutants placed on pavement (i.e., directly on the foil) to model a strip of vegetation that will slow runoff and pick up pollutants such as oils and solids.
- **Wetlands:** Form a small depression in the soil and place a piece of sponge in it to model a small wetland. The "wetland" can be placed below an area approximating a farm field with fertilizer and pesticide or a factory with various industrial pollutants.
- **Erosion barrier:** Erosion control barriers such as plastic netting or crimped straw are placed on disturbed soil at construction sites to minimize erosion of bare soil before final vegetation or pavement is in place. Place a strip of paper towel (i.e., an "erosion barrier") over an area of loose soil to minimize the erosion caused by the "rain" from the spray bottle as it hits the soil and runs downhill.

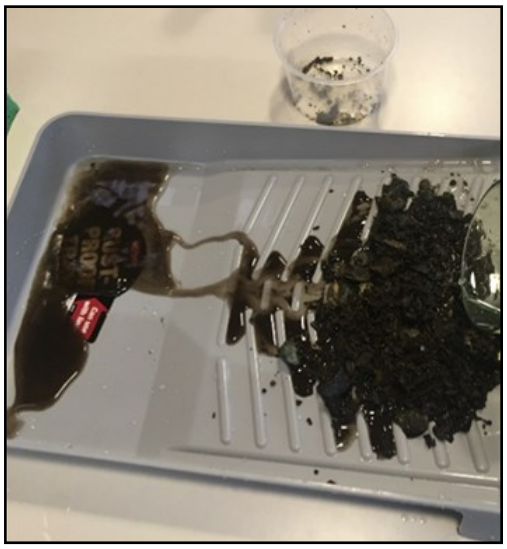
If you are creating this as a standalone activity, follow the directions on the next two pages.

If creating this model as a standalone activity:

Use a paint tray or other shallow container to represent the land portion of a watershed as it directs all water to a lower, central body of water, like a lake. Pour some water at the higher end of the tray or container, which represents rain. What will happen to the water? *Hint: It should runoff quickly into the body of water.*

Next, collect that water in a jar or cup. Then place a sponge in the pan at the base of the tray representing a wetland as a buffer zone between the land and the body of water. Don't place it in the "lake" area, but rather just before. Pour some water on the land again. What do you notice?

Next, collect the water in the lake in a cup or jar once more. Then remove the sponge and spread soil over the top of the tray. Proceed to pour water over the soil. Observe what happens to the runoff after it comes into contact with the soil. Compare the water in the cup or jar to the water that ends up in the body of water.



Finally, add the sponge and repeat the experiment. What happens to the runoff now?

Further thinking: What might happen if a wetland is destroyed and houses or other developments are built in its place? Unfortunately for many years, human beings did not understand the important roles that wetlands play in protecting our ecosystems and communities. Wetlands were drained and developed for a variety of reasons, which led to an increase in flooding, pollution and property damage and a decrease in useable habitat for plants and animals in our region.

Optional Activity

Stormwater Stewardship Challenge for Day 3

Our storm drain system is an intricate piece of our cities' infrastructure to mitigate rainwater and snow melt that falls onto our cities. This precipitation is referred to as stormwater. Storm drains help to prevent flooding and damage to our homes by directing stormwater into the closest waterway. However, our cities are covered in solid surfaces resulting in most of this stormwater becoming runoff rather than being absorbed. This means the initial design of our storm drain systems not only moves stormwater but also any pollutants that may be captured as runoff.

Materials: Computer/phone/tablet, internet connection, any gear needed to conduct drain cleanup (like gloves, trash bags, broom, etc.), writing utensil, colored pencils/markers, paper

To help your community keep storm drains working well, you can volunteer to adopt a storm drain!

You don't need to volunteer officially to do your part though. Anyone can help to keep a drain near them clear of leaves, sticks and other natural materials that could potentially clog a storm drain.

With an adult, find a storm drain near your home and remove any debris from the drain opening.

- **Do not go into the street!**
- **Be careful when walking and always watch out for cars, bikes, and other traffic. Whenever you are outside, it is important to be safe, responsible and respectful.**
- **Use a broom or rake to sweep leaves, sticks, and small rocks away from the top of the storm drain.**
- **Never use your hands to pick up anything!**
- **Never pick up anything sharp or dangerous.**

If you aren't able to make it outside, you can still help! Make an informational sign reminding others to keep storm drains clear of debris to ensure these drains work efficiently! Display the sign in a window or take a picture and send to friends and family.

To share your work, post your challenge to Facebook and/or Instagram (***with an adult***) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

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DAY 4

Puget Sound

In the Puget Sound ecosystem, humans are responsible for negatively impacting other species in the food web. Overfishing, pollution, introduction of non-native species, and the release of toxic chemicals and substances are some of the examples of this. In turn, these actions are also responsible for the decline in the populations of some species in the Puget Sound.

Toxic substances (e.g. pesticides and other chemicals) are released into the air and waterways in a variety of ways, including factory runoff, emissions, fossil fuels, burning waste, microplastics, and stormwater contamination. These sources of pollution find their way into Puget Sound, causing **bioaccumulation**. This occurs when toxic substances accumulate in the tissue of an organism over time due to prolonged exposure.

These toxic substances are absorbed by **producers**, such as phytoplankton. They then make their way up the food chain to **primary consumers**, like zooplankton, and **secondary consumers**, like herring. After travelling through the food chain, the toxic substances make their way to **tertiary consumers**, like salmon and orcas. This increasing concentration of harmful chemicals in the tissues of organisms at higher **trophic levels** is referred to as **biomagnification**.

In spite of their protected status as an endangered species by Washington State, the United States, and Canada, the Southern Resident orca population has decreased. It has declined from 98 orcas in 1995 to only 73 as of August 2019, the lowest in more than 30 years, according to a Washington State Department of Ecology report from November 2018. These Southern Resident orcas face three main threats:

1. Availability of Chinook salmon
2. Toxic contaminants in the environment
3. Disturbance from noise and vessel traffic

Vocabulary

Bioaccumulation: When a substance is consumed by a consumer and accumulates faster than it is excreted (i.e. toxins can accumulate inside an organism's body)
Biomagnification: When an organism consumes a large number of organisms containing small amounts of substance (refers to the increasing concentration of a toxin in tissues of an organism at successively higher levels of the food chain)
Mercury: Highly toxic chemical, commonly added to our environment by burning fossil fuels
Producers: Organisms that make their own food that get energy from the sun, and with the help of water convert energy into useable energy in the form of sugar or food (e.g. a plant)
Primary consumer: An organism that feeds on primary producers (e.g. an herbivore)
Secondary consumer: Organisms that feed on primary consumers (e.g. an herbivore or a carnivore)
Tertiary consumer: An animal that obtains its nutrition by eating primary consumers and secondary consumers (i.e. a carnivore but can also be an omnivore)
Trophic levels: Any of the sequential stages in a food chain, occupied by producers at the bottom and in turn by primary, secondary and tertiary consumers

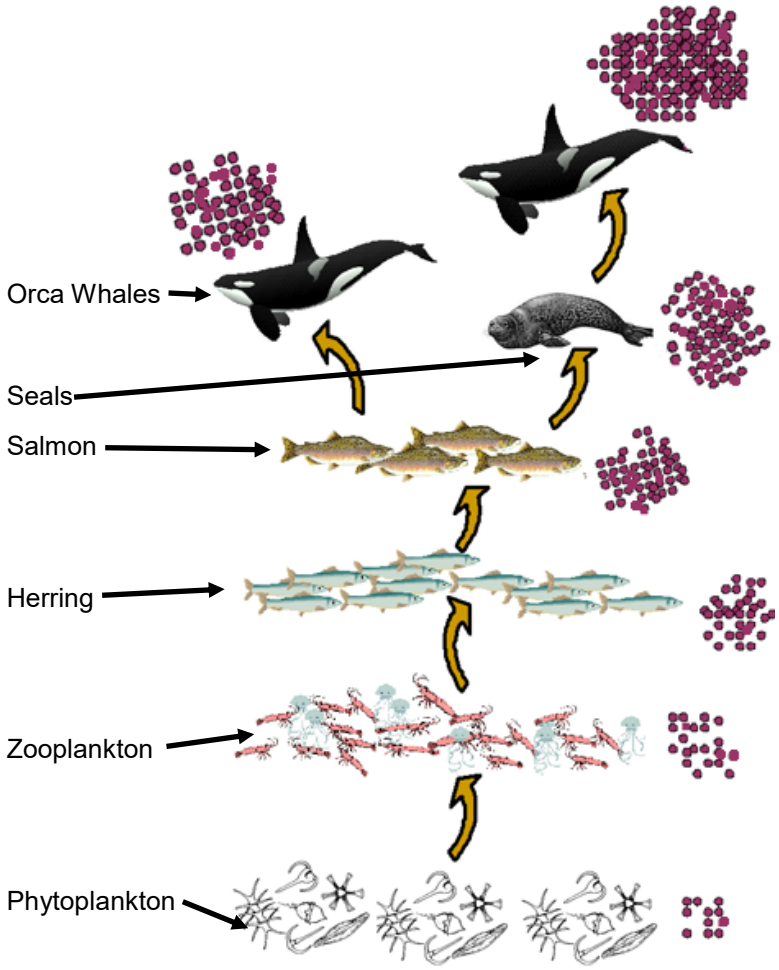
Main Activity

Ecosystem Interaction

Use the graphic to answer the prompts on the following worksheet page to help you learn more about bioaccumulation.

Materials: Writing utensil

Biomagnification in a Marine Food Web



Source: https://ptmsc.org/programs/investigate/citizen-science/completed-projects/orca-project/contaminants-in-orcas

Ecosystem Interaction Worksheet:

1. *Identify one or more tertiary consumers from the ecosystem interaction chart.*

2. *Identify one or more primary consumers from the ecosystem interaction chart.*

3. *Describe how bioaccumulation works.*

4. *Describe how biomagnification works.*

5. *Give 3 examples of chemicals that bioaccumulate.*

6. *How do our actions on land impact the health of this marine environment?*

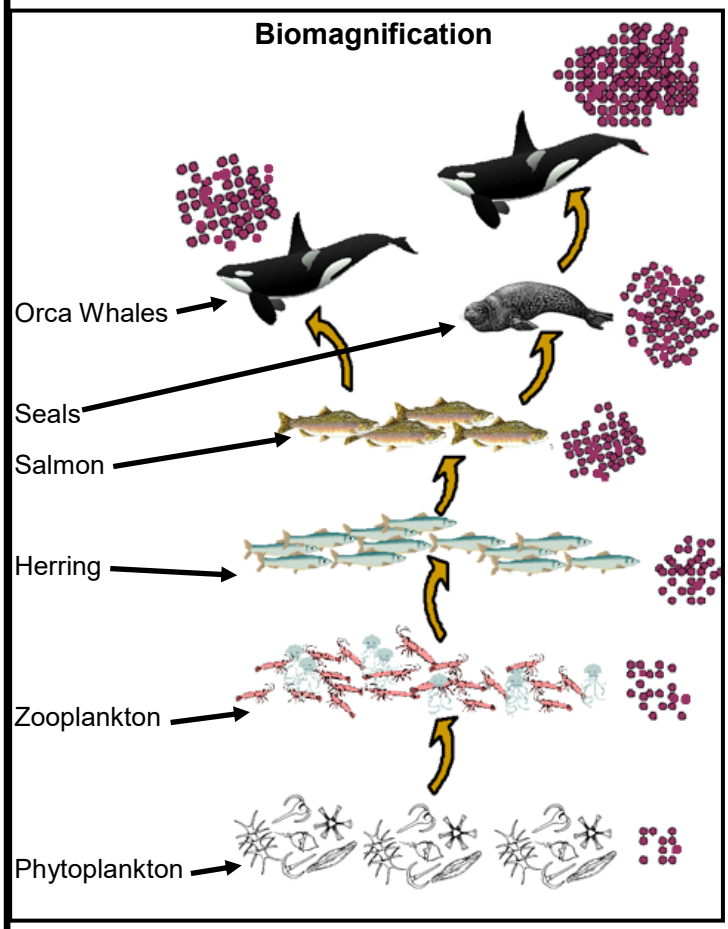
Optional Activity

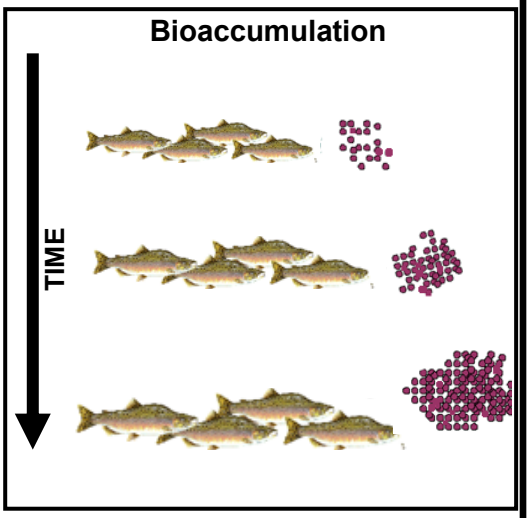
Biomagnification and Bioaccumulation Calculation

As a reminder, biomagnification refers to the increasing concentration of a pesticide or other chemicals in the tissues of an organism at successfully higher levels of the food chain. Bioaccumulation refers to the increasing amounts of a toxic substance in an organism, as it is accumulating faster than the substance can be excreted from the organism over time. This activity will help you learn more about this difference by learning how to calculate each!

Materials: Writing utensil

Harmful chemicals are washed down your neighborhood storm drain. They are carried by stormwater out through the watershed into the Puget Sound. As stormwater enters Puget Sound, toxins such as **mercury** are absorbed by phytoplankton. The mercury remains in the cells of the phytoplankton which accumulates over time. This is called bioaccumulation. Organisms at higher levels of the food chain obtain and accumulate the mercury from the food that they eat. This is called biomagnification. Take a look at these graphics and complete the calculations on the following page.





Adapted from: https://ptmsc.org/programs/investigate/citizen-science/completed-projects/orca-project/contaminants-in-orcas

Using the information you have just learned, complete the following calculation and answer the questions below:

Assume that each "unit" of phytoplankton contains 1 "unit" of mercury.

If zooplankton eat about 8 units of phytoplankton per year, how many units of mercury accumulates in its body? Write that number below "Zooplankton" in the food chain.

A herring eats approximately 50 units of zooplankton per year. How many units of mercury accumulates in its body? Write that number under "Herring" in the food chain.

If a salmon eats 50 herring per year, how many units of mercury accumulates in its body? Write that number under "Salmon" in the food chain.

If an orca whale eats 250 salmon per year, how many units of mercury will accumulate in its body? Write that number next to the "Orca whale."

FOOD CHAIN — Mercury Levels Present:

Phytoplankton: 1 Zooplankton:_____ Herring:_____ Salmon:_____ Orca whale:_____

1 X _____ = _____ X _____ = _____ X _____ = _____ X _____ = _____

Which organism had the most mercury in its body? Why?

What does this example demonstrate? Bioaccumulation, biomagnification, or both? Explain your answer.

Optional Activity

Stormwater Stewardship Challenge for Day 4

The orca or killer whales that live in Puget Sound are called the Southern Resident orca whales. These orca whales live in family groups called pods. The J, K, and L pods inhabit Puget Sound. As we just learned, the total orca population has dropped to only 73 whales for all three pods combined. This low population is partially due to stormwater runoff pollution contaminating Puget Sound's water quality. The health of the Southern Resident orca whales is greatly affected by the bacteria, metals, oils, and other chemicals that flow into Puget Sound as stormwater runoff. These pollutants remain as toxins in the whales' bodies. Help the Southern Resident orca whales by creating a slogan that inspires others to become stewards of Puget Sound.

Materials: Writing utensil, computer/phone/tablet, internet connection

Create a slogan to remind others of the stormwater pollution problem and its detrimental impact upon the Southern Resident orca whales' population. *A slogan is a short phrase or set of words that helps to remember something.* For example, a common slogan you might have seen or heard before about storm drains: "Only Rain Down the Storm Drain!" Your slogan does not have to rhyme but an effective slogan is recommended to be short for easy recall.

Orca and Stormwater Slogan:

_____

There are more resources available online that will help you learn more about our Southern Resident orca whales! ***With an adult***, learn more about them at whaleresearch.com.

To share your work, post your challenge to Facebook and/or Instagram (***with an adult***) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

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DAY 5

Stewardship

Stewardship is how we care for the natural world. A steward is someone who is responsible for the care of our natural resources. Stewardship includes conservation of natural resources (e.g. water) that all living things need to survive, carefully considering how we interact with the world around us, and doing our best to make sure that we have a positive impact on the environment.

This week we have learned about how our stormwater affects the health of our watershed and the Puget Sound, and ultimately all creatures that live here. These activities will focus on what we all can do to take care of what is entering our stormwater and help protect our rivers, streams, wetlands and the Puget Sound. We can all be stewards!

Vocabulary
Audit: A detailed inspection
Stewardship: The act of caring for and being responsible for something; being a protector

Main Activity

Stewardship Poster

The health of the Puget Sound is impacted by the health of our stormwater. Orcas rely on fat stores to survive. The toxins that bioaccumulate in their blubber as well as in the fish and other animals that they feed on hurt their chance for survival. What can an average citizen do to help? How can we step up as stewards on a daily basis?

Materials: Paper, writing utensil, (if available) poster board and markers

The following is an excerpt from the King County Stormwater Pollution Prevention Manual that highlights community efforts to reduce pollutants going into the Puget Sound. After reading the excerpt, take some time to brainstorm some actions that you personally can take. Next, make a poster that reflects an action that you can start to help steward the Puget Sound.

"*Good practices for homeowners to keep stormwater clean*"
Source: (King County Stormwater Pollution Prevention Manual, 2016)

There are things we can do at home to reduce stormwater pollution in the region:

Waste Disposal and Spills
1. *Never dispose of oils, pesticides, or other chemicals onto driveways, roadways or storm drains. The next rain will carry it into a surface water or help it soak into ground water.*
2. *Report polluters and spills so pollution can be cleaned up.*
3. *Stencil storm drains with "DUMP NO WASTE, DRAINS TO SOUND" message.*

Drainage
1. *Consider replacing impervious surfaces like sidewalks, decks, and driveways around your home with more pervious materials or methods like mulch, turf block, pervious concrete or clean stone.*
2. *Review your home for stormwater handling. If your gutters, downspouts, driveways, or decks directly discharge into a water body, retrofit them by redirecting the runoff onto grassy areas or installing berm/swale systems.*
3. *Collect stormwater runoff in closed rain barrels and use if for yard and garden watering.*

Car care
1. *Make sure your automobile isn't leaking fluids.*
2. *Instead of washing your car at home, take it to a commercial car wash. The drains in commercial car washes are connected to the sanitary sewer system, so rinse water doesn't wash down storm drains. Many commercial car washes conserve water by recycling rinse water.*
3. *If you must wash your car at home, use a mild dishwashing liquid and try to keep the soapy water from flowing to a storm drain. Park your car on grass or vegetation that will absorb the water, and use a spray nozzle that shuts off.*

Yard and garden care

1. *Practice natural lawn care to reduce the use of hazardous products while saving time, water, money, and helping to preserve the environment.*
2. *Instead of cleaning walkways with a hose, sweep up grass clippings, leaves, twigs and put them into a yard waste container or compost pile. Sweep up dirt and put it back into the garden. This way, you won't accidentally wash debris into a storm drain or waterway, and you'll save water.*
3. *Choose plants and trees that resist pests and disease. Certain flowering cherry trees are resistant to brown rot. Some roses are resistant to aphids and mildew. Certain rhododendrons are resistant to root weevils and are drought tolerant. Nurseries can help you in making choices.*
4. *Avoid using weed and feed products. Applying this product to your entire lawn is overkill for weed control. Pull weeds by hand or with tools. If you decide to use a weed killer, wear gloves, spot spray just the weed, and spray when it isn't windy or when rain isn't predicted. Never use pesticides, fertilizers, or herbicides near streams, lakes, or wetlands.*
5. *Avoid using Diazinon, often used to treat crane flies in lawns. This pesticide has also been found in our streams, and the Environmental Protection Agency is phasing it out because of the potential health risk to children.*
6. *If you have an irrigation system, make sure it is in good working order and limit its use to actual watering needs.*
7. *Collect stormwater runoff in closed rain barrels and use if for yard and garden watering*
8. *Retain shrubby vegetation along waterfronts to prevent erosion and help stop heavy rain sheet flow.*
9. *Stencil storm drains - DUMP NO WASTE DRAINS TO SOUND*

Pool or spa care

1. *Do not drain your pool or spa to a lot, ditch or outside drain where water could enter groundwater, a stream or lake, or a storm drain.*
2. *Do not drain your pool or spa to a septic system, as this action could cause the system to fail.*

Poster Brainstorm Ideas:

Here are a few additional household ideas to get you started:

1. Reduce contaminants by switching to natural household cleaners.
2. Make sure you are using beauty products that don’t contain microplastics.
3. Use eco-friendly products like reusable water bottles.
4. Use reusable grocery bags for shopping.
5. Stop using plastic straws.

POSTER SPACE:

Optional Activity

Eco Audit

Now that we know some ways that we can help prevent pollution from stormwater runoff, let's see what can be done around our home or neighborhood. An **audit** is when someone takes a close look at something and measures what is going well and what can be improved. Today, you're going to take a look around your home (or neighborhood) to conduct an audit. Using what you've learned, see what you are doing well and where there is room for improvement.

Materials: Writing utensil

If you're able to go outside and look around, ***make sure that you have an adult accompany you*** and ensure that you are safe, responsible and respectful. If you're not able to go outside you can still look out the window or just use your memory to do this part.

When conducting your home (or neighborhood) audit, ask yourself questions like these:

- Where does the water from your roof go? Is it collected in a rain barrel? Is there a place for that water to be absorbed by the earth? Does it go directly into the street?
- Are there trees, bushes, or green space near your home to slow down and absorb water?
- Are the streets and sidewalks near your home clean of litter?

Use the chart on the following page to list of each way that pollution could start around your home and make its way into the water. Then, either list what you and your family have done to help prevent that or come up with a recommendation for what you could do to help. Remember to look closely! If you need help, take a look at the rest of this packet for ideas. Once you've finished your audit, share it with some of the people in your home and community.

POLLUTION:	PREVENTION:

Optional Activity

Stormwater Stewardship Challenge for Day 5

There are so many ways to protect and care for our water. At the end of every daily lesson, we will be giving a stormwater challenge to help you show off what you've learned.

Materials: (Optional) writing utensil, colored pencils/markers, computer/phone/tablet, internet connection

Using what you've learned this week regarding stormwater pollution, it's time to be creative! Create a challenge you can pose to those in your household, to your friends, to your community, or to a broader audience on the internet through social media. Think about each topic the packet covered this week and list one aspect you can take from each lesson to incorporate into a new stormwater challenge for today:

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-
-
-
-

To share your work, post your challenge to Facebook and/or Instagram (***with an adult***) so other people in your community can learn, too! Don't forget to tag @naturevisionorg in your post! Do you live in Auburn, Bothell, Lynnwood, or King County? Use the hashtags and tag the city or county group below. They want to see all the work you are doing to keep our water clean!

- If you live in City of Auburn: Tag @auburnwa and include the hashtag #auburnwa
- If you live in City of Bothell: Tag @BothellWaUSA and include the hashtag #PugetSoundStartsHere
- If you live in City of Lynnwood: Tag @LynnwoodWA and include the hashtag #Lynnwood
- If you live in King County: Tag @KingCountyDNRP and @kingcountywtd

Answer Key

Day 2 Optional Activity: Salmon Streams and Stormwater Study Article

What are the common contaminants that make stormwater toxic?

Potential answer: **Carcinogenic hydrocarbons, metals other unidentified organic compounds.**

Briefly describe how scientists carried out this research.

Potential answer: **Placing fish in a tank containing stormwater, observing them and measuring time until they began to show signs of illness.**

Which type of salmon were most impacted by stormwater pollution? Which were mostly unaffected?

Potential answer: **Coho are being negatively impacted, while Chum seem not to be.**

What "clues for the next round" did scientists see in this study?

Potential answer: **Impacted species become hypoxic, meaning they are not getting enough oxygen.**

How might knowing that one species is more immediately impacted by pollution help scientists while measuring water quality?

Potential answer: **We can know when water quality is going down as we see Coho populations being negatively affected.**

Answer Key

Day 3 Main Activity: Constructed Wetland Investigation

What are the suspected benefits of these floating wetlands for salmon?

Potential answer: **Floating wetlands will provide habitat, food sources, and hiding places.**

What are the suspected benefits for water quality?

Potential answer: **Filtering polluted stormwater runoff.**

Why are floating wetlands being placed in addition to restoring the river banks?

Potential answer: **Much of the lower Duwamish banks is heavily developed and shoreline restoration is limited.**

How many gallons of stormwater runoff is the city hoping to manage with “green infrastructure projects”?

Potential answer: **700 million gallons.**

Answer Key

Day 4 Optional Activity: Biomagnification and Bioaccumulation Calculation

FOOD CHAIN — Mercury Levels Present:

Phytoplankton: **1** Zooplankton: **8** Herring: **400** Salmon: **20,000** Orca whale: **5,000,000**

1 X **8** = **8** X **50** = **400** X **50** = **20,000** X **250** = **5,000,000**

Which organism had the most mercury in its body? Why?

The orca has the most in its body because of biomagnification and its place at the top of the food chain.

What does this example demonstrate? Bioaccumulation, biomagnification, or both? Explain your answer.

Both. The mercury accumulating within the phytoplankton is an example of bioaccumulation while the rest of the species above the phytoplankton in the food chain are consuming that mercury as they eat one another. This mode of transferring the mercury through the food chain is an example of biomagnification.