TEACHER OVERVIEW

Watersheds

9th — 12th grade

Nature Vision Student Packet

The materials contained within this packet for students 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 curriculum 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 by students either independently from home, or with the help of an adult caregiver. Materials for each day of the week build on the previous days' learning by offering a variety of activities that involve art, writing, and safe field exploration.

These materials are provided to you by Cascade Water Alliance (Cascade). Cascade wants everyone to understand the importance of conserving and protecting our limited water resources. Cascade supports Nature Vision in the development and delivery of water education programs and we are happy to offer these materials to our friends in the community. Learn more about Cascade at 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 watersheds and the importance of fresh water, followed by an exploration of plants and animals in the watershed. Students then explore the role human impact plays in maintaining adequate levels of clean water. The unit concludes by exploring ways that we can help to protect and restore the environment in our local watersheds.

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-LS2-1, HS-LS2-2, HS-LS2-7, HS-ESS2-5, HS-ESS3-4, HS-ETS1-2, HS-ETS1-3.

Grades 9-12
Day 1 - Watershed Basics
Day 2 - Plants in the Watershed
Day 3 - Animals in the Watershed
Day 4 - Human Impacts
Day 5 - Stewardship

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CASCADE WATER ALLIANCE

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PARENT/CAREGIVER OVERVIEW

Watersheds

9th – 12th Grade

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 that 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 Cascade Water Alliance (Cascade). Cascade wants everyone to understand the importance of conserving and protecting our limited water resources. Cascade supports Nature Vision in the development and delivery of water education programs and we are happy to offer these materials to our friends in the community. Learn more about Cascade at cascadewater.org.

Another great resource to learn about saving water and how to help our salmon and watershed is weneedwater.org. Check out the We Need Water webpage or on Instagram @WeNeedH20 to see how you can be part of this campaign! Challenge yourself to use #WeNeedWater to post all the things you are doing with your friends and family to conserve and protect water!

Please contact info@naturevision.org with any questions or concerns
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NOTE: 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.

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PARENT/CAREGIVER OVERVIEW: DAY 1

Watershed Basics

Background Information: A watershed is all of the land in an area that directs water to a certain place. Any water that falls on the western side of the Cascade Mountains eventually drains into the Salish Sea, otherwise known as the Puget Sound. Therefore, we live in the Puget Sound Watershed. We can think of watersheds being nested inside one another, so inside of the greater Puget Sound Watershed, there are local watersheds, like those where water drains to Lake Washington and then to the Puget Sound. Another local watershed example is a place where water drains to Lake Sammamish, then to Lake Washington, and then to the Puget Sound, and so on. It's important to understand our watersheds, because we share both this space and our freshwater with all of the living things in these Regions. The water that we use impacts the available water for these other plants and wildlife in our watershed.

Learning Objectives: Students will better understand where they live in the watershed, and what effects humans have in their local watersheds. They will explore the basics of how water moves through the environment.

Main Activity: Watershed Mapping

- ***Overview***: Students explore maps to find where they live, go to school, and play within their watershed, while locating the specific rivers and lakes that water flows to and from on its journey to the Salish Sea/Puget Sound
- ***Parent/Caregiver Tasks****:* Help students locate specific areas on maps

Optional Activity: We Need Water Challenge

- ***Overview***: Students complete a daily task related to a water conservation habit and a challenge to spread awareness on the importance of saving water
- ***Parent/Caregiver Tasks****:* If possible, help the student post their #WeNeedWater challenge on social media

Optional Activity: Watershed Community

- ***Overview***: Students add natural and human made elements to a drawing of a watershed consider how water flows through an environment and what things may interact with it
- ***Parent/Caregiver Tasks****:* None

PARENT/CAREGIVER OVERVIEW: DAY 2

Plants in the Watershed

Background Information: Plants are a vital part of the watershed. They help to manage and clean our water, giving it places to absorb in the soil, and helping to keep water available for organisms to use.

Learning Objectives: Students will learn the role that plants and greenspaces play in healthy watersheds.

Main Activity: Soil Infiltration Testing

- ***Overview***: Students test the rate at which water can be absorbed by the soil
- ***Parent/Caregiver Tasks****:* None

Optional Activity: We Need Water Challenge

- ***Overview***: Students complete a daily task related to a water conservation habit and a challenge to spread awareness on the importance of saving water
- ***Parent/Caregiver Tasks****:* If possible, help the student post their #WeNeedWater challenge on social media

Optional Activity: Native Plant Scavenger Hunt

- ***Overview****:* Students explore their neighborhood or make observations from home for the types of plants that grow nearby
- ***Parent/Caregiver Tasks****:* Provide supervision

Optional Activity: Videos

- ***Overview****:* Students watch videos explaining the importance of using native plants to enhance our green spaces and support our ecosystem
- ***Parent/Caregiver Tasks****:* Provide technical support

PARENT/CAREGIVER OVERVIEW: DAY 3

Animals in the Watershed

Background Information: There are two vital members of the watershed community: salmon and beavers. Salmon populations have been declining in recent years, with human impact to habitat being a key factor. Beavers are a member of the watershed community whose behavior as ecosystem engineers helps to create salmon habitat and manage water, but they are sometimes at odds with humans in their impact to our watersheds.

Learning Objectives: Students will learn about the importance of salmon, specifically kokanee salmon in Lake Sammamish. They will also explore the relationship between salmon, beavers, and people.

Main Activity: Salmon and Beavers in King County

- ***Overview****:* Students learn about these two important animals, their relationship to people and each other, and how they have been impacted by people
- ***Parent/Caregiver Tasks****:* None

Optional Activity: We Need Water Challenge

- ***Overview****:* Students complete a daily task related to a water conservation habit and a challenge to spread awareness on the importance of saving water
- ***Parent/Caregiver Tasks****:* If possible, help the student post their #WeNeedWater challenge on social media

Optional Activity: Video

- ***Overview****:* Students highlight the work being done to increase salmon populations and restore habitat
- ***Parent/Caregiver Tasks****:* Provide technical support and supervision

Optional Activity: Beavers in the Watershed

- ***Overview****:* Students read and analyze an article from *The Atlantic* that details the work being done in Washington to relocate beavers and the important work that they do for the watershed
- ***Parent/Caregiver Tasks****:* None

PARENT/CAREGIVER OVERVIEW: DAY 4

Human Impacts

Background Information: Human impacts on our watershed have changed the environment in big ways. As we have built more and more urban areas, there are fewer places for water to soak into the ground, more sediments and pollution makes its way to local bodies of water.

Learning Objectives: Students will understand the impact that human development can have on areas in the watershed that are important for the flow of water through our environment.

Main Activity: Water Importance Through Degradation Mapping

- ***Overview****:* Students analyze and interpret relationships between the areas in our watershed that are important for the flow of water, and areas that have been negatively impacted by people
- ***Parent/Caregiver Tasks****:* None

Optional Activity: We Need Water Challenge

- ***Overview****:* Students complete a daily task related to a water conservation habit and a challenge to spread awareness on the importance of saving water
- ***Parent/Caregiver Tasks****:* If possible, help the student post their #WeNeedWater challenge on social media

Optional Activity: Neighborhood Exploration

- ***Overview****:* Students explore their neighborhood to discover how water moves through the environment, where it is absorbed or not, and where it may cause issues in the future
- ***Parent/Caregiver Tasks****:* Provide supervision

PARENT/CAREGIVER OVERVIEW: DAY 5

Stewardship

Background Information: Stewardship is the action of caring for our natural resources. At its core, stewardship takes both knowledge and action to address environmental issues

Learning Objectives: Students learn about how water resources are distributed unequally throughout the globe, measure their household water use, and consider ways that they can conserve water in the future.

Main Activity: Water Footprint Calculator

- ***Overview****:* Students calculate the water they use directly and indirectly in their daily lives
- ***Parent/Caregiver Tasks****:* If needed, provide technical support and help with estimations of water use

Optional Activity: We Need Water Challenge

- ***Overview****:* Students complete a daily task related to a water conservation habit and a challenge to spread awareness on the importance of saving water
- ***Parent/Caregiver Tasks****:* If possible, help the student post their #WeNeedWater challenge on social media

Optional Activity: Stewardship Through a Story

- ***Overview****:* Students create a story to encourage conservation and stewardship
- ***Parent/Caregiver Tasks****:* None

PARENT/CAREGIVER OVERVIEW: VOCABULARY

DAY 1
Aquifer: An underground water supply flowing through sand, gravel and unconsolidated rock
Groundwater: Water that lies beneath the earth's surface
Headwaters: Source of a stream
Infiltration: The slow movement of water from the surface to the groundwater
Runoff: Water rinses the watershed into streams, rivers, lakes and Puget Sound
Watershed: The land from which rain collects and runs to a single point

DAY 2
Ecosystem: A biological community of interacting organisms and their physical environment
Invasive Plants: Non-native species that show a tendency to spread out of control and cause significant harm to the ecosystem
Native Plants: Species that normally lives and thrives in a particular ecosystem

DAY 3
Alluvium: Loose sediment or soil that has been eroded and hasn't become compressed
Kokanee: A sub-species of sockeye salmon that live their whole life in fresh water
Keystone Species: A species on which other species in an ecosystem largely depend

DAY 4
Impervious: Does not allow water and particles within to absorb or pass through it
Pervious: Allowing water and particles within to soak in and pass through the surface
Urbanization: The process of creating more city spaces, such as roads, pavement, and
sidewalks
Water Flow Degradation: How the flow of water has been negatively affected
Water Flow Importance: How areas control and direct the flow of water in a watershed

DAY 5
Direct Consumption: Water that we can see, feel and use at any given time or location
Virtual Water: Water used to create the products and services we use every day but don't see or pay for specifically. It is just part of the value of those goods and services

DAY 1

Watershed Basics

A **watershed** is all of the land that directs water to a certain place. Essentially, it is how the water moves off of the land and is collected in streams, rivers, lakes, and eventually the ocean. Watersheds are both regional and local. For example, all of the water that falls on the western side of the Cascade Mountains eventually makes its way to the Salish Sea/Puget Sound. This means that all of that water moves through the Puget Sound Watershed. If you look on a more local level, the places where water makes its way to Lake Sammamish, then Lake Washington, and finally into Puget Sound is a smaller watershed: the Lake Sammamish Watershed.

This water travels down from the Cascade Mountains in the form of streams and rivers, with the source of these bodies of water being the **headwaters**. After forming into streams, this water either remains above ground, joining the surface water through a process called **runoff**, or soaks into the ground to become **groundwater** through a process called **infiltration**. Once the water has soaked into the earth, it may join an **aquifer**, a water source that humans can access by digging a well, or that will come to the surface through a natural spring. Both surface and groundwater have the possibility of carrying things like sediment or pollution to other areas, and therefore must be carefully monitored and cared for.

The important thing to remember is that water is always moving through our environment, and all of the other living things in our region depend on having clean, adequate water. What affects one part of the watershed ultimately has an effect on the rest of it as well. We'll start our exploration of watersheds by learning more about where you are in the watershed and the specific bodies of water you interact with.

Vocabulary
Aquifer: An underground water supply flowing through sand, gravel and unconsolidated rock
Groundwater: Water that lies beneath the earth's surface
Headwaters: Source of a stream
Infiltration: The slow movement of water from the surface to the groundwater
Runoff: Water rinses the watershed into streams, rivers, lakes and Puget Sound
Watershed: The land from which rain collects and runs to a single point

Main Activity

Watershed Mapping

Below is a topographic map of our greater watershed. A topographic map measures elevation as well as distance, essentially giving a three dimensional image of an area. In this map areas in **red** show higher elevations and areas in **blue** show lower elevations. This is useful for us tracing the movement of water through our environment. The source of our rivers and streams in the mountains are the headwaters, and from there the water is on a constant journey downhill.

Source: https://en-us.topographic-map.com/maps/na3/Seattle/

Materials: Writing utensil

Figure 1: Topographic Watershed Map

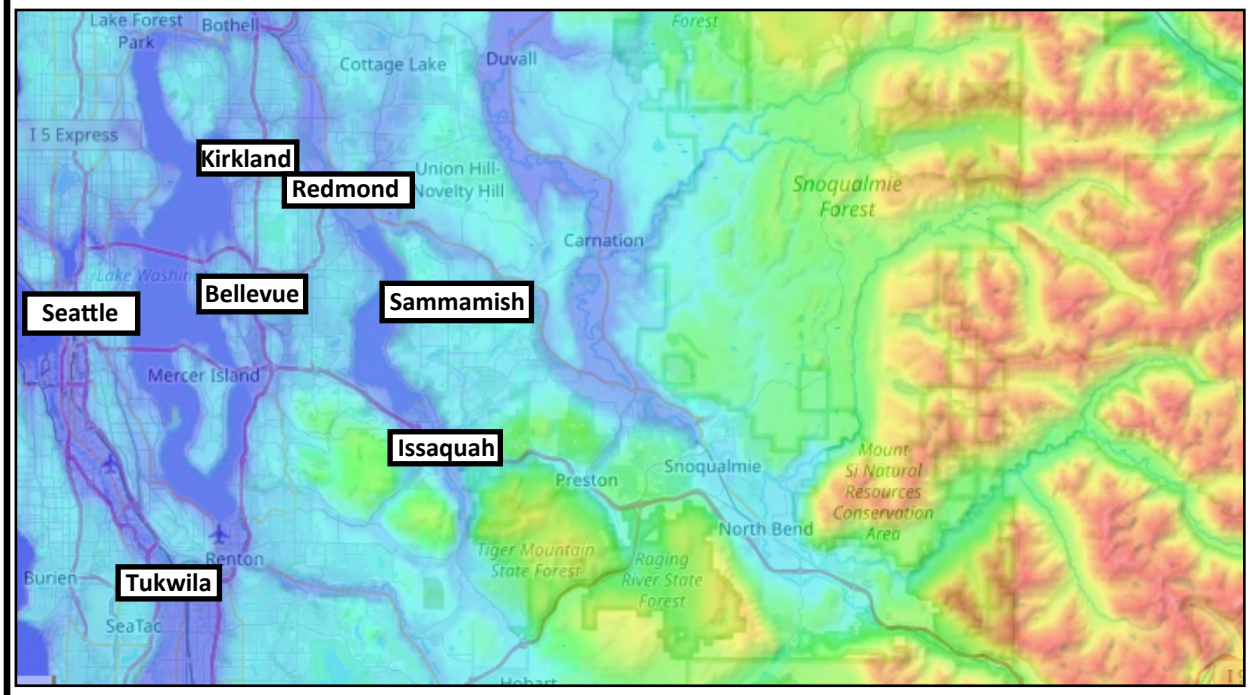

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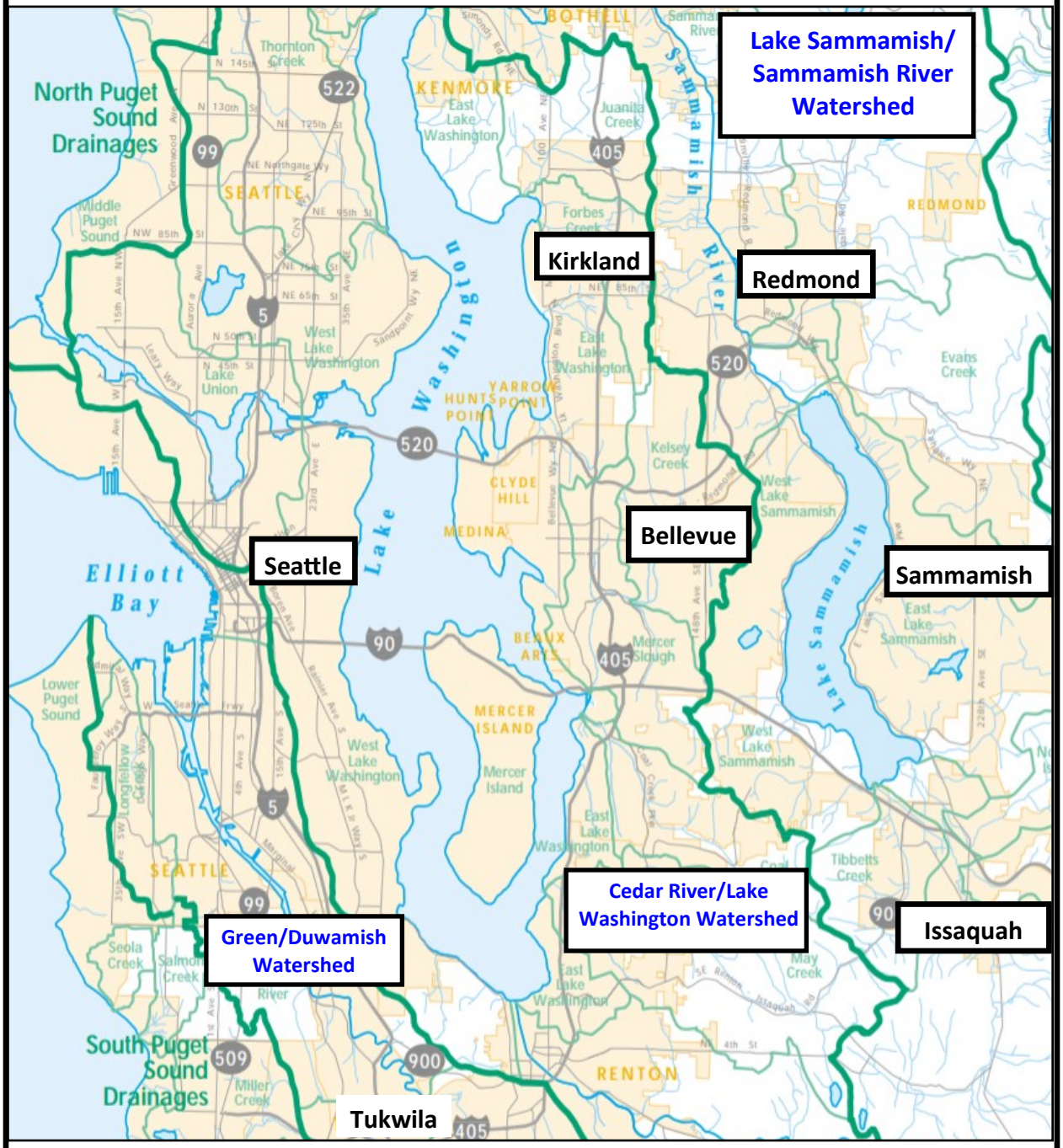
Figure 2: King County Watersheds



Source: https://your.kingcounty.gov/dnrp/library/vcgis/maps/county/0004kcWATERfeatures.pdf

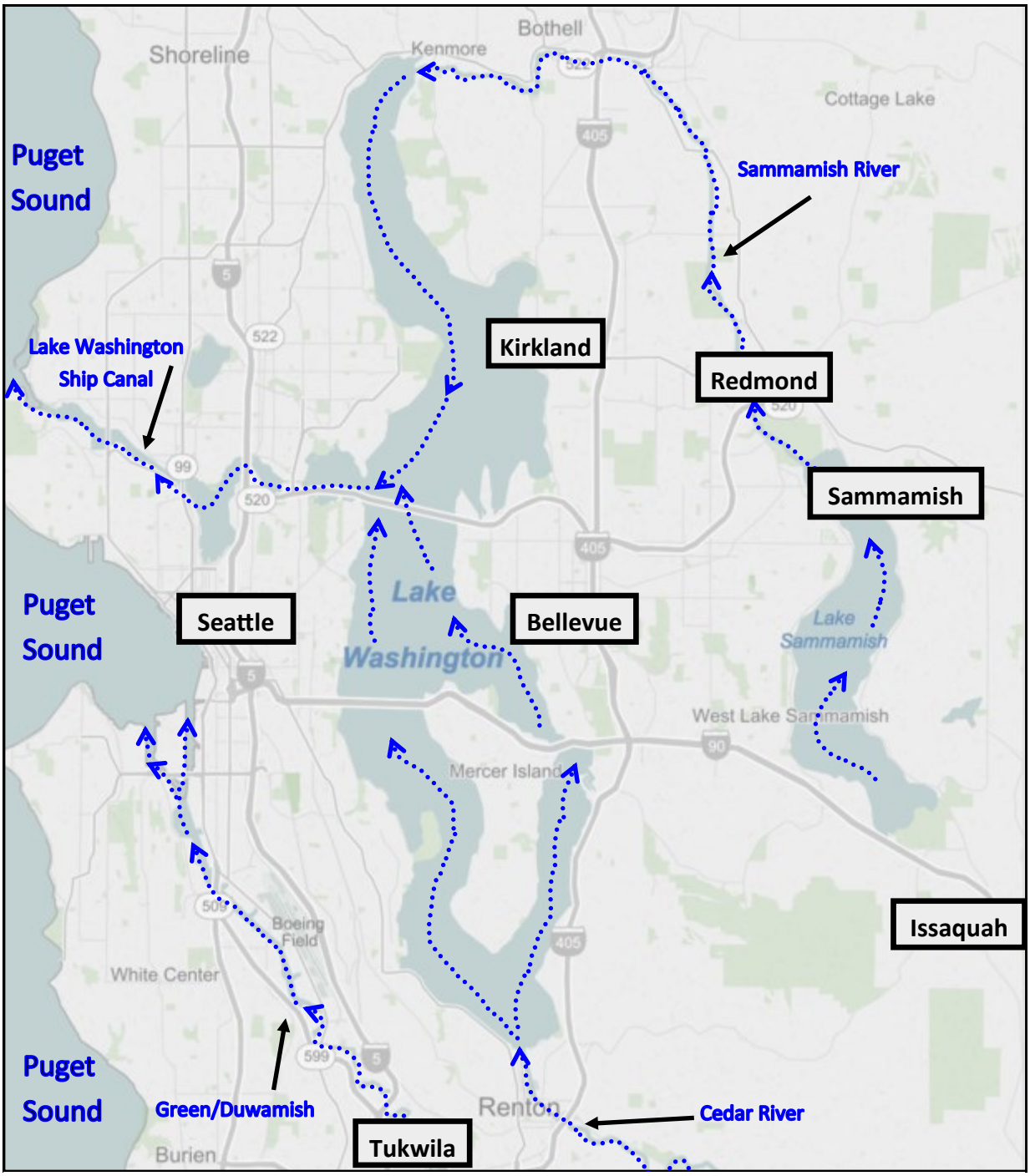
This is a map of our local watersheds that shows how the Green-Duwamish, Cedar River/ Lake Washington and Sammamish watersheds connect to the Puget Sound Watershed. This allows us to get a sense for our regional water system, and the movement of water from the Cascade Mountains to Puget Sound. Watersheds are labeled in **blue**, cities are labeled in **black**.

In which watershed do you live?

Now we'll look more closely at the rivers that carry water through our communities. The major cities in the Cascade Water Alliance are outlined in a black box, and the way water moves to the ocean is in blue with arrows showing the direction the water moves.

- What city do you live in, or closest to? What lake or river is closest to where you live?
- Where does the water come from before your community? Where does it go after?

Figure 3: How Water Flows Through Our Communities



Source: Google Maps

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Optional Activity

We Need Water Challenge

Our watersheds provide the water that wildlife and people need for survival and for exercise and recreation. Do you have a favorite place to enjoy the water near you? Sometimes we don't know where the closest body of water is, where the water comes from, where it goes, or how we might be affecting it.

Do you know what the closest stream, river, pond, or lake near you is? Today's #WeNeedWater challenge is to find out, and think about the impact you might have on the water as it moves through the watershed. All of the water in a watershed is connected.

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

With an adult, do some research on our local watersheds using a mapping website like this one: https://www.kingcounty.gov/services/environment/watersheds.aspx. The website takes you to a page that shows an interactive watershed map of the image below. Click on the specific watersheds and it will lead you to a webpage that tells you more about each watershed. Choose a watershed that is close to your city and list three facts you learned about your own watershed!

What are three facts you learned from the Interactive Watershed Map on the King County webpage?

1.

2.

3.

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If you can't go online, use the watershed map below to identify your city and find your watershed! Draw a model of your watershed and include the following: The name of your watershed, the major waterways that flows through your watershed, and your city name. Feel free to include additional details on your model! Like additional city names, connecting waterways, neighboring watersheds, etc. Feel free to use the following page to draw your watershed.

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 use the hashtag #WeNeedWater and tag @weneedh20 and @naturevisionorg in your post so we can see your work!

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Draw your watershed here:

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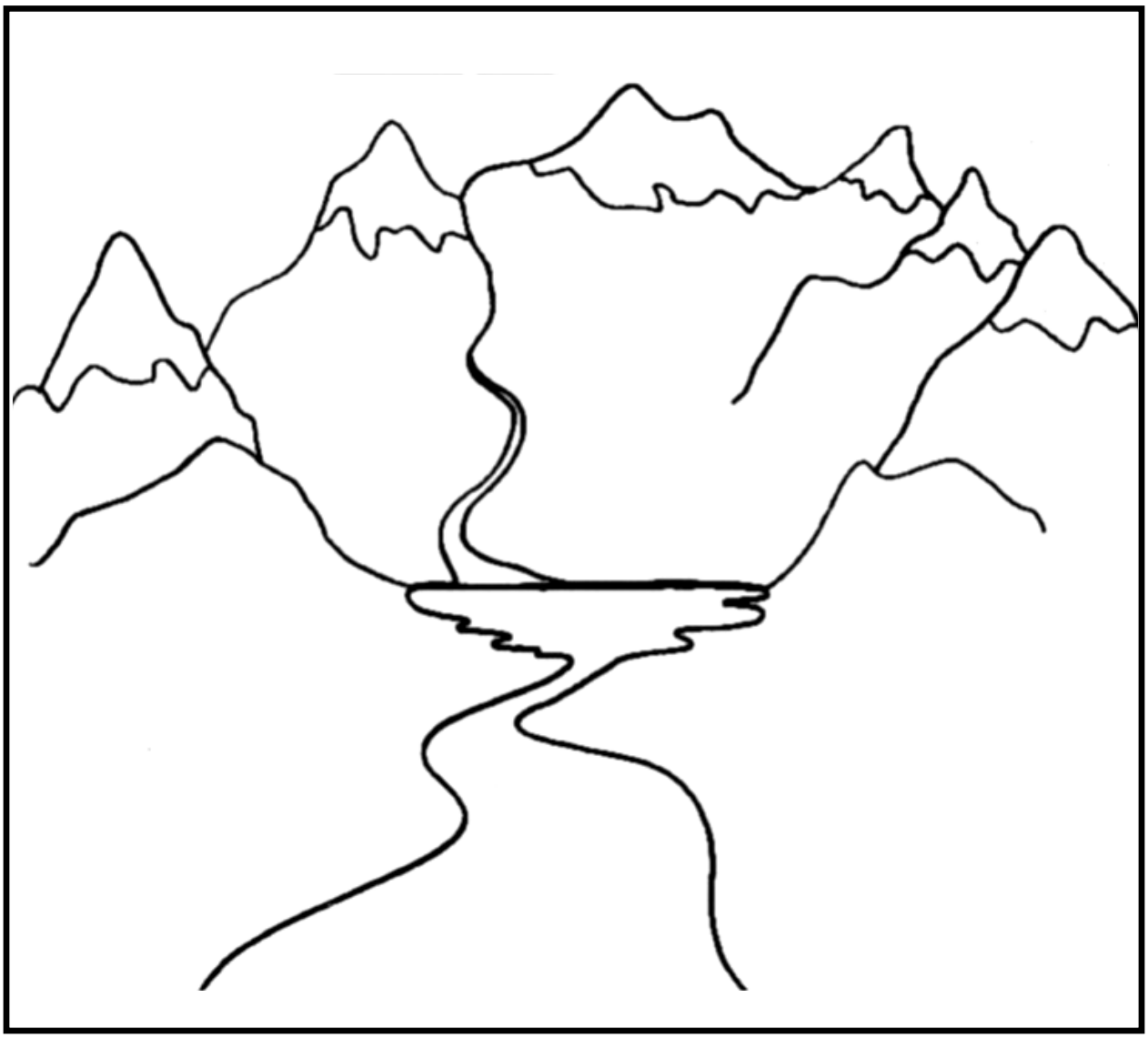
Optional Activity

Watershed Community

You've spent some time thinking about how water moves through the environment, and how it interacts with nature and people, now you can create your own watershed community. Using the template below, include both natural and human made elements such as plants, animals, buildings, and vehicles. Try to include the things that you've observed and experienced in your everyday life, or things that you know are a part of our environment, like salmon, even if you've never personally seen them. Include at least five different natural elements, and five different human made elements. Think about how these would impact water and impact one another.

Materials: Writing utensil, colored pencils/markers



DAY 2

Plants in the Watershed

We've already discussed the idea of a watershed and how water connects everything within our environment. We've also briefly touched on the amazing journey that water makes from the time when it falls to earth to when it finds its way to the bottom of the watershed in lakes, streams and oceans. Today, we are going to explore the closely related topic of **native plants** in our watershed and why they are so important.

Native plants are plant species that have evolved in a particular **ecosystem** over millions of years, long before humans. These species are essential to the health of our watershed and can also be fantastic options for gardens, yards and public spaces. Plants that are not originally from the region that they are growing in, usually because they were transported here by humans, are known as **invasive plants**. Invasive plants often thrive in their new environment where the competition from other plants that held them in balance in their own ecosystems aren't present. These species can spread quickly, destroy native plants, and take away food sources and habitats that other life depends on. Once introduced, invasive plants can be nearly impossible to remove and have devastating effects on the ecosystem.

Native plants are good for an ecosystem and us for the following reasons:

- They use less water and save energy.
- They need less gardening time to maintain.
- They are resistant to disease and don't need pesticides to survive.
- They help control erosion and maintain good soil conditions.
- They reduce flooding and clean our water and air.
- They provide proper food and shelter for wildlife.
- They belong to the Northwest ecosystem and help maintain a diverse plant community.

With these in mind, it is easy to see why abundant native plant life can help protect and conserve our limited water supplies and improve our lives and that of our watershed as well.

Vocabulary

Ecosystem: A biological community of interacting organisms and their physical environment

Invasive Plants: Non-native species that show a tendency to spread out of control and cause significant harm to the ecosystem

Native Plants: Species that normally lives and thrives in a particular ecosystem

Main Activity

Soil Infiltration Testing

One critical function of native plants is their ability to regulate water. During periods of high precipitation or snow melt, these plants help to hold the soil in place, preventing erosion, flooding, and landslides that can be catastrophic to the rest of the ecosystem (not to mention human infrastructure). Plants help to anchor soil and absorb much of the liquid, storing it throughout the season. As drier conditions prevail, the moisture that is held in the plants and soil around them will slowly release into nearby streams and lakes, helping to hydrate the watershed year round. When this system works as it is supposed to, forests are more resistant to disease and fires, streams carry enough water to support salmon and other life year round, and we have a steady supply of fresh water that is clean.

To better examine the relationship between plants, soil and water, we are going to conduct a soil infiltration test. This is one method we can use to measure the rate at which water passes through different kinds of environment.

Materials: Toilet paper tube cut in half (or similar cylindrical device), 2 coffee filters, paper towels or scraps of cloth, timer, measuring cup, drinking glass or cup, soil samples, timer or digital stopwatch application

Please ask an adult to accompany you if you choose to do this experiment outside. If you can go outside, remember to be safe, responsible, and respectful. If you can't go outside, you can still find nature by looking out a window, or staying on your balcony, porch, or front steps.

1. To prepare, we will need to take a toilet paper tube or similar object and cut it in half, making two smaller tubes. Then using string, tape or a rubber band, cover one end of each of your tubes with a coffee filter, thin paper towel, or a thin chunk of cloth scrap.

2. Take both tubes outside if possible. Fill one tube almost (but not quite!) to the top with loose soil. In the other, find a small sample of soil with some moss, grass or other small plant growth. Carefully remove this sample and place it in the other tube. The amount of soil should be as close to identical between the two as you can. It is okay if the plants protrude out of the top. A sample this small will not hurt the rest of the life in the site you take it from, but please only collect samples from places that you have permission to use and are discreet.

3. Set a timer for one minute and fill your measuring cup with ¼ cup of water.

4. Holding your sample over the drinking glass or cup, start your timer and pour the ¼ cup of water into your sample.

5. Once one minute has passed, remove your sample from above the cup. Make note of any observations you made and use your measuring cup to help estimate how much water was collected after it ran through your sample below.

6. Repeat these steps with the other sample.

Carefully return your samples to where you collected them from and answer the below questions:

What differences did you notice between the two tests?

What could the results mean for our watershed as a whole?

With these results in mind, what are some things people could do to improve the health of our watershed?

Optional Activity

We Need Water Challenge

Water is always on the move, but sometimes the things we build get in the way. For today's #WeNeedWater challenge, think about the ways that human development can interfere with the natural flow of water through your watershed. You can look outside you window to find examples. If you can go for a walk outdoors with an adult to look, please make sure you are safe, responsible, and respectful. When you look around your neighborhood, do you notice any man-made objects that affect the flow of water? Record your findings below, explaining how they each affect the movement of water and how you think we might be able to improve them.

Materials: Writing utensil

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 use the hashtag #WeNeedWater and tag @weneedh20 and @naturevisionorg in your post so we can see your work!

Optional Activity

Native Plant Scavenger Hunt

Below is a list of common native and invasive plants. If you are safely able to, take a walk in your area with an adult and see how many of these different species you can find. Make note of where you found each below. If you are unable to walk around outside, you can just look out a window, use pictures of your neighborhood or school or just see if you can identify where you have seen them from memory.

Materials: Native plant ID cards (below), writing utensil

If you need help identifying invasives, you can check out King County's identification page: https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification.aspx

For native plants, try their plant photo guide: https://green2.kingcounty.gov/gonative/Photo.aspx?Act=browse

Native Plants

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Western Red Cedar

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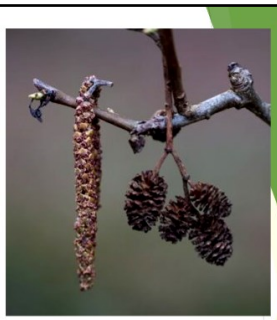
Red Alder



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Oregon Grape

Salal

Sword Fern

Cattails

Vine Maple

Invasive Plants

Bittersweet Nightshade (*Solanum dulcamara*)
Semi-woody, non-native vine with purple and yellow flowers and clusters of bright red berries that are poisonous to people but attractive to birds; it is often found along creeks where it can overwhelm other plants.

Butterfly Bush (*Buddleia davidii*)
Tall, gangly ornamental from China with spikes of purple flowers and seeds that can move 40 miles in the wind; it is capable of replacing native vegetation along sandy shorelines and in forest openings.

English Holly (*Ilex aquifolium*)
European tree with spiny evergreen leaves that spreads into forests with help from birds eating the berries; it crowds out native understory bushes and young conifers.

English Ivy (*Hedera helix*)
Evergreen vine from Europe that can weigh 2,100 pounds and topple trees, blanket tree seedlings and understory plants, and form thick mats that collect garbage and rats.

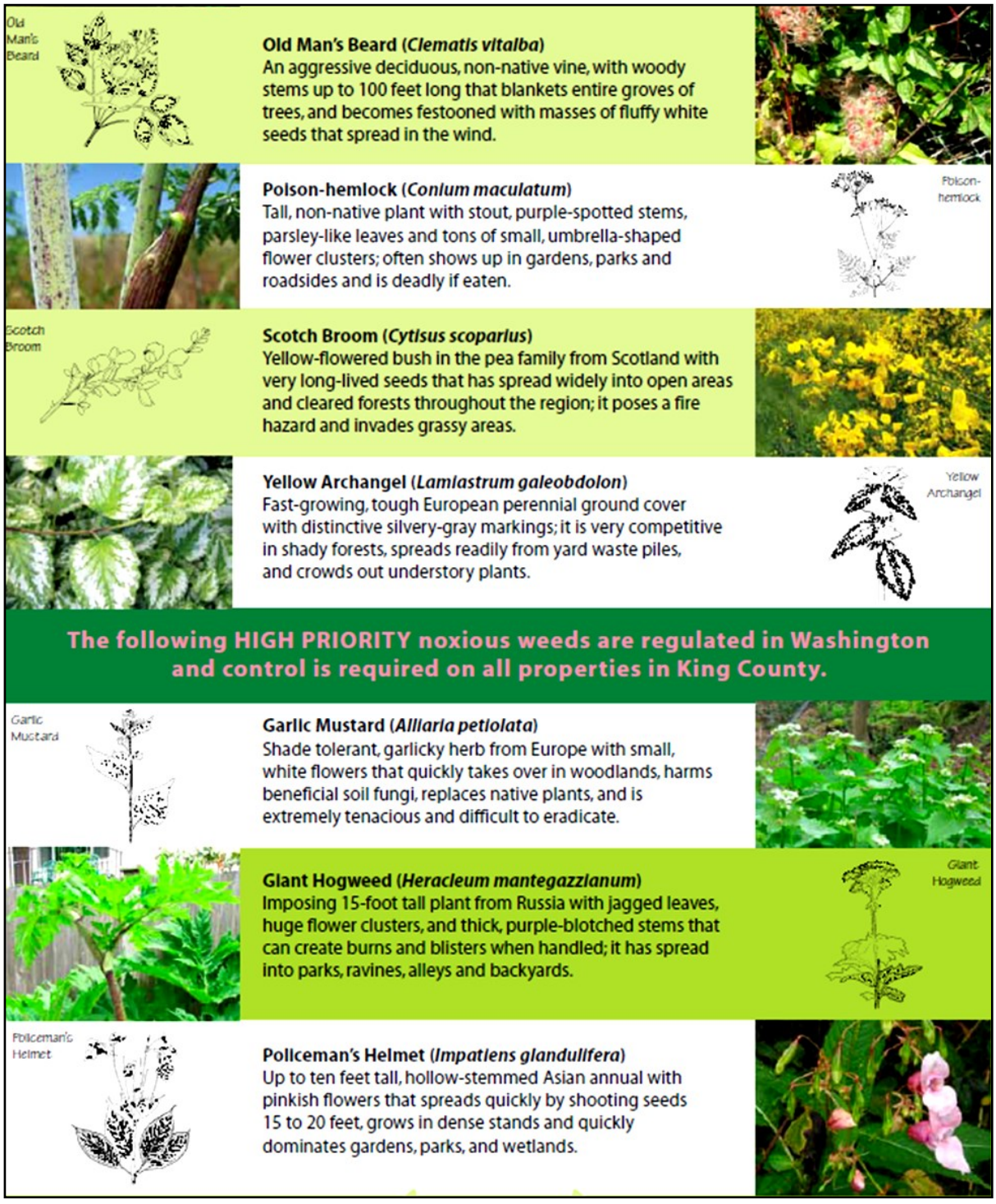
Hedge Bindweed/Morning Glory (*Calystegia sepium*)
Aggressive, climbing, non-native vine that winds its tendrils around stems of plants and trees or any convenient structure; it spreads by long-lived seeds and by deep roots that multiply from even small fragments.

Herb Robert (*Geranium robertianum*)
A small shade-tolerant, European geranium—also known as Stinky Bob—with reddish, hairy stems and a strong odor; it spreads by ejecting sticky seeds 15 to 20 feet and can quickly dominate an area.

Himalayan Blackberry (*Rubus armeniacus*)
Prolific, fast-growing brambles from Central Europe that can overwhelm most other plants, crowding out even small trees and covering nearly every available hillside and vacant area with its imposing thorny thickets.

Knotweed (*Polygonum cuspidatum*, *Polygonum sachalinensis, and Polygonum bohemicum*)
Massive, clump-forming, bamboo-like perennials from Asia that spread aggressively from stem and root fragments and crowd out native vegetation, degrade habitat, and increase erosion.

From: "Brochures and Publications." Brochures, Reports and Publications of the King County Noxious Weed Control Program - King County, www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/brochures-reports.aspx.



From: "Brochures and Publications." Brochures, Reports and Publications of the King County Noxious Weed Control Program - King County, www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/brochures-reports.aspx.

Optional Activity

Videos

Please ask for an adult's permission to watch these videos.

"Yard Talk": King County has a TV series titled "Yard Talk" that is all about natural gardening and the importance of using native plants to enhance our green spaces and support our ecosystem.

Check out the episodes for free at: https://www.kingcounty.gov/services/environment/stewardship/nw-yard-and-garden/yard-talk.aspx

"Native Plants": In the "Native Plants" episode #6, the hosts mention ways that everyone can help to harvest, plant and support the use of native plant life in their community. If you feel inspired to volunteer in some of these efforts, check out the Environmental Stewardship page on the county's website and sign up to volunteer at an event! These are a great way to help your community, meet some new people and get outside for a little while. Check this out by following this link: https://www.kingcounty.gov/services/environment/stewardship/volunteer.aspx

Materials: Internet access, computer/phone/tablet

DAY 3

Animals in the Watershed

Our watersheds are home to many different organisms. Plants, birds, mammals, fish, and invertebrates all call this area home, and they all share the same water that we do. Salmon are a **keystone species** in our ecosystem, which makes them some of the most important species that we share this environment with, and they are also some of the most highly impacted by how we have altered the environment.

While most salmon spend part of their life in freshwater and part of their life in salt Water — making the journey from the mountain streams to the sea and back — our region is home to a very special type of salmon called **kokanee**. Kokanee salmon spend their whole lives in fresh water, specifically in Lake Washington and Lake Sammamish. Because they spend their lives in a relatively small area, they are especially vulnerable to changes in the amount or quality of water in the watershed, as well as the changing environment in the highly urban area around Seattle. Today we'll explore the current status of these important members of the watershed community.

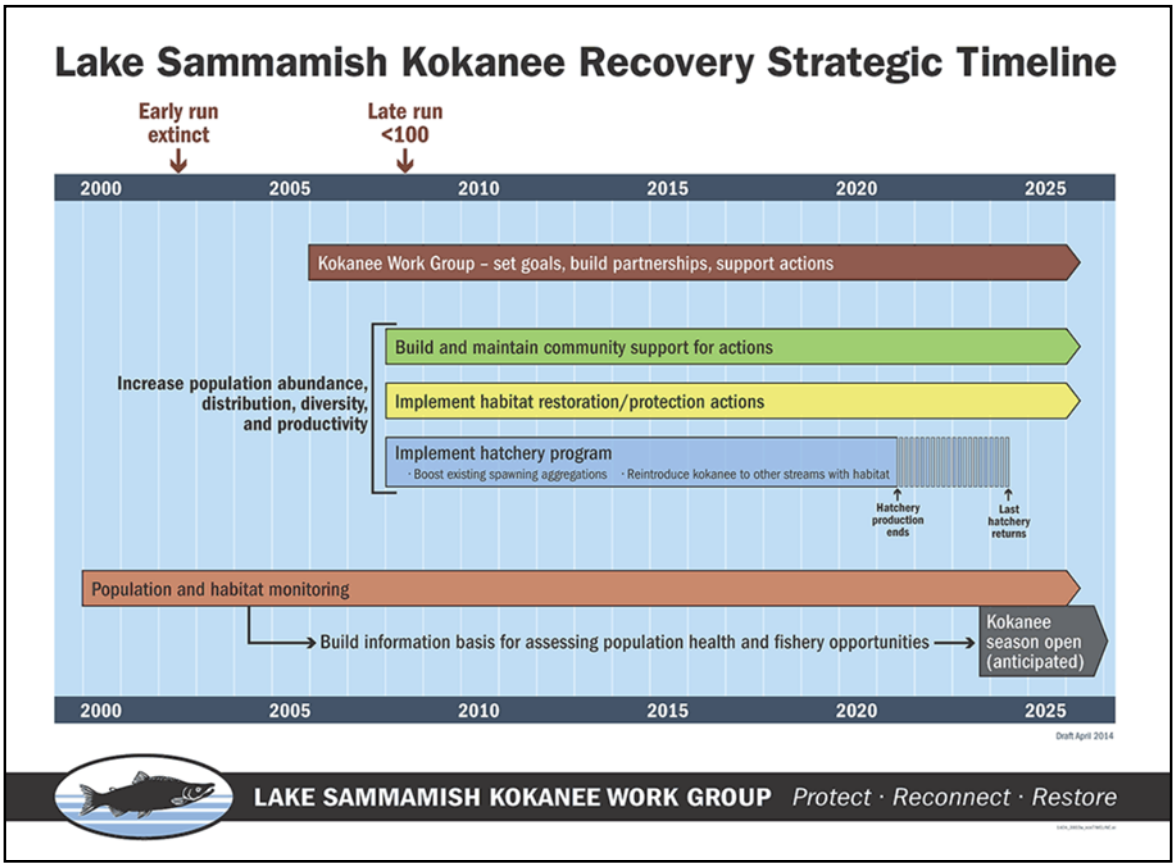
Vocabulary
Alluvium: Loose sediment or soil that has been eroded and hasn't become compressed
Kokanee: A sub-species of sockeye salmon that live their whole life in fresh water
Keystone species: A species on which other species in an ecosystem largely depend

Main Activity

Salmon and Beavers in King County

The following timeline is from King County's Lake Sammamish Kokanee Work Group, which developed a timeline on the restoration work being done to return populations to sustainable levels. Look at the timeline and other photos and answer the questions that follow.

Materials: Writing utensil



What actions are being taken to increase population abundance, distribution, diversity and productivity?

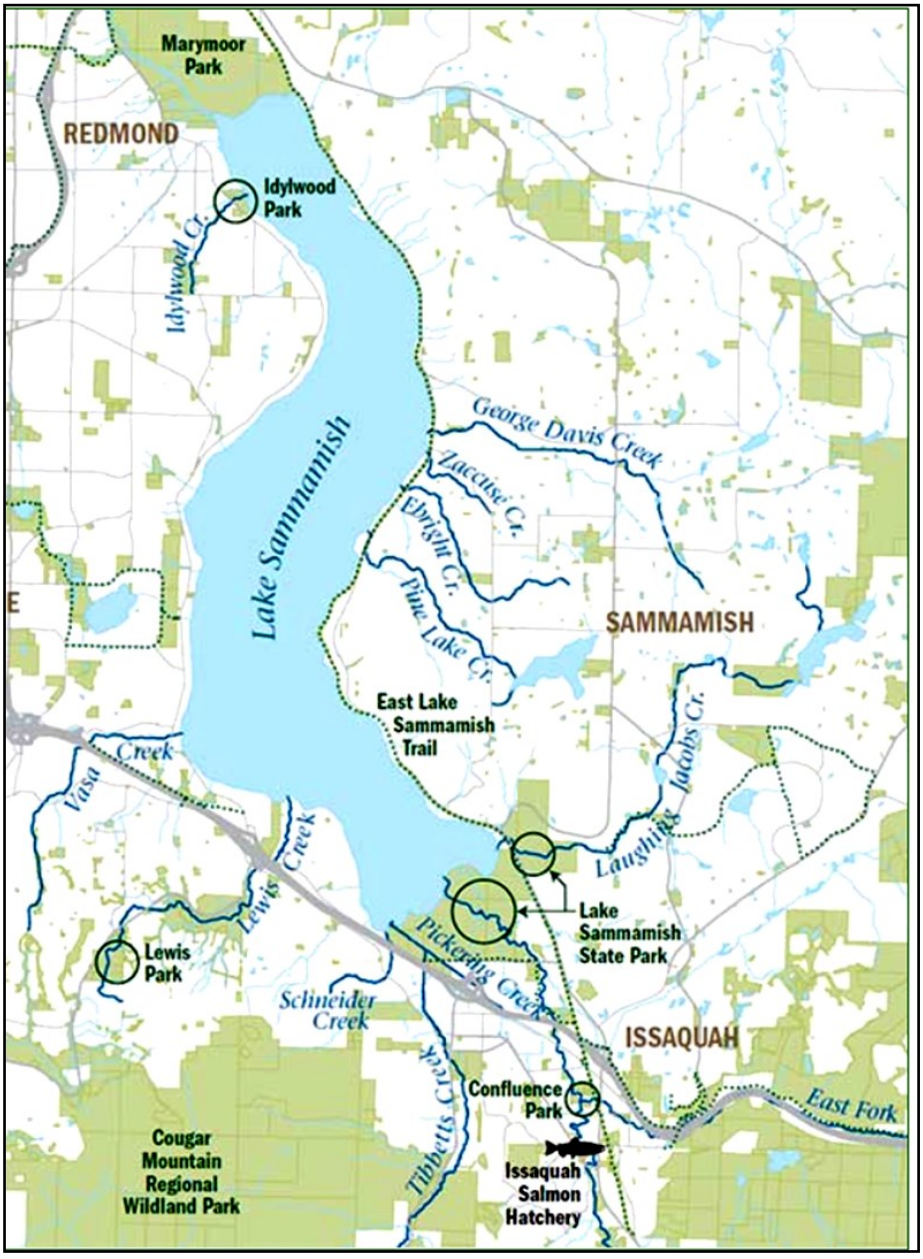
CASCADE WATER ALLIANCE

Nature VISION

Below is a map of Lake Sammamish created by King County that shows the different creeks that Kokanee salmon rely on for spawning. *(Note: the creeks that have been confirmed as Kokanee habitat have been labeled with the name of the creek.)*

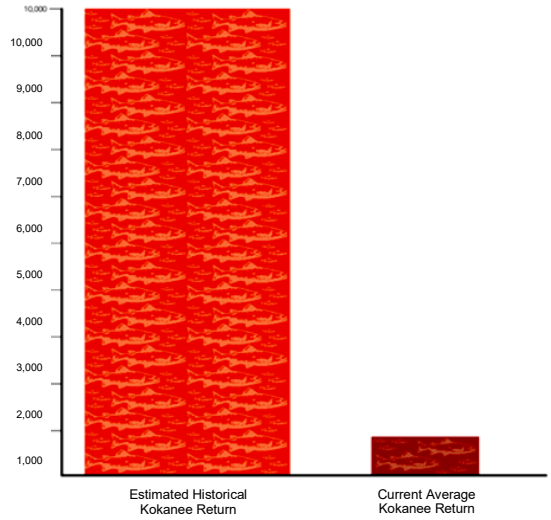
How many creeks have been labeled as kokanee habitat?

What human habitats do these creeks interact with?



Source: https://your.kingcounty.gov/dnrp/library/water-and-land/salmon/kokanee/1405-lake-sammamish-kokanee-map.pdf

The Following data come from *Trout Unlimited*, a group working to preserve and restore kokanee salmon habitat in Lake Sammamish. For more information about the work they are doing visit lakesammamishkokanee.com/



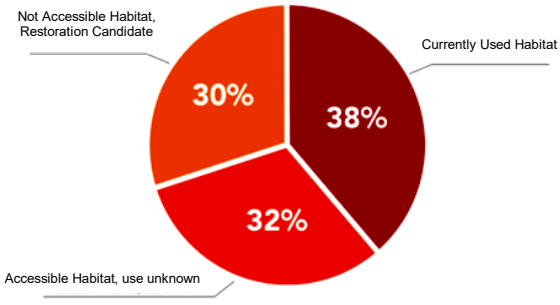
The Current Status

Once the most abundant pacific salmon in this watershed with numbers in the tens of thousands of fish, recent returns are less than 5% of their historic levels and have dipped below 110 individuals three times (avg. return = 800 fish). Recent data indicate that spring and summer runs of native kokanee are likely already extinct, with the winter/later run holding on only by a thread.

Kokanee salmon are an important cultural resource to local First Nation peoples. Before their decline, kokanee also provided food and recreational resources to all that lived near the watershed. The once productive fishery has been closed since the mid-1980s.

What is the average number of returning fish?

What is the current return of Kokanee compared to historic levels?



Habitat

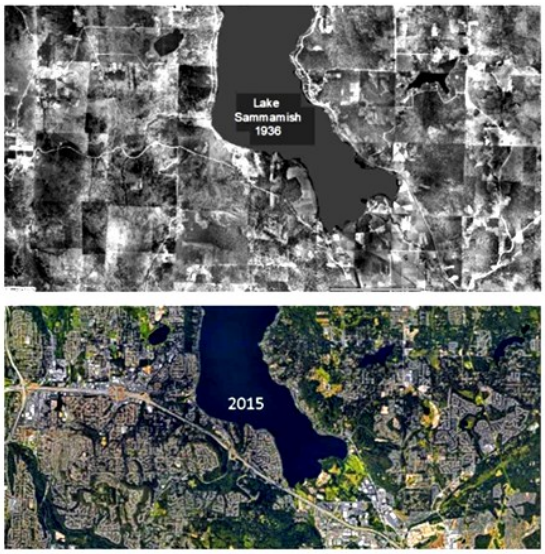
The urbanization of the Lake Sammamish Watershed has greatly reduced the spawning habitat available to returning adult fish. Kokanee distribution historically extended throughout most of the Lake Washington Watershed, but this distribution is now limited to only Lake Sammamish and several of its tributary streams, which is less than 10% of its historic range. Of the estimated total historical habitat available in Lake Sammamish, only 13% (45,500 feet) is currently known to be utilized by kokanee salmon. The remaining potential stream habitat (72,591 feet) is in need of further study and/or restoration.

What percentage of habitat is currently being used by Kokanee?

What percentage of habitat is not accessible to Kokanee, and would be a "restoration candidate"?

Urbanization

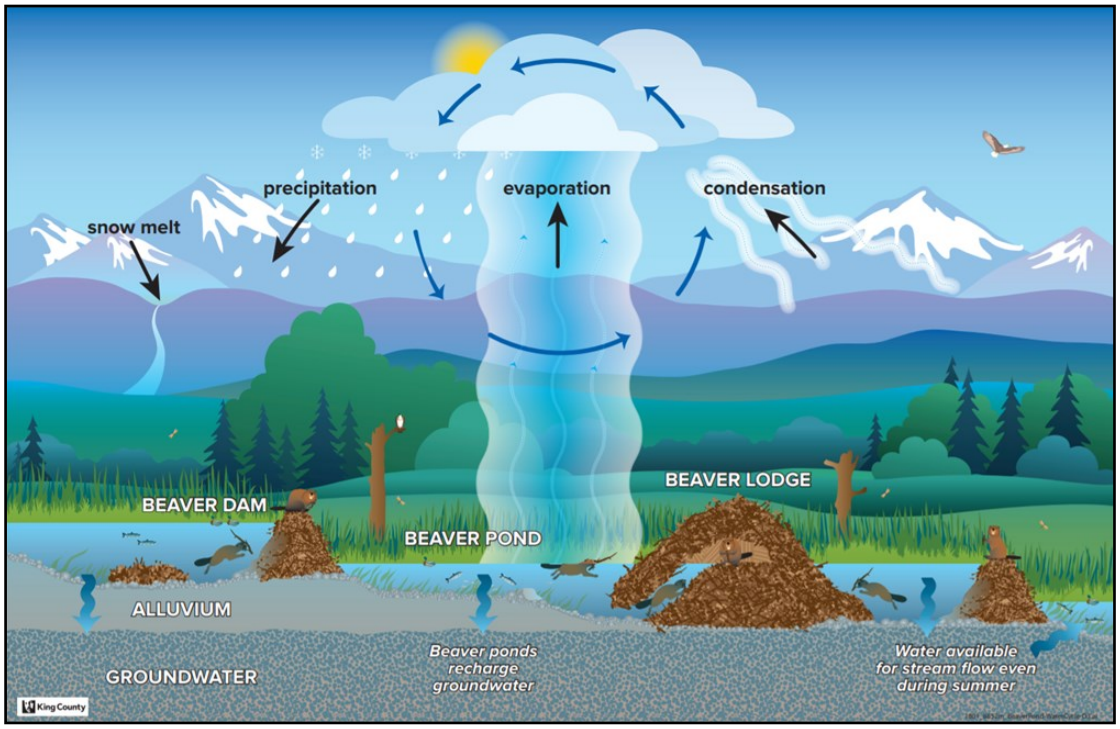
The population in King County has steadily increased since 1860 to nearly 2 million in 2010. With the increase in population, the Lake Sammamish Watershed has witnessed a dramatic increase in urbanization. The photos to the right show the dramatic change in development in the Lake Sammamish area over the last century. Unfortunately, this rapid urbanization has resulted in the installation of undersized culverts that prevent fish passage, improper stormwater management, impacted stream habitats, and disturbed riparian areas. These factors have contributed significantly to the decline in the amount and quality of stream habitat available to kokanee.



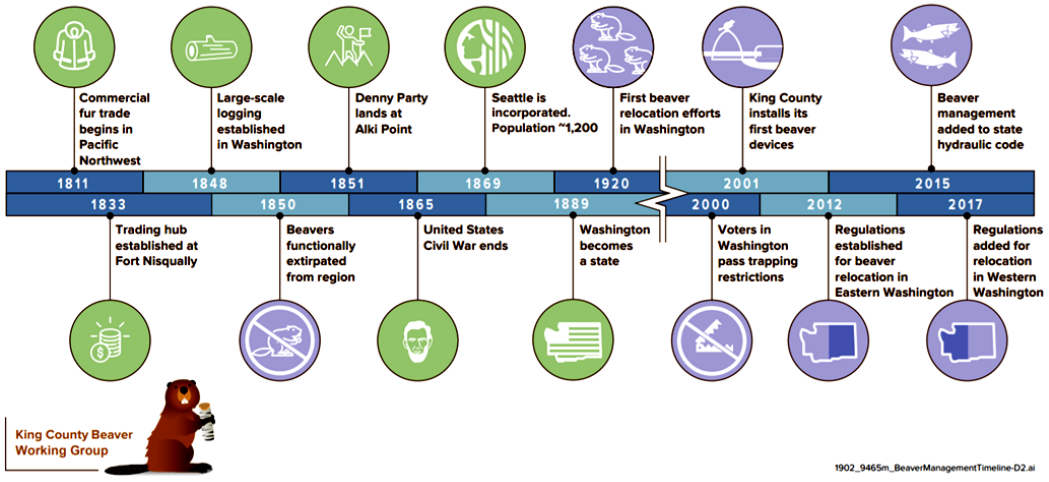
What was the average population of King County in 2010?

List 3 ways this rapid urbanization has impacted Kokanee populations.

Along with salmon, one of the most important animals in our watersheds that humans have a big impact on are beavers. Beavers are ecosystem engineers. They help to manage water and create vital habitats for other animals, including ponds, where young salmon can live until they are large enough to survive in areas with more predators. Beavers also allow water to be absorbed into the soil. Historically, beavers have been considered “nuisance” animals because their dams and ponds can flood areas that people do not want them to. In 2017, King County began a “beaver working group” to find how we can best interact with these industrious mammals and to understand their benefits to our watersheds. Below you’ll find two graphics from King County that illustrate the importance of beavers in our hydrologic cycle, as well a timeline of our interaction with beavers “post contact” which refer to the timeframe after European settlement of this area began. You can learn a lot more about how beavers impact salmon, and people, in the optional activity included with this packet.



POST-CONTACT HISTORY OF BEAVER MANAGEMENT IN WASHINGTON STATE



CASCADE WATER ALLIANCE

Nature VISION

Optional Activity

We Need Water Challenge

Did you know leaks waste hundreds of gallons of water a week in our house? Leaky toilets are usually the reason why our households waste so much water. Leaky toilets sometimes go unnoticed so they are less likely to be fixed. Testing your toilet for a leak is easy. With an adult, go and check your toilet for a leak by following these 5 steps. You will need food coloring or powdered drink mix.

Materials: Food coloring or powdered drink mix, computer/phone/tablet, internet connection

Make sure you are doing these steps with an adult!

1. Carefully remove the toilet tank lid and place it somewhere sturdy like the ground. It can be heavy!
2. Place 10 drops of food coloring or the powdered drink mix into the tank water. Do not flush.
3. Carefully pick up the lid and place it back on the tanks. Do not flush.
4. The image below says wait till next morning but usually 15 minutes is enough time to tell if your toilet has a leak
5. If you see color in your bowl, then your toilet has a leak!

Take a video or picture of you and an adult testing your toilet for a leak. For your caption you could write; “Testing our toilet for a leak! A leaky toilet wastes hundreds of gallons every week and my family wanted to make sure we weren’t wasting water. Want to test your own toilet for a leak? Put 10 drops of food coloring into the tank water. Don’t flush and wait to see the color in your bowl. If you see color in the bowl, your toilet has a leak!”

A leaky toilet can be easy to fix, as well. The toilet flapper might be old and needs to be replaced. This is a great video showing you how to “Replace Your Leaky Toilet Flapper” on Youtube. Check it out with an adult if your toilet is indeed leaking! https://www.youtube.com/watch?v=TPeViXIgOPE

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 use the hashtag #WeNeedWater and tag @weneedh20 and @naturevisionorg in your post so we can see your work!

Optional Activity

Video

Please ask for an adult's permission to watch this video.

"**How King County is Removing Barriers to Healthy Salmon Habitat":** People are doing a lot of work to help salmon navigate our watersheds. This video shows what is happening around lake Sammamish to help kokanee populations navigate the streams and remove some of the negative human impact from the environment.

This short video can be found at https://vimeo.com/299479829 or by doing a web search for "How King County is removing barriers to healthy salmon habitat"

Materials: Computer/phone/tablet, internet access

Optional Activity

Beavers in the Watershed

This article from *The Atlantic* details some of the efforts that people and beavers face coexisting in our watersheds. After reading the article, consider the questions below.

Materials: Writing utensil

How are beavers providing a benefit to people and wildlife in the watershed?

How are beavers creating challenges for people and wildlife in the watershed?

What actions if any are being taken to address these challenges?

To learn more about beavers in our watersheds, and the work being done to meet the needs of people and nature visit www.beaversnw.org and https://methowbeaverproject.org/.

The Re-beavering of the American West
An industrious but finicky pest could be the key to restoring Washington State's wetlands and salmon populations.
BEN GOLDFARB DECEMBER 4, 2018

"It's before dawn on a late August morning, the Washington sky blanched with smoke drifting from distant wildfires, and Molly Alves and David Bailey have caught a beaver.
The two biologists haul the ornery package of fat and fur, still penned into the trap that closed around him overnight like a giant clam, up the banks of a meandering, tea-colored stream.
The drainage is cluttered with Himalayan blackberry and Japanese knotweed, whose rhubarb like stems the beaver has commandeered to build his lodge—a native mammal thriving amidst invasive plants. The beaver, his lustrous fur shimmering in the pale light, flaps his tail and gnaws at the trap with burnt-orange incisors. His forepaws grasp the wire mesh, a prisoner straining against his cell walls.

"That is a very feisty sub-adult," Bailey grunts as he and Alves lug the beaver toward the road. "When they're trying to nom on the trap like that, it means they're pretty stressed."
Although not indigenous themselves, Alves and Bailey relocate beavers under the auspices of the Tulalip Tribes, a sovereign nation with nearly 5,000 members. This week, they've set their traps in the Puget Sound suburb of Marysville—half an hour north of Seattle if you leave before daybreak, an eternity at rush hour. Across the street from the Marysville Public Library waits their Silverado pickup, its right two wheels perched on the curb. Alves and Bailey, foreheads damp with sweat, set the beaver down and lower the tailgate. Morning traffic roars past, drivers craning their necks.

An elderly pedestrian wanders toward us, snatching up candy wrappers and soda cans with a long-handled trash picker. Ah, I think, a Good Samaritan, out for a spot of neighborhood cleanup. If anyone would appreciate local fauna, it's this guy. I sidle up and point out the beaver, now being boosted into the truck.

The man gazes at me, his eyes a milky blue. "What are you going to do with him?"

Relocate him, I reply.

The man smiles. "Why don't you just shoot (it)…?"

I am momentarily flabbergasted. I sputter something about transferring the beavers to nearby public lands where they can build dams, create wetlands, and do some ecological good. He cuts me off.

"Good?" he laughs. "What good do they do? They're always clogging up culverts and being a pain...You're lucky you got to him before I did." Before I can craft a response, he snaps up a crushed water bottle and strolls off.

The sentiment that Castor canadensis is little more than a tree-felling, water-stealing, property -flooding pest is a common one. In 2017, trappers in Washington State killed 1,700 "nuisance" beavers, nearly 20 times more than were relocated alive. In neighboring Oregon, the herbivorous rodents are classified as predators, logic and biology notwithstanding. California considers them a "detrimental species." Last year alone, the U.S. Department of Agriculture eliminated more than 23,000 conflict-causing beavers nationwide.

Running countercurrent to this carnage is another trend: the rise of the beaver believer. Across North America, many scientists and land managers are discovering that, far from being forces of destruction, beavers can serve as agents of water conservation, habitat creation, and stream restoration. In Maryland, ecologists are promoting beaver-built wetlands to filter out agricultural pollutants and improve water quality in the Chesapeake Bay. In North Carolina, biologists are building beaverlike dams to enhance wet meadows for endangered butterflies. In England, conservationists have reintroduced the Eurasian beaver (Castor fiber) in hopes that their pond complexes will attenuate destructive floods. And in Washington, where a century of habitat loss has devastated salmon, the Tulalip Tribes are strategically dispatching beavers to support the fish so integral to their history and culture.

Back at the truck, I recount my exchange with the beaver-abhorring walker. Alves laughs. She has heard such slander before, and has a rebuttal at the ready.

"I would have asked him if he likes fresh water and salmon."

That beavers benefit salmon is, in some quarters, a provocative claim. Many biologists historically regarded beaver dams as stream-choking barriers to fish passage. In the 1970s, Washington, Oregon, and California even passed laws mandating the removal of in-stream wood, beaver dams included. More recently, a 2009 proposal funded by the Atlantic Salmon Conservation Foundation suggested eradicating beavers from 10 river systems on Prince Edward Island and employing trappers to enforce "beaver-free zones" in others.

The notion of purging beaver dams to allow salmon to pass, however, doesn't stand up to scientific scrutiny. One 2016 study documented individual salmonids traversing more than 200 beaver dams on their way to spawn in Oregon streams, suggesting that fish have little trouble negotiating the obstacles. Far from harming salmon, in fact, beavers create indispensable fish nurseries. By filling up ponds and digging canals, beavers engineer the deep pools, lazy side channels, and sluggish backwaters that baby salmon need to conserve energy and evade predators such as great blue herons. Today, the National Marine Fisheries Service considers "encouraging formation of beaver dams" vital for recovering Oregon's endangered coho populations.

"Beavers create complex habitat and enhance local biological diversity in a way that's really unique," says Michael Pollock, an ecosystems analyst at the National Oceanic and Atmospheric Administration who's among the beaver movement's grandfathers. "They do a much better job of managing these systems than we do."

The Pacific Northwest once boasted far more beaver-built salmon habitat than it does today. When Europeans landed on North America's shores, as many as 400 million beavers inhabited the continent. By 1900, three centuries of unabated trapping had converted all but 100,000 or so into fancy fur hats and other garments. As derelict beaver dams crumbled and ponds drained, untold thousands of streams eroded into desolate gullies. In a 2004 study, Pollock found that beaver ponds in a single river basin, Washington's Stillaguamish, once supported as many as 7.1 million juvenile coho each winter. By the early 2000s, the watershed's depleted ponds could sustain fewer than a million—an 86 percent crash in fish-rearing potential.

The joint demise of beavers and salmon also harmed the Pacific Northwest's indigenous groups—particularly the Tulalip, so bound to the mighty fish that they refer to themselves as People of the Salmon. To the Snohomish, Snoqualmie, Skykomish, and other Puget Sound tribes that compose the modern-day Tulalip, salmon were no mere resources. The fish were partners, symbionts that loyally sustained their human dependents so long as the tribes protected their rivers and treated them with due reverence.

The white colonists who overran Puget Sound did not share that respect. On January 22, 1855, Isaac Stevens, the governor of the new Washington Territory, and dozens of tribal chiefs signed the Treaty of Point Elliott, an agreement that forced many of the Sound's Native people onto the 22,000-acre Tulalip Reservation. While a judge later called the treaty "unfair, unjust, ungenerous, and illegal," it did have a redeeming feature: permanently preserving tribal members' rights to fish at their "usual and accustomed" places. Although the provision was seldom honored—Native fishermen were arrested and harassed, sometimes violently, by their white counterparts—a federal court finally intervened on the tribes' behalf in 1974, granting Native people half the annual harvest.

Yet the victory was, in some ways, a hollow one. The Puget Sound's salmon were in free fall, the victims of dams, overfishing, and the Seattle area's explosive growth. Thousands of acres of marsh had been paved over, hundreds of embayments wiped out. Beaches had been bulwarked, lowland forests demolished. What use was having your right to fish confirmed by the courts if there were no fish to catch? "We'd lost so much natural water storage," says Terry Williams, the Tulalip's treaty-rights commissioner. "We needed to come up with plans for longer-term watershed recovery, to have natural approaches that allow ecosystems to restore themselves."

Williams, a genial and gravel-voiced tribal member, grew up on the Tulalip Reservation in the 1960s, eating not salmon but government rations—hardtack, crackers, butter dyed with yellow food coloring. "We'd have to filter all the flour and take the bugs out before we could use it," he recalls. Williams spent his youth tromping through the reservation's woods and tracking its fauna, including beavers. He and a young cousin caught juvenile beavers alive, wrangled them into sacks, and relocated them to wetlands near their home to watch them work—for no other reason, he says, than that he was "13 years old and curious." They caught raccoons, too, which they kept in the house: "My mom's sister went a little crazy when they started going through the cupboards."

After a stint in Vietnam, Williams returned to Washington to work for a railroad company and attend college via the G.I. Bill. He tried commercial fishing in Puget Sound for a season, netting salmon to sell and flounder to take home. In the early 1980s, some friends asked if he'd consider working for his tribe's fisheries department—just for a year, they promised. The Tulalip Tribes were then embroiled in legal struggles all over Washington State in defense of their members' fishing rights, and Williams spent seven days a week on the road, preparing arguments and sitting in on court sessions. A year on staff turned into two, 10, a career. In the decades since, Williams has directed the Environmental Protection Agency's American Indian Environmental Office, served on the United Nations' Convention on Biological Diversity, and held a seat on just about every board, council, and commission pertaining to salmon recovery in Puget Sound. "I just got addicted to it," he laughs.

Around 2007, Williams began to ponder beavers. One of his friends, a farmer in Whatcom County, had harvested a bumper crop after beavers built ponds on his property and lengthened his irrigation season. Williams recalled his own childhood experiments in beaver relocation, and began to wonder if rodent restoration might be the "natural approach" the region's salmon habitat so badly needed. "He brought up beaver in just about every meeting for years, to the point that he drove people crazy," recalls Abby Hook, a former hydrologist with the Tulalip's treaty-rights division. "They'd say, 'Okay, let's talk about [Clean Water Act] permits.' And he'd say, 'No, let's talk about beaver.'"

In 2013, Williams found a sympathetic soul in Ben Dittbrenner, the founder of Beavers Northwest, a group dedicated to helping landowners coexist with the meddlesome mammals. Dittbrenner hoped to study the benefits of beaver relocation for his doctoral degree at the University of Washington; now all he needed were some beavers to relocate. The tribe had the desire and the resources, Dittbrenner the beaver expertise. He and Jason Schilling, a tribal biologist, developed a computer model to identify gentle, low-gradient streams ideal for beaver releases, then spent months traipsing the Skykomish River basin, ground-truthing prospective relocation sites.

Before the project launched, though, it had to overcome a legal obstacle. The previous year, the state of Washington had passed a bipartisan "Beaver Bill" praising beavers' ecological value and encouraging their relocation. Although the legislation was well intentioned, it contained a grave flaw, a provision inserted by a beaver-fearing legislator on the Olympic Peninsula. While the law permitted biologists to move beavers around sparsely settled eastern Washington, it prohibited releasing them west of the Cascades—the region that's home to Seattle, Tacoma, Olympia, and most of the state's other population centers. The message: Beavers can do good, but keep the...things away from people.

Still, the Tulalip's lawyers were undaunted. The tribe's authority to manage wildlife superseded the state's, they argued, and their treaty rights gave them the ability to restore salmon habitat as they saw fit. The tribe struck a deal with the U.S. Forest Service, which was hungry for more beavers on public land. In 2014, its inaugural year, the Tulalip Beaver Project relocated 23 beavers onto federal acres in the Skykomish River basin. "They're doing us a service all the way around," says Joe Neal, a district ranger in the Mt. Baker-Snoqualmie National Forest. "Anything we can do to hold water up here, that's good."

Through 2018, the project—which brought aboard Molly Alves in 2014 and David Bailey the next year—has moved 122 beavers to 20 locations around the Skykomish. Seven of those sites were first populated this year, meaning it's still too early to know whether the relocations have taken. At the 13 sites whose success the Tulalip can assess, beavers have established six colonies and constructed more than 12 acres of wetlands—more than 10 football fields' worth of the West's most important ecosystem.

Merely quantifying the impact of released beavers, however, misses the project's point. When the Tulalip Tribes began releasing rodents, Dittbrenner's modeling suggested that around three-quarters of the suitable beaver habitat in the Skykomish was vacant—a gap too large for any relocation effort to fill. Instead, the Tulalip's hope is to jump-start a natural re-beavering of the Puget Sound's uplands.

"The whole idea is to seed the watershed in high-quality areas where colonies will persist and crank out lots of baby beavers, sending out offspring and repopulating the watershed," Dittbrenner explains. "That's the really important assumption about what's going to happen." The beaver now safely ensconced in the pickup, Alves and Bailey drive back to the nearby Tulalip Reservation to examine their bucktoothed prize. The heart of the Tulalip Beaver Project is the tribe's fish hatchery, a compound of pools and pens that pumps out 11 million chinook, coho, and chum salmon fry each year. When they're not holding salmon, the gnaw-proof concrete walls and flowing water within the hatchery's raceways also make them perfect beaver enclosures.

At the hatchery, Alves and Bailey swiftly process their ward. They place the trap on a scale, which registers the creature's weight at around 30 pounds—a juvenile, Bailey says—snip a hair sample, and staple color-coded tags in the animal's ears for future identification: white in the left, yellow in the right. Although the biologists handle him as tenderly as possible, the beaver doesn't enjoy the poking and prodding, and begins to chatter his teeth as though he were cold—another sign of stress.

Once he's had a few minutes to calm down, Alves and Bailey usher the beaver into a cloth sack, with only his withers exposed, for the most sensitive step: sexing. Because even males possess internal genitalia, conclusively determining a beaver's sex can't be done visually; instead, it requires some serious olfactory skills. Alves presses on the beaver's belly, feeling for his anal glands—nubbins of flesh whose secretions beavers use to mark their territories and tell friend from foe. The anxious beaver has clenched his tail, making matters more difficult, but at last the glands emerge, like pinkish teats, from the plush underfur. Alves squeezes gently, milking a dollop of viscous, yellowish fluid onto her gloved finger.

Males, they say, are redolent of motor oil. Females smell like old cheese.

Alves wrinkles her nose. "Male," she confirms.

"It's kind of musky and urine-y," Bailey opines later. "At this point, it's all over my waders, and it's never coming out. Sometimes I'll be in the car and suddenly smell it and think, Oh, where's the beaver?"

His ordeal mercifully concluded, the beaver is released into one of the raceways, gliding up the narrow pen to huddle against the far wall. A cinder-block hut, floored with wood chips, stands at the raceway's center. When we return the next morning, we'll find that he's settled into the makeshift lodge to await a family reunion. Beavers are kin-oriented creatures, with as many as 10 family members sharing a lodge: the mating adults, their newborn kits, 1 year-olds, and 2 year-olds. (The latter depart the colony each spring in search of their own territories, like college-bound teenagers.) Relocate a beaver by himself and he's liable to wander the landscape, searching for companionship, until he's devoured by a bear or cougar. Move him with his clan, and he's more likely to stay put and build.

The Tulalip beaver relocation effort, like most projects of its kind, thus strives to capture and release cohesive families. When they catch unattached beavers, they attempt to match them at the hatchery, like a rodent dating service. "If you give them a few nights together, they usually pair up," Alves says. "They get lonely—they want to be with other beavers."

When all goes well, relocation can produce spectacular results. Later that week, Bailey and Alves drive me to a stream high in the Mt. Baker-Snoqualmie National Forest, the 1.7 million acre block of Douglas fir and western red cedar that sprawls across the western flank of the Cascade Range. The Tulalip had dropped off a family of seven beavers in this creek in fall 2015. Nothing happened at first, and Alves and Bailey concluded the site was a bust. When they found signs of dam-building the next spring, they figured another colony had moved in on its own. Grainy camera-trap footage, however, revealed that the nocturnal construction workers bore the Tulalip Tribe's ear tags. The relocation had worked after all.

Now a lonely beaver outpost has blossomed into an empire. Eleven separate dams have transformed the stream from a string-straight, free-flowing riffle into a patchwork of sun-dappled pools and serpentine side channels. We teeter along felled trunks and bushwhack through thickets of vine maple, exploring a complex that seems only to expand as we press on. The vast maze of channels and ponds would be an impressive feat for an engineer in a backhoe; for a handful of rodents armed only with incisors, it's practically miraculous. The largest dams are graceful crescents of latticed wood, buttressing serene ponds with yellow alder leaves swirling across their surface—the Platonic ideal of beaver infrastructure. Others are loose stickjams that hold back only a turbid bathtub. "I think they were drunk when they made this one," suggests Bailey, eyeing a crooked, homely ridge of mud.

For the salmon thriving in this beaver-built paradise, even the humblest dams provide key habitat. Everywhere we look, we see shoals of coho fry milling about the pools, their orange-edged fins waving like pennants as they flee our shadows. Behind one dam glitters freshly swept gravel marking a pair of redds, or salmon nests—a visible rebuke to those who still claim that beaver dams block fish passage. We're high in the western Cascades, hours by car from the Puget Sound lowlands, yet beavers and salmon have connected this slender stream to the sea.

While expanded ponds are beavers' most visible hydrologic impact, their ability to recharge groundwater might be an even greater contribution. At the Tulalip's relocation sites, Ben Dittbrenner has found that for every cubic meter (264 gallons) of surface water that beavers impound, another 2.5 cubic meters (660 gallons) sinks into the earth. As that water trickles through the soil, it cools off, eventually reemerging to mingle with streamflows downriver. Elsewhere, such hyporheic exchange between surface water and groundwater keeps streams hydrated later into the dry season, turning seasonal creeks perennial. Dittbrenner's research suggests that beaver-facilitated cooling and mixing also reduces water temperatures by more than 2 degrees Celsius (about 3.5 degrees Fahrenheit), a huge boon for heat-sensitive salmon and trout.

Although beavers won't singlehandedly save us from climate change, such findings suggest that they might be able to help our stressed water supplies adapt to a warmer future. "By 2100, we're expecting to see snowpack, which is basically our water storage reservoir, disappear throughout a lot of the Cascades," Dittbrenner says. "I'm curious whether beavers could make up an appreciable storage component of that lost snowpack."

Yet beavers' drought-fighting powers only go so far. After our visit to the salmon mecca, Alves and Bailey take me to another stream complex, dubbed Mahoney, where the Tulalip introduced beavers in 2015. The creatures had done their job with aplomb, reconnecting several disjointed, fishless channels into a massive pond buttressed by a sturdy 100-foot dam. I'd visited Mahoney the previous summer and found its waters vibrating with coho fry—a shining example of all that beaver relocation can achieve. "You know it's succeeded when you need a flotation device to monitor your site," Bailey had joked then.

When we emerge into the Mahoney clearing this year, though, it's apparent that no watercraft will be necessary. Catastrophe has plainly befallen the colony. The vast pond has receded into a handful of scattered puddles, exposing the beavers' once-impregnable lodge—now a sad, vulnerable pile of brittle sticks. Thickets of ghostly dead alder stand marooned atop muddy hummocks. Deer and bear tracks pock the soggy ground, suggesting that new visitors are already taking advantage of sprouting sedges and grasses. The scene has the mysterious, dilapidated grandeur of a medieval ruin.

"This is still a functioning space, and it's obviously beautiful in a different way," Alves says as we survey the abandoned kingdom. "It's eons better than it was when we found it." Still, there's no mistaking the disappointment in her voice.

Beavers abandon sites for all kinds of reasons, from disease to predation to food depletion. At Mahoney, though, Alves and Bailey suspect a different culprit: drought. The previous summer, the stream that fed Mahoney had completely dried up, cutting off the site's spigot. Beavers are geniuses at capturing running water, but they cannot conjure it from thin air.

Even in the best of times, getting beavers to stay where you put them poses immense challenges. When biologists dumped more than 200 beavers into Wyoming streams in the 1990s, for instance, many fell prey to bears, cougars, and other carnivores. Altogether, fewer than 20 percent took to their new environs. As drought diminishes western Washington's beaver-carrying capacity, persuading the rodents to stick around has become harder still.

"With these sites drying up earlier in the year, we're running out of places to put these beavers," Alves says. "We didn't anticipate that four years ago."

So how do you get beavers to cooperate? One option: Give them a leg up. After touring Mahoney, we jounce up yet another endless string of dirt roads to yet another remote tributary, this one shielded from the road by a verdant screen of maple and Devil's club. The Tulalip had installed beavers here a year ago, with disheartening results. "They just kind of waddled off, never to be seen again," Bailey says.

To entice the next colony to stay, Bailey and Alves have decided to attempt a new tactic—human-built walls of wooden posts and sticks known as beaver-dam analogues. The idea behind beaver-dam analogues, or BDAs, is simple: In situations where suboptimal habitat discourages beavers from settling down, a human-assisted starter kit can persuade them to stay put and build dams of their own. In one Oregon stream where scientists built more than 120 beaver-dam analogues, beaver activity increased eightfold—and juvenile steelhead trout survival spiked by more than 50 percent. Little wonder that BDAs are now among the American West's hottest stream-restoration techniques, deployed to enhance wet meadows for greater sage-grouse in Wyoming, remediate mining waste in Montana, and improve fish habitat in Northern California.

The appeal of beaver-dam analogues is not merely that they're effective—they are also easy to install. Armed with sledgehammers, the Tulalip biologists and a few volunteers begin to thwack upright silver-fir logs into the gravel stream bed, pounding them a few inches deeper with each satisfying swing. The hollow thump of hammer meeting wood resounds in the summer air. Between the thuds the crew shouts encouragement.
"You're a monster, David!"
"You're a beast, Bethany!"
"Shiloh, you been working out?"

Soon the creek is picketed with two rows of vertical posts, slightly askew, like a mouthful of crooked teeth. Coho fry flit around our boots, picking at insect larvae stirred up by the activity. Mike Sevigny, the Tulalip's wildlife program manager, plops down on the bank, his shirt darkened by sweat, and pulls off the surgical mask he wears to filter the wildfire haze. While Sevigny spends much of his time managing elk—another creature of vital cultural importance to the tribe—he considers beavers to be the center of terrestrial ecosystems as well as aquatic ones.

"Beaver ponds increase forbs, grasses, and shrubs, which are forage for bear, elk, deer, and everything else," Sevigny says. "The beaver gave us so much we don't understand because they're gone. We don't know how good the land could be because we never saw it. A lot of these habitats are screaming for help."

We return the next day to complete the job. Shayna Schultz and Bethany Tegt, the project's technicians, thread willow and maple sticks between the posts like basket weavers, then pack the interstices with straw to form a semipermeable seal. Soon knee-deep water has backed up behind the ramshackle dams. The crude structures don't look durable—they'll likely blow out in a flood a few springs hence—but permanence isn't the point. "They just need to last long enough to get beaver back into the system," Alves explains as we slosh through the nascent pool. By furnishing a safe, attractive pond and a semi-stable base of operations, these beaver-dam analogues will, with luck, convince the next relocated colony to stick around, get to work, and reproduce.

Thanks in large measure to the Tulalip's example, tribal-led beaver restoration in Washington will soon take another leap forward. Among the volunteers at the beaver-dam analogue installation is Erik White, wildlife manager with the Cowlitz Tribe. The Cowlitz's Southwest Washington territory encompasses the Lewis River, which in turn is home to bull trout, a cold-loving fish imperiled by climate change.

"A lot of projections show that 80 percent of bull trout habitat in the Lewis River basin is going to disappear in the next 25 years because of increasing water temperatures," White says during a break in our post-pounding. Inspired by the Tulalip, he and the Cowlitz Tribe have launched a beaver-relocation project of their own, and plan to begin moving the animals to the Gifford Pinchot National Forest in spring 2019. "We've got less and less snowpack every year," White adds. "Beavers could be a way to spread flows out into a more natural hydrograph."

Not only have the Tulalip spurred other tribes to action, they have also expended considerable political capital refining the Beaver Bill, the law that prevented relocations in western Washington. Although the Tribe's unique legal status meant that it was never bound by the prohibition, the law's illogic irked Terry Williams, the treaty-rights commissioner. More beavers on more Washington rivers would mean more salmon in Puget Sound, he figured. So, in 2017, the tribe flexed its political muscle, dispatching a lobbyist to Olympia, the state's capital, to advocate for a revision. The stubborn lawmaker who had opposed moving beavers west of the Cascades had retired, and a new Beaver Bill, this one permitting relocations on both sides of the mountains, sailed through. Starting in 2019, nontribal groups, such as environmental nonprofits, will be able to relocate the animals west of the Cascades, too. The doors to re-beavering have been flung open.

Williams was pleased by the outcome, but not surprised. When he began his career in fisheries management decades ago, he recalls, he'd found that the Tulalip were subject to a skein of laws intended to thwart tribal fishing. He'd griped to the tribe's chairman about the legal obstacles. "Well, that's not so difficult," the chairman retorted. "If the law doesn't work for you, change it."

Williams chuckles hoarsely as he recounts the story. "Because of that simple statement," he says, "I've changed so many laws I can't count 'em anymore."

In early October, I rendezvous once more with the Tulalip crew, this time on a winding forest road that parallels the Snoqualmie River. The summer's wildfires have been quelled, and the morning is crisp and blue, lit by the sun cresting over the granitic spires of the western Cascades. I arrive in time to catch Schultz and Tegt unloading four wire cages, which between them hold seven hulking beavers. Fourteen beady eyes rove over their captors. The creatures—two adults, four 1- or 2-year-olds, and a skittish kit—were trapped at a golf course near Tulalip, where they'd been irking the groundskeepers. "They all get along pretty well, so we think they're from the same colony," Schultz says.

We lug the crates down to a marshy tributary. A fork in the stream has created a natural impoundment, offering a prime release site and obviating the need for any beaver-dam analogues. At the base of an alder copse, the crew has built a slapdash lodge, temporary barracks that will keep the beavers safe from bears and cougars until they can build a permanent home. The crew lifts each cage to the lodge entrance, opens the door, and watches the beavers trundle into the dark interior. Although a previous relocation here failed, Alves and Bailey hope the threat of oncoming winter will motivate this batch to immediately start building. "We usually have more late-season establishment success," Alves explains in a whisper. "They're in hunker-down mode."

Collaborating with beavers, many scientists point out, confers extraordinary benefits: Rodent restoration is a natural, cost-effective strategy capable of tackling problems as diverse as nitrogen pollution and stream erosion. But beaver work can be as frustrating as it is rewarding. No matter how thoughtfully you choose release locations, no matter how many beaver-dam analogues you install, beavers are wont to do what beavers are wont to do. For all the science that guides it, beaver relocation entails, on some level, an act of faith. Dig a wetland with a backhoe, and you can be reasonably certain it will still exist in five years. Outsource the job to beavers, and they might succeed beyond your wildest expectations—or, as at Mahoney, permit your pond to lapse into a meadow.

It is thus with considerable trepidation that we wait before the makeshift lodge to see how its new inhabitants react. For a time, all is quiet; then a chorus of grunts and gurgles, eerily akin to the cries of a human infant, rises from the hut. We hear the staccato rasp of incisors on wood. Through gaps in the slats we catch a flash of fur, a glittering eye.

Abruptly a snout, culminating in a quivering nose, pokes from the logs, followed by a plump torso and a leathery tail. It's one of the adults, a male whose mahogany fur seems more suited to an orangutan. He slips into the still water and cruises up the creek, head high, alert to our presence but unafraid. We hold our breath as he reaches the cul-de-sac at the far end of the impoundment, performs a tight pirouette, and glides back toward his new home. His inspection complete, he squirms back into the lodge and vanishes from view—master, now, of his own fate.

Goldfarb, Ben. "The Re-Beavering of the American West." The Atlantic, Atlantic Media Company, 4 Dec. 2018,

DAY 4

Human Impacts

Like all animals, humans impact the environment that we live in, and we create the most dramatic and expansive changes of any living thing on the planet. By changing the environment to fit our needs, creating farms to feed our populations, and cities to house growing numbers of people, we drastically alter the land and water around us. We often think of this strictly in terms of how we can negatively impact our environment, we also have the ability to think carefully and deeply about how to preserve and restore the environment.

One of the biggest changes that we cause is **urbanization**. Urbanization is the process of creating more city spaces, leading to an increase in areas with roads, pavement and sidewalks. These materials are **impervious** and do not allow water to be absorbed by the environment. Impervious surfaces channel water very quickly, increasing the flow of streams. The high rate of flow can lead to the rapid transport of pollutants and also contributes to erosion, landslides and flooding. At the same time the process of building more city space generally means that there is less green space available and therefore less **pervious** material to absorb water. Whether or not an area has pervious or impervious surfaces has a big impact on the way the water moves through the environment and if it available for use by plants, animals, and people.

On the following activity pages, we'll explore the way human development has impacted the flow of water in our watershed.

Vocabulary

Impervious: Does not allow water and particles within to absorb or pass through it
Pervious: Allowing water and particles within to soak in and pass through the surface
Urbanization: The process of creating more city spaces, such as roads, pavement, and sidewalks
Water flow degradation: How the flow of water has been negatively affected
Water flow importance: How areas control and direct the flow of water in a watershed

Main Activity

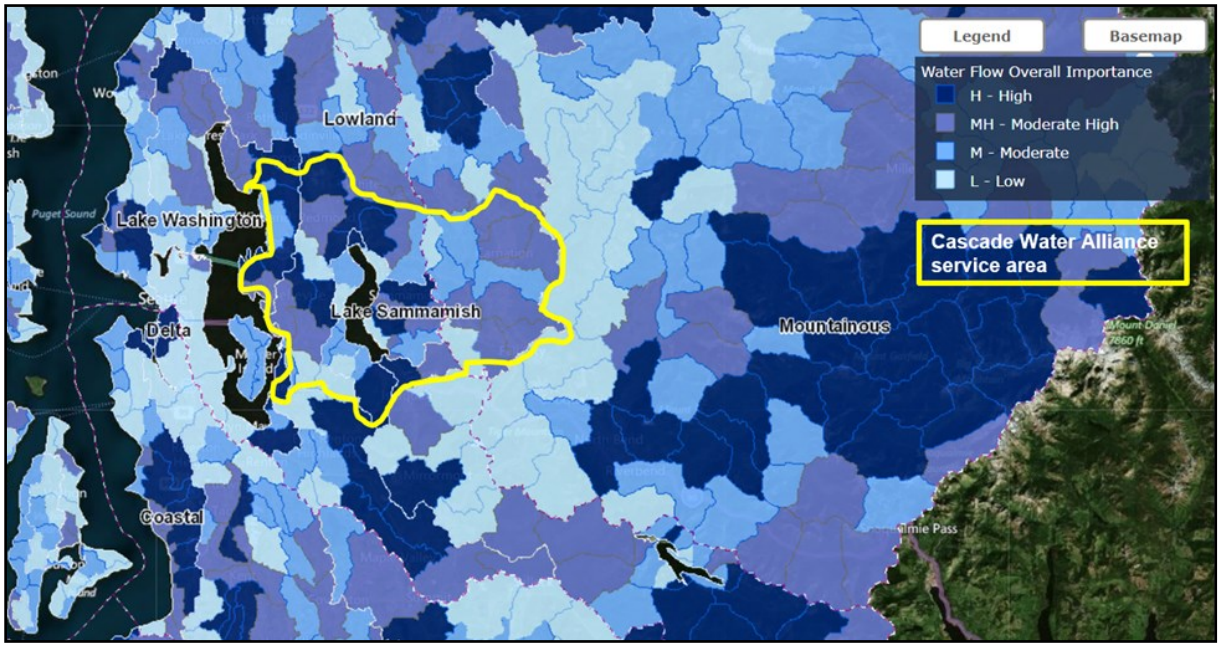
Water Importance Through Degradation Mapping

Today, we'll look at ways that we have impacted our watersheds using mapping data gathered from Washington State Department of Ecology. First, we'll explore the **water flow importance** of areas for the flow of water in our watershed. These are areas that help to collect and direct the flow of water for use by people and the natural environment. Next we'll look at **water flow degradation**, which is how these areas have been negatively impacted by people, creating problems in the movement of water for people and animals.

Below are two maps of our local watersheds and related questions that we will use to understand these concepts.

Materials: Writing utensil

Let's look at areas that control the flow of water through our watershed, also known as areas that have varying levels of water flow importance. Areas in **Dark Blue** have high overall importance, areas in **Light Blue** have less overall importance. When precipitation is "delivered" as either rain or snow, there are physical features that control its movement. These physical features include land cover and storage areas such as wetlands and floodplains. These areas are considered "important" to the overall water flow process.



Using this map, answer the questions on the following page.

CASCADE WATER ALLIANCE

Nature VISION

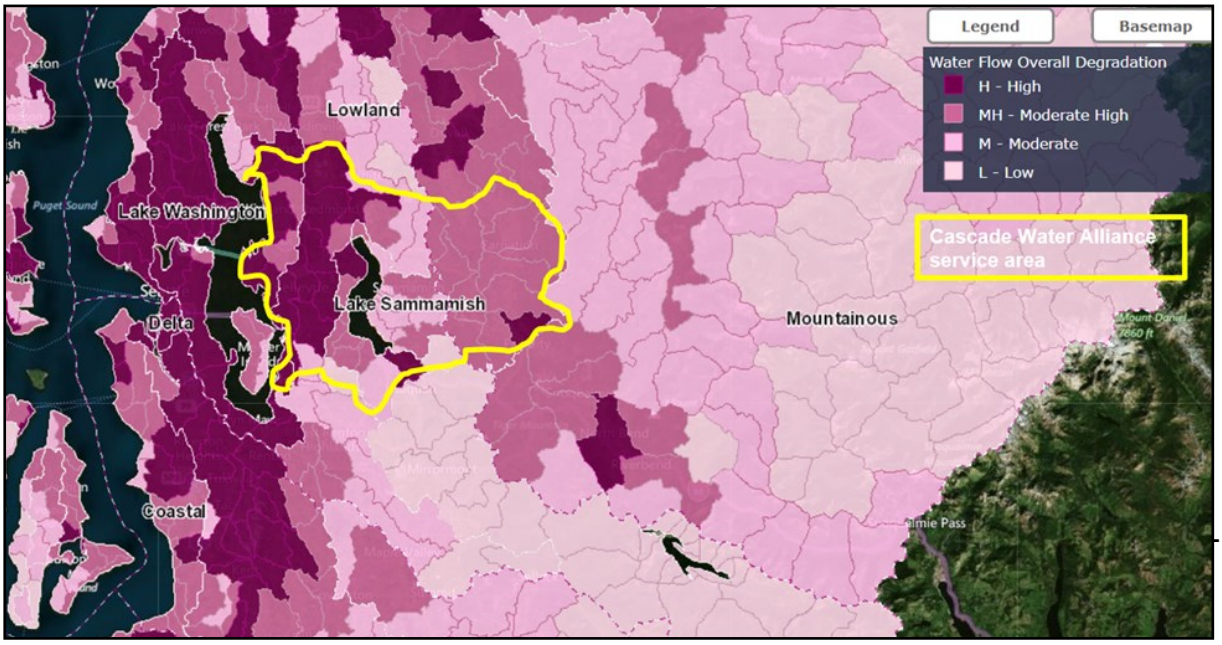
Where do you notice areas "High Importance"? Where do you notice areas with "Low Importance"?

How could these areas be affected by pollution or other human impacts?

How might that affect our watershed?

What patterns do you notice with the "Overall Degradation" map?

Now let's look at areas that negatively impact the flow of water through our watershed, also known as areas that have varying levels of water flow degradation. Areas in **Maroon** have high amounts of degradation, areas in Pink have less degradation. Areas with high amounts of degradation have more impervious surfaces (i.e. areas that do not absorb water) and also higher levels of development (i.e. areas with more buildings and pavement).



Using this map, answer the questions below.

How could these areas be affected by pollution or other human impacts?

How might that affect our groundwater?

What patterns do you notice with the "Overall Importance" map?

CASCADE WATER ALLIANCE

Nature VISION

Optional Activity

We Need Water Challenge

Wetlands are important ecosystems and they are found throughout a watershed. Wetlands are areas of land that is wet for majority of the year. They can be called ponds, marshes, sloughs, swamps, and bogs. Even though they are named differently based on varying factors, all wetlands share the same three components: saturated soil, water tolerant plants, and water.

Materials: Paper, writing utensil

If you can, go with an adult and find a wetland in your neighborhood or at a nearby park that is within walking distance. Together, find and identify at least one of these three water tolerant plants below. Make sure you and your adult stay on the trail or pavement and you don't bother plants or wildlife. Be safe, responsible, and respectable when outdoors. Bonus if you find a "stormwater retention pond." A stormwater retention pond is a manmade pond that was built to help hold extra rainwater so it doesn't go rushing into our watershed all at once. Do you have a stormwater retention pond in your neighborhood?

Cattail

Skunk Cabbage

Duck Weed

If you can't go outside, draw a simple model of a wetland. In your model, include the three components of a wetland: saturated soil, water tolerant plants, and water. Think of the components as layers. Which layer would the soil be? What about the plants? How much water do you need to include? Remember, a wetland is just land that is wet! ***Label the layers: soil, plants, and water.***

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 use the hashtag #WeNeedWater and tag @weneedh20 and @naturevisionorg in your post so we can see your work!

Optional Activity

Neighborhood Exploration

The way water moves through our watershed is affected by conditions that we, in part, can control. To get an idea of how water moves through our environment, we want to be aware of what kinds of surfaces absorb water, and what surfaces create runoff.

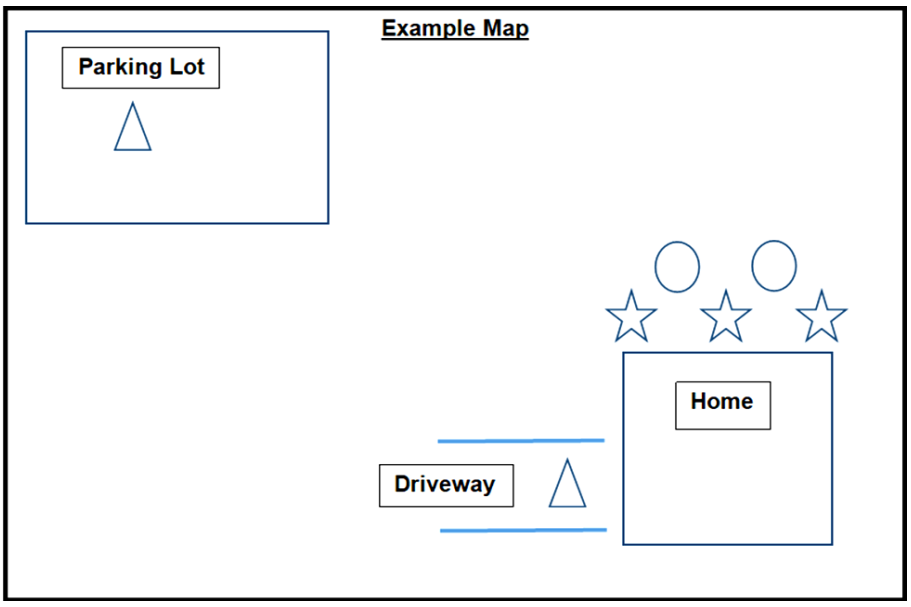
Materials: Paper, writing utensil, 1-2 liter water bottle

With an adult, you'll explore the area around your home and make a basic map marking where water is soaking in, and where it is flowing over the surface. If you're unable to go outside, try to make observations from a window or balcony or think back to a time during a rainstorm where you noticed water moving, collecting, or soaking into the soil.

Pervious surfaces, areas with grass and soil that allow water to soak into the ground, generally help control water, and make it available for organisms like plants and invertebrates. Impervious surfaces, where water cannot soak in, will move more water more quickly and contribute to issues like flooding, erosion, and pollution.

Using a liter or two of water, test areas that are important to you and think about how you use them. For example, you can pour some water to test where water goes when it rains near your front door, in a greenspace, or in a driveway.

- Mark a triangle on areas where the water does not absorb
- Mark a circle on areas where the water soaks in to the ground
- Mark a star where you find trees and other plants



Do you find areas that water is collecting or flooding?

How do you think these surfaces affect our ability to use them?

Have you ever noticed any large puddles forming in areas you use for recreation, like a soccer field or basketball court?

How might this affect the greater water system?

Can you think of any solutions you could put in place to benefit the flow of water in your neighborhood?

DAY 5

Stewardship

Like last week, Day 5 is about stewardship. Remember, 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. Specifically, these activities are focused on what everyone can do to save water and keep it clean for the rest of the environment.

We use far more water than what come into our homes in pipes every day. When you consider how much water is needed to produce food, to make energy and to manufacture products we use, our daily use is significant. We do not want to create a situation where our demand for water will exceed our water supply. Understanding the total amount of water each one of us uses is critical to understanding how we can create daily habits ensure plenty of water for everyone in years to come.

Water use is broken into two categories. The first **direct consumption**. This is the water that we can see, feel and use at any given time or location. This could be tap water, the water in your shower or used in your laundry machine.

The second category is **virtual water**. Virtual water is the water used to create the products and services we use every day but don't see or pay for specifically, it is just part of the value of those goods and services. For instance, it takes 22 gallons of water to manufacture one pound of plastic. A new cotton t-shirt requires 650 gallons of water to create and one gallon of gasoline requires 2.5 gallons of water to be refined.

We've already calculated how much direct consumption water we use in our home, now let's take a look at all of it together.

Vocabulary

Direct consumption: Water that we can see, feel and use at any given time or location

Virtual water: Water used to create the products and services we use every day but don't see or pay for specifically. It is just part of the value of those goods and services.

Main Activity

Water Footprint Calculator

The amount of water we consume directly and the virtual water we use through the products and services we use added together equals what is known as a water footprint. Water footprints are a way for us to estimate the total amount of water we use so we can better identify the impact each person has on our limited fresh water supplies.

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

Visit https://www.watercalculator.org/ to calculate your water footprint, then answer the questions below. (NOTE: If you are unable to look online, take a look at the graphics on the next page for some information that can help you with these questions in relation to you and your home.)

What were some of the biggest uses of water in your home?

What were the most surprising uses of water that you found?

What are some easy ways that you could reduce your virtual water consumption?

Water Footprint of Common Products

Car	*13,737-21,926 Gallons Each*
Leather shoes	*3,626 Gallons / Pair*
Phone	*3,190 Gallons Each*
Cotton bed sheet	*2,839 Gallons Each*
Blue jeans	*2,108 Gallons Each*
Cotton shirt	*659 Gallons Each*
Apple	*33 Gallons Each*
Banana	*42 Gallons Each*
Beef	*1,849 Gallons / Pound*
Wheat bread	*193 Gallons / Pound*
Butter	*667 Gallons / Pound*
Cabbage	*28 Gallons / Pound*
Cheese	*1,846 Gallons / Pound*
Chicken meat	*516 Gallons / Pound*
Chocolate	*2,065 Gallons / Pound*
Coffee	*60 Gallons / Cup*
Cucumber/Pumpkin	*42 Gallons / Pound*
Dates	*273 Gallons / Pound*
Eggs	*24 Gallons / Egg*
Goat meat	*663 Gallons / Pound*
Peanuts/Ground nuts	*334 Gallons/ Pound*
Cowhide leather	*2,053 Gallons / Pound*
Lettuce	*29 Gallons / Pound*
Corn	*147 Gallons / Pound*
Mango/Guava	*216 Gallons / Pound*
Cow milk	*67 Gallons / Glass*
Olives	*362 Gallons / Pound*
Orange	*67 Gallons / Pound*
Pasta	*222 Gallons / Pound*
Peach/Nectarine	*109 Gallons / Pound*
Margherita Pizza	*151 Gallons / Pizza*
Pork	*719 Gallons / Pound*
Potatoes	*35 Gallons / Pound*
Rice	*300 Gallons / Pound*
Sheep meat	*1,250 Gallons / Pound*
Sugar	*214 Gallons / Pound*
Tea	*3 Gallons / Cup*
Tomato	*26 Gallons / Pound*

Fabrique [merken, design & interactie]. "Product Gallery." Home, waterfootprint.org/en/resources/interactive-tools/product-gallery/.

Optional Activity

We Need Water Challenge

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

Materials: Writing utensil, markers/colored pencils, computer/phone/tablet, internet

Using what you've learned this week, and the other We Need Water challenges you've done, it's time to get 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 stewardship challenge for today:

-
-
-
-

Final #WeNeedWater challenge:

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 use the hashtag #WeNeedWater and tag @weneedh20 and @naturevisionorg in your post so we can see your work!

Optional Activity

Stewardship Through a Story

In every culture throughout time, stories and myths have been told to pass on wisdom, teach one another and create community. Looking at some of the cultural traditions of the Coastal Salish native people of our region, environmental stewardship plays a central role. The stories, customs, and acknowledgements that have been practiced for all of recorded history and continue to impact everyone who experiences them often include lessons and morals focusing on environmental stewardship. This, however, is just one example. Cultures from all over the world have spun legends, stories and more about their close ties with nature and how a strong relationship between the two can be mutually beneficial.

Materials: Writing utensil

For this activity, write a story, poem, song or something else in the form of a tale or legend with the intent to inspire stewardship and strengthen the relationship of its audience and nature. Think about everything we have covered to this point and remember that it doesn't have to be set in the distant past, contemporary stories can have tremendous impact as well!