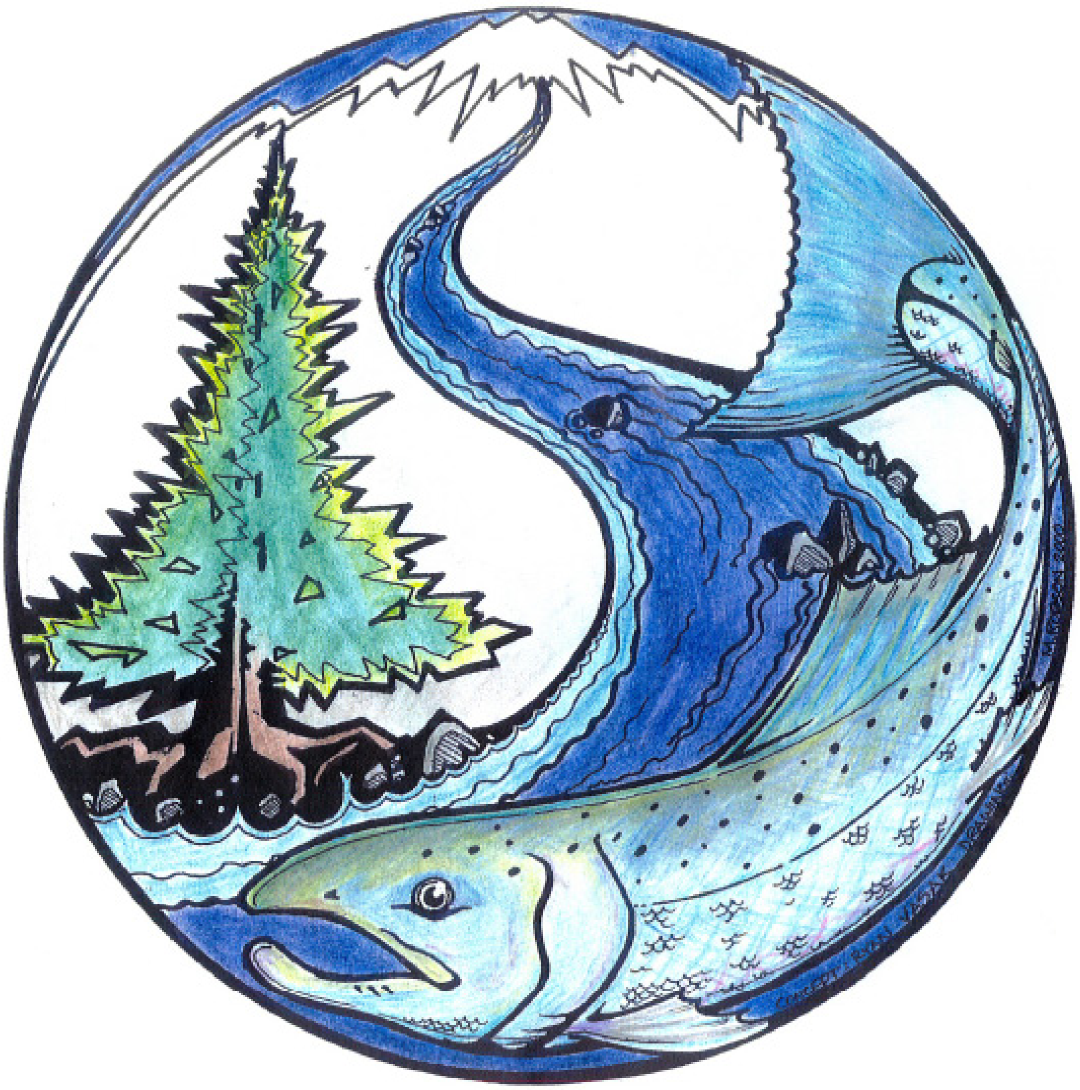
Students for Salmon

Elementary Environmental Science Program: Grade 4

Curriculum



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Nooksack Salmon Enhancement Association's

Students for Salmon Program

Mission Statement

The Nooksack Salmon Enhancement Association (NSEA) is a community-based nonprofit organization dedicated to restoring sustainable wild salmon runs in Whatcom County.

Education and the Students for Salmon Program

Education is a central part of NSEA's mission to restore salmon to our streams. Our educational programs began in 1999, and are designed to increase the public's awareness of the crucial interdependence between clean water, healthy watersheds, quality salmon habitat, self-sustaining wild salmon runs, and the future of our community. NSEA's *Students for Salmon* Program involves students throughout Whatcom County, providing school groups with opportunities to participate in hands-on watershed science and stream restoration projects. Through classroom and field-based activities, NSEA is educating the next generations of "decision makers" in our community.

How To Use This Curriculum

The *Students for Salmon Curriculum* is made up of five Units. Units 1-3, covering watersheds, salmon, and salmon habitat, should be covered prior to the Stream Exploration Field Trip. Unit 4 is the Stream Exploration Field Trip, taught by NSEA staff and volunteers. You are not responsible for teaching this unit, though we have included these lessons in the curriculum so that you can familiarize yourself with what will be covered during the field trip. All components of Unit 4 will be provided at the field trip. Unit 5 is designed to support the work done by students during the Stream Exploration Field Trip and should be covered after the field trip. Extension lessons are always encouraged and can be found on our website along with other resources.

Each unit begins with a formative assessment. Students will brainstorm what they know and what they want to know about each unit topic. Teachers can gauge existing knowledge of the students and revisit this again at the end of the unit, or the completion of the program, to determine what they've learned. The lessons are designed to be sequential, building on each other in order. The student worksheets for each unit can be found in the *Students for Salmon Student Journal*, however there are also examples of each worksheet in this *Students for Salmon Teacher Handbook*. Bolded words are found in the glossary.

We are proud that our curriculum supports the Next Generation Science Standards (NGSS). Each lesson in this curriculum indicates connections to NGSS, and the associated Performance Expectations, Scientific and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

Our Partners

We strive to provide the *Students for Salmon* Program at no monetary cost to schools thanks to generous partners and contributions from our community. For a current list of supporters and to learn how to contribute, please visit our website.

Contact Us!

We're here to help. Please feel free to contact us at any time with questions, concerns, suggestions, or ways we can better support you and your students in salmon education!

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NSEA
NOOKSACK SALMON ENHANCEMENT ASSOCIATION

Students for Salmon

Suggested Timeline for Program

Student Pre-Test facilitated by NSEA staff or by teacher*

Teacher Led	NSEA Led
Unit1: Our Watershed (five 30-60 min lessons)	**Introductory Classroom Visit** (60 min, can be anytime before, during, or after Units 1-3)
Unit 2: Salmon (five 30-60 min lessons)	
Unit 3: Salmon Habitat (three 45-60 min lessons)	
	Unit 4: Stream Exploration Field Trip (Units 1-3 preferably completed)
	Habitat Restoration Field Trip (optional)
Unit 5: Save Our Salmon (several lessons to synthesize learning from the field trips)	**Post Program Classroom Visit & Student Post-Test** (60 min)

3-6 weeks for entire program

- This diagram is the *suggested* timeline of the Students for Salmon Program. Curriculum units are to be taught in coordination with the NSEA led components, however this is flexible depending on scheduling and teacher preference.
- While none of the curriculum is *required* to be taught, students get the most out of the program if they learn the background knowledge (i.e. Units 1-3 of the *Students for Salmon Curriculum)* before the Stream Exploration Field Trip (Unit 4).
- NSEA requires that parents/guardians complete a **student release of liability form** in order for their child to attend field trips. This form will be sent to teachers before the introductory presentation. Completed forms for all students must be given to NSEA staff on their first visit to your classroom.

* NSEA conducts pre and post program evaluations to measure the impact of our program. The pre-test should be taken by students before any *Students for Salmon Currriculum* elements are taught to measure students' knowledge before the program. If you plan on teaching any part of the curriculum before the Introductory Presentation, please contact NSEA to obtain the pretests so your students can complete the tests prior. The post-test will be taken by students at the Post Program Classroom Visit.

Students for Salmon

Curriculum Table of Contents

UNIT 1 - Our Watershed

UNIT 2 - Salmon

UNIT 3 - Salmon Habitat

UNIT 4 - Stream Exploration Field Trip: NSEA-led Unit

UNIT 5 - Save Our Salmon

Glossary and Resources

Student Journal

UNIT 1 - Our Watershed

Led by Classroom Teacher

What We Know	What We Want to Know

1.1 Where in the World is our Water?

Subject
Earth and Space Sciences

Objectives
The students will:

- Discuss where water is stored on our planet and draw a supporting diagram
- Describe how water moves from one place to another as an introduction to the water cycle
- Describe and graph percentages of water in various reservoirs

Materials

- *Students for Salmon Journal*
- Art Supplies—crayons, markers, pencils
- Globe or World Map

Size/Setting/Duration
Entire class and small groups/classroom/~45 minutes

Background
Where is our water stored?

Polar ice caps and Glaciers: The amount of ice and snow has changed through global glaciations and periods of warming in Earth's history. This includes water locked up in polar ice caps, glaciers, and snow packs.

Surface Water: Surface freshwater includes: lakes and swamps that hold water at the surface and rivers that transport water great distances.

Atmosphere: The air is full of molecules we can't see, including water vapor molecules. The atmosphere moves water all over our planet!

Oceans: 97% of the water on Earth can be found in our oceans, so it is not surprising that almost all of our clouds come from the ocean evaporating from liquid to gas.

Groundwater: The soil and rocks beneath our feet contain many cracks and spaces where water can exist underground.

What processes move water between these storage areas?

There are more details to explore with the water cycle, but for this introduction we will simplify the processes. It is important to remember that the water cycle is driven by the sun. The sun heats the Earth, driving evaporation and causing wind which moves water in the form of clouds around our planet.

Evaporation: evaporation changes liquid and frozen water into water vapor gas, which floats up to become clouds because of the sun's energy (heat).

Condensation: As water vapor particles float up into the cooler air higher in the atmosphere, it condenses, which means the vapor turns into water droplets, forming clouds.
Precipitation: Clouds are a collection of tiny water droplets. When these water droplets combine into heavier drops, those can fall as rain, snow, or hail, known as precipitation.
Runoff: Water runs over the landscape due to precipitation or melting ice and snow, reaching rivers, creeks, lakes, and oceans.
Infiltration: When rain falls on the landscape, some of it soaks into the ground to join groundwater.
Groundwater Flow: Water is beneath our feet and is always moving, transporting groundwater to oceans, lakes, and rivers.

<u>Earth's Water Percentages</u>

All Earth's Water	
97 %	Salt Water
3 %	Fresh Water

Of Earth's **Fresh Water**	
68.7 %	Ice caps, Glaciers
30.1 %	Groundwater
0.3 %	Surface Water
0.9 %	Other

Of Earth's **Surface Water**	
87 %	Lakes
11 %	Swamps
2 %	Rivers

Procedure

1. Show students the globe or map—ask, where in the world is our water?

2. Explain to students that there has always been the same amount of water on our planet—there never has been more or less, and there will never be more or less. What does change is where water is stored and in what form it can be found (vapor, liquid, solid).

3. Have students brainstorm in smaller groups where in the world we find water. More specifically, where is water stored? Share thoughts as an entire class. Water is stored/can be found in the atmosphere, ice and snow, lakes and rivers (freshwater), groundwater, and oceans (saltwater).

4. Have students draw a full-page diagram that includes the main water storage areas—atmosphere, ice and snow, lakes and rivers, groundwater, and oceans. If needed, show the class an example.

5. Have students discuss in their small groups how water might move between these different storage areas—they may know some of the vocabulary already, but its ok for them to simply think it through without being given the terms. If they need prompts for discussion, assign groups pathways. Group 1-discuss how water moves from the atmosphere to snow and ice, Group 2-discuss how water moves from oceans into the atmosphere, Group 3-discuss how water moves from the ground to oceans, etc…

6. After students have had time to discuss, bring class back together. Display your own labeled diagram on the board—as students share these relationships as a whole class, make notes of key thoughts, observations, or words they're using to describe the cycling of water on your diagram.

7. Next, walk through these processes and add the proper terms to your diagram. Have students label their own diagram as well.

8. Transition to *The Water Cycle* lesson to further discuss the vocabulary behind these processes.

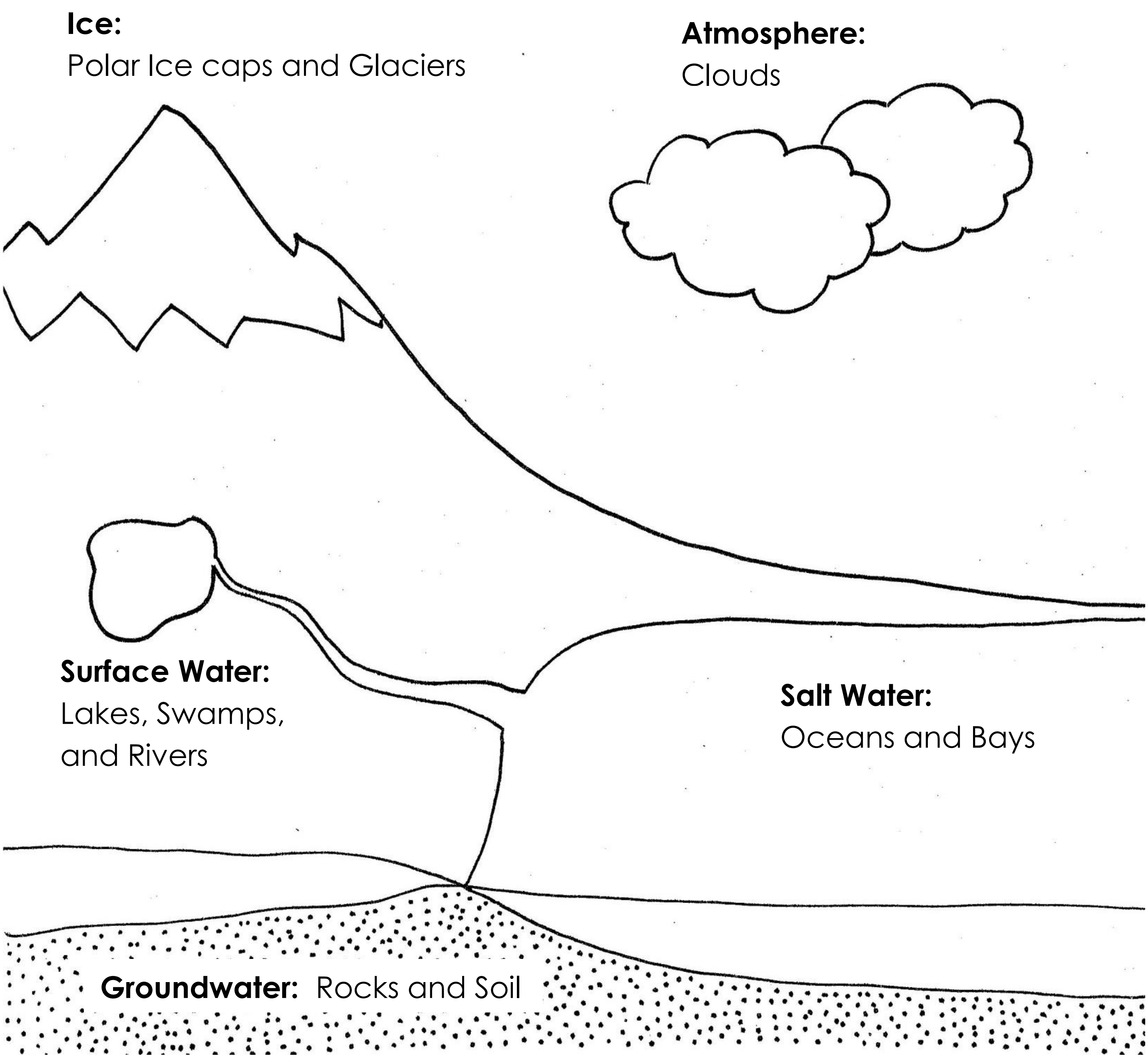
Extension

MATH EXTENSION: For a visual of where our water is stored, students can draw a diagram that represents this graphically. Provide students with the percentages under "Background" section of this lesson plan. Using graph paper, have students draw three 10 by 10 block squares and label them Total Water, Total Fresh Water, and Total Surface Area. Students color in boxes—one box per one percentage—to match the proportions provided.

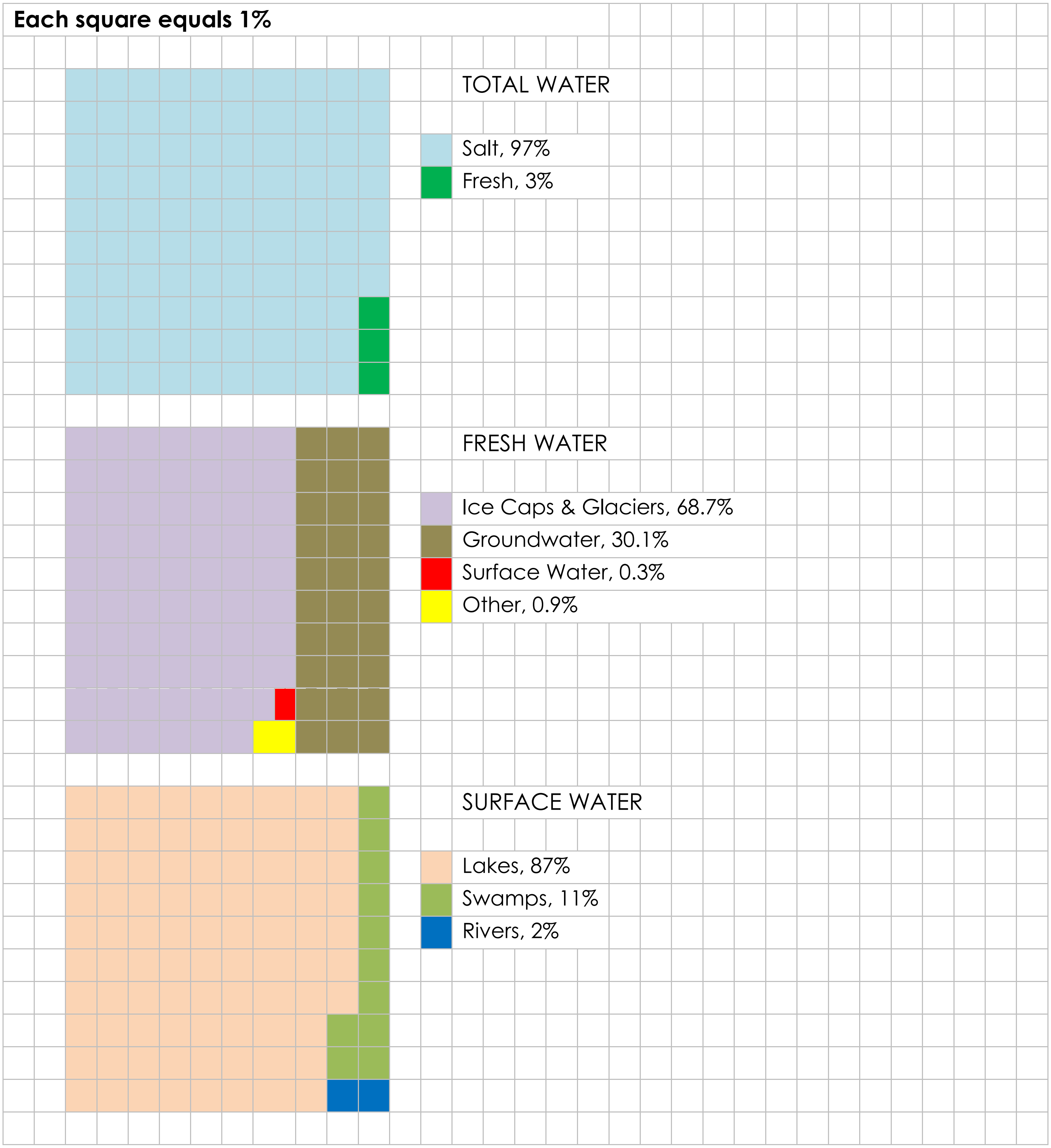
Next Generation Science Standards

Performance Expectations		
5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact. **5-ESS2-2**: Describe and graph the amounts and percentages of water and fresh water in various resevoirs to provide evidence about the distribution of water on Earth.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Developing and Using Models ▪ Analyzing and Interpreting Data ▪ Using Mathematics and Computatational Thinking	▪ ESS2.A: Earth Materials and Systems ▪ ESS2.C: The Roles of Water in Earth's Surface Processes	▪ Scale, Proportion, and Quantity ▪ Systems and System Models

Where in the World is our Water? *–Example*



Where in the World is our Water, by Numbers?-*Math Extension*



Where in the World is our Water?

Draw a diagram that shows where Earth's water is stored. Include labels!

Where in the World is our Water?

1.2 The Water Cycle

Subject
Earth and Space Sciences

Objectives
The students will:

- Use a diagram to label and explain the water cycle and its components
- Label the water cycle model with appropriate natural features

Materials

- *Students for Salmon Journal*
- Art Supplies—crayons, markers, pencils

Size/Setting/Duration
Entire class/classroom/~30 minutes

Background
Almost three-quarters of the Earth is covered by water. A small quantity of this water is regarded as fresh water, and only a small amount of the fresh water is available for use by humans. The water cycle is an endless process of water exchange between clouds, land, and oceans, constantly recycling all the water that covers the Earth.

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

Procedure

1. Introduce the idea that you are going to be studying watersheds. To understand watersheds you first have to know how water moves—the water cycle. The sun drives the water cycle, since water changes forms as temperature changes.

2. Explain that the amount of water that is present on the Earth now is always the same amount. Water is continuously changing form and location. Go through the water cycle with students explaining that a cycle is a circle. Ask students where they think water comes from. Once rain is mentioned, tell them that there are other ways water comes from our atmosphere such as snow and hail. Tell the students that all of these are categorized as **precipitation**.

3. When rain or precipitation falls, it soaks into the ground to recharge (refill)aquifers or runs off the earth to fill up lakes, rivers, and wetlands. When it soaks, or seeps, into the ground, it is called **infiltration**. The top of this zone of water is called groundwater and moves through the watershed in a process called **groundwater flow**.

4. As water sits in one place, such as a lake or wetland, or even pools up on a leaf, it will turn from a liquid state to water vapor when it is heated. This is called **evaporation**.

5. As the water vapor rises, the air gets colder and the water vapor will begin to condense to form clouds. If the air cools even more, the water vapor will condense further and turn back into a liquid or crystal (snow/ice) state. This process is called **condensation**.

6. Upon completion of your discussion, have students fill in *The Water Cycle* worksheet in their *Students for Salmon* Journal.

Extension:

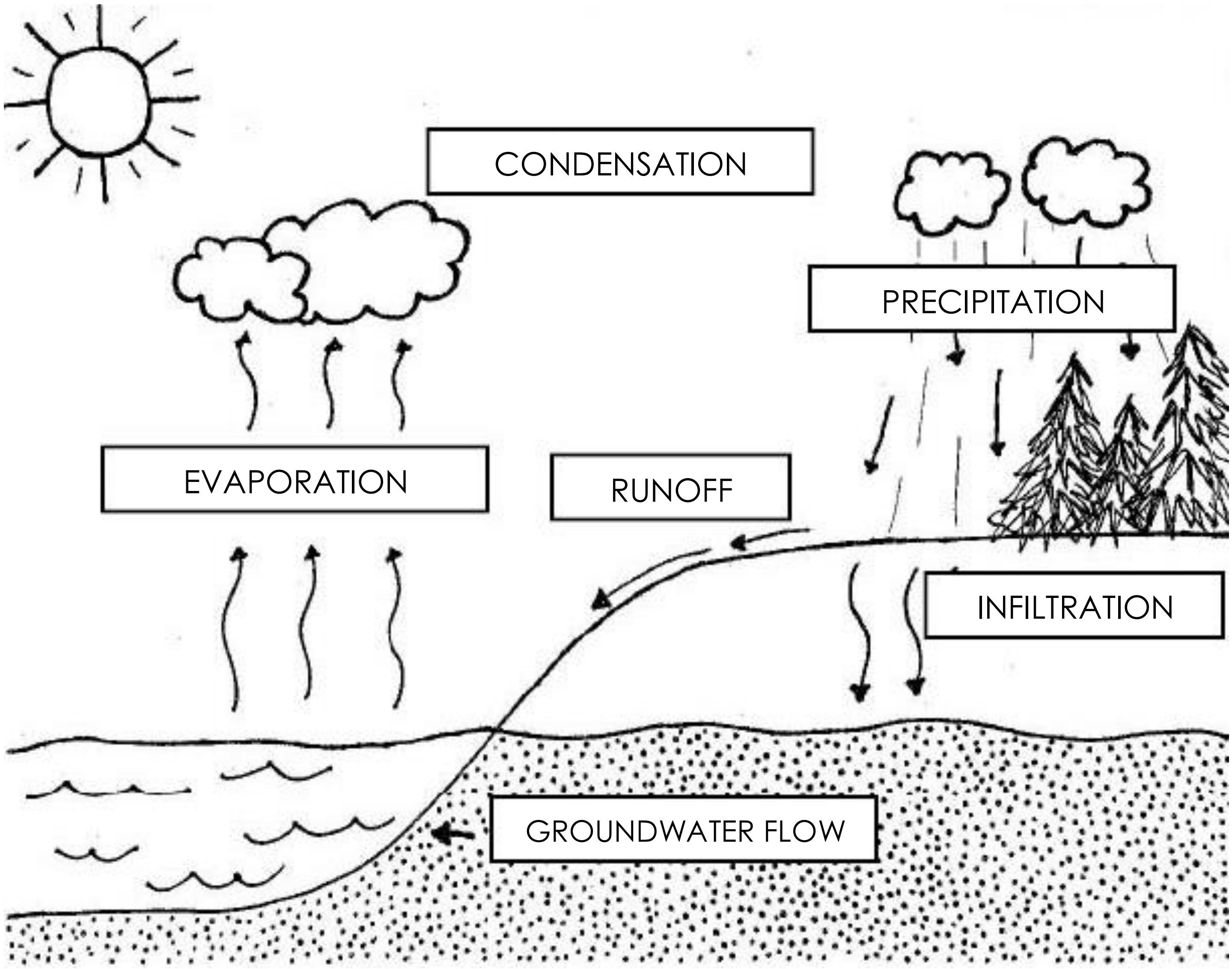
Demonstrate the different states of water for students—solid, liquid, and gas. Melting ice cubes display the change of water from a solid to a liquid. A hot plate with boiling water displays *evaporation* as water changes from liquid to vapor. A cold glass of ice water shows water vapor becoming liquid as the water *condenses* on the side of the glass.

Can students come up with these everyday examples on their own that exhibit processes of the water cycle? An option is to have them design an investigation into the states of water—how can they mimic evaporation? How can they display condensation? And so on.

Next Generation Science Standards

Performance Expectation		
5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Developing and Using Models ▪ Constructing Explanations and Designing Solutions	▪ ESS2.C: The Roles of Water in Earth's Surface Processes	▪ Patterns ▪ Systems and System Models ▪ Energy and Matter: Flows, Cycles, and Conservation

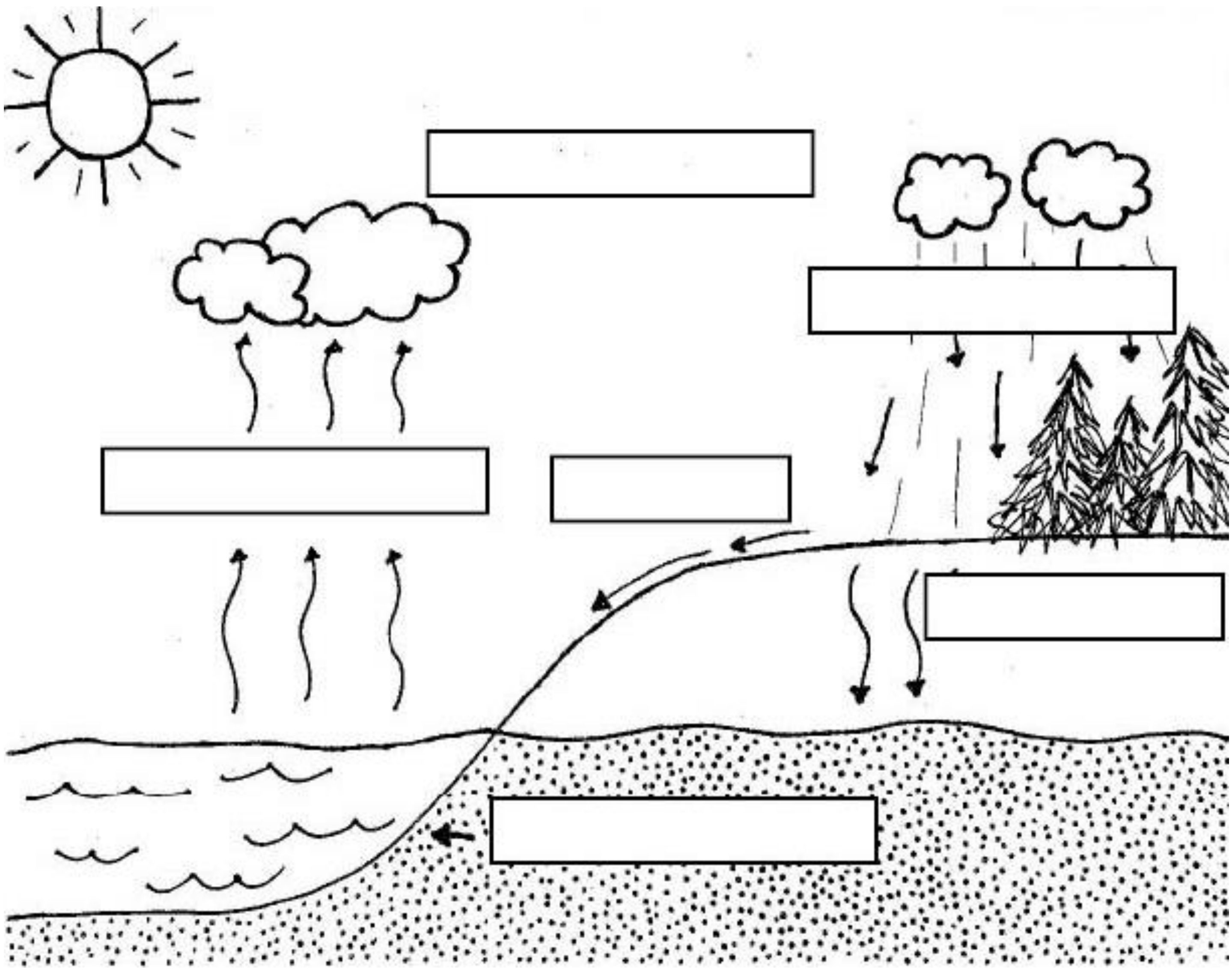
The Water Cycle - *Answer Key*



1. Evaporation
2. Groundwater Flow
3. Precipitation
4. Runoff
5. Infiltration
6. Condensation
7. Sun/Solar Energy

The Water Cycle

Fill in the Water Cycle diagram as a class, then answer the questions below!



The Water Cycle

1. The process when liquid water becomes gas in the atmosphere is called ____________________.

2. The movement of water underground is called _________________________.

3. ______________________ is the water that falls from clouds as rain or snow.

4. Water on the earth's surface which moves into a stream or lake without absorbing into the soil is called _________________________.

5. ____________________________ is the downward movement of water through the spaces of rock or soil; when surface water becomes groundwater.

6. The process when gas condenses to form clouds is called _____________________.

7. BONUS QUESTION (not a word from your diagram):
   What type of energy drives the entire water cycle?
   ____

1.3 What is A Watershed?

Subject

Earth and Space Sciences

Objectives

The students will:

- Be able to define and explain what is a watershed
- Label the watershed *model* diagram with appropriate natural features
- Identify *causes and effects* of human impacts in watersheds and add these to the illustration

Materials

- *Students for Salmon Journal*
- Art Supplies—crayons, markers, pencils

Size/Setting/Duration

Entire class/classroom/~60 minutes

Background

A **watershed** is an area of land that consists of all the water and land between ridges that drains to a particular outlet. The outlet could be a river, lake, bay, or the ocean. A watershed is drained by a system of **tributaries**. The place where two watersheds separate is called a divide. Bathtubs or sinks make good, simple analogies.

When cities and counties decide how to manage their watersheds, it's important to take into consideration the factors that affect the health of the watershed: **soil**, **vegetation**, rural and urban land uses and other human impacts, forest practices, and roadways.

Procedure

It is helpful if students first complete *The Water Cycle* worksheet from the *Students for Salmon Journal* before starting this activity so that they use their knowledge about how water is exchanged between the land, oceans, and clouds.

1. When introducing watersheds to your students, ask them which direction water tends to flow on land. This is the most important thing to remember when studying watersheds. Water runs downhill due to the force of gravity.

2. The *What is a Watershed?* worksheet in the *Students for Salmon* Journal gives the definition of a watershed for the students. You can expand on this with the background information given.

3. The illustrated watershed that follows is a model of what a watershed looks like. Students should use a brightly colored pen to trace the outline of the watershed's boundary.

4. With the words provided, have students fill in the appropriate box with the correct word on their diagram, using their glossary from the back of their *Student Journal* as a resource. The words describe the "natural" features of a watershed. For example, the word "bedrock" is assigned to the illustration because it is the support for the landscape over which water flows.

5. Once students have filled in the watershed worksheet with the natural watershed features vocabulary, use the human land use list to discuss our impact on the watershed with your students.

6. Have students draw in these human land uses on the watershed illustration. While doing this activity the students should understand that all of these human impacts affect the watershed directly, especially the water quality due to **stormwater runoff** pollution. Brainstorm and add other human influences as a class.

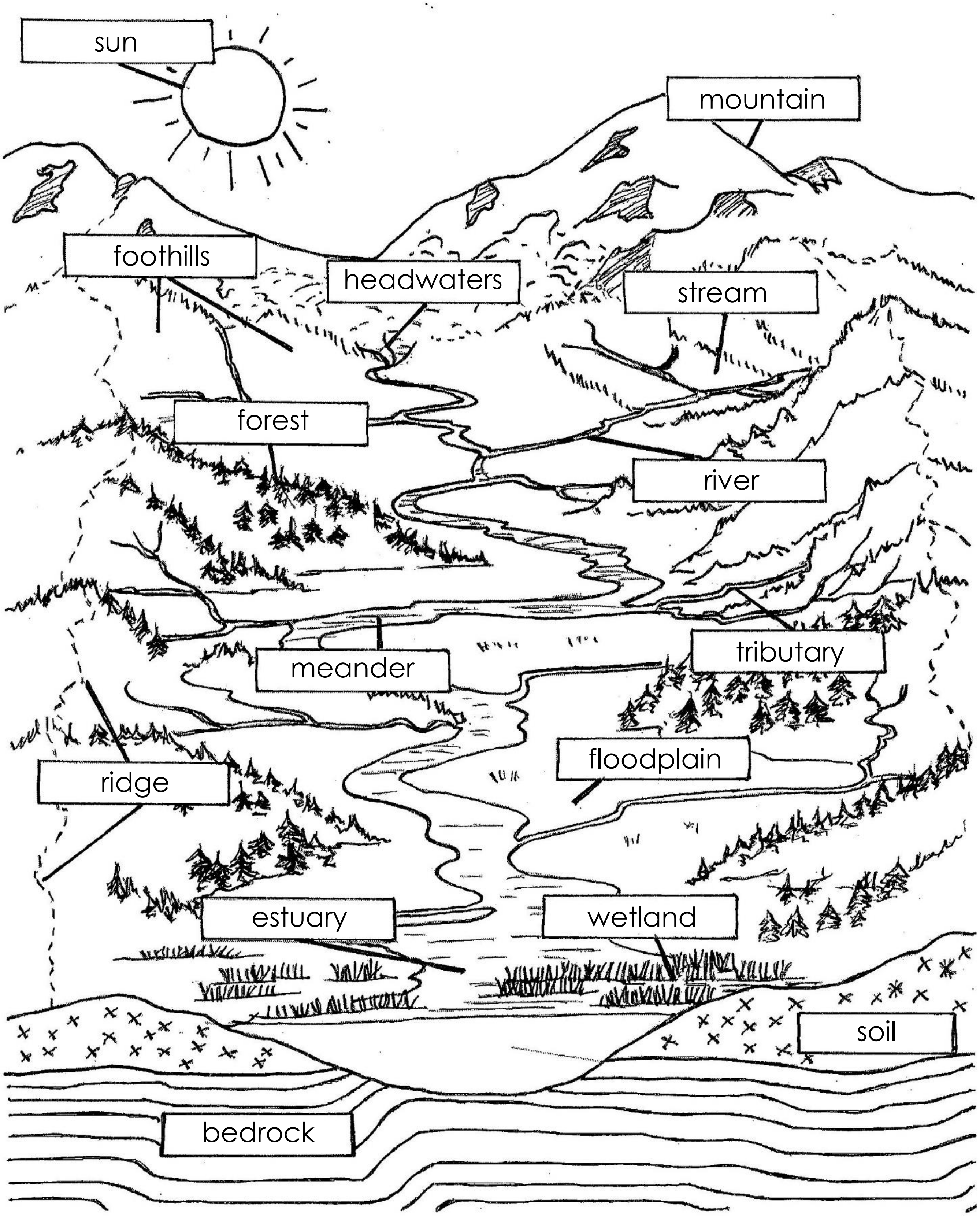
Extension

Have students select any two watershed features from the list in their journal. They can be natural or human. Have them write about how these two features may affect one another. You could also pre-select several combinations to offer the class as well.

Next Generation Science Standards

Performance Expectation		
4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Asking Questions and Defining Problems ▪ Developing and Using Models	▪ ESS2.A: Earth Materials and Systems ▪ ESS3.C: Human Impacts on Earth Systems	▪ Cause and Effect: Mechanism and Explanation ▪ Systems and System Models ▪ Structure and Function

Watershed –Answer Key

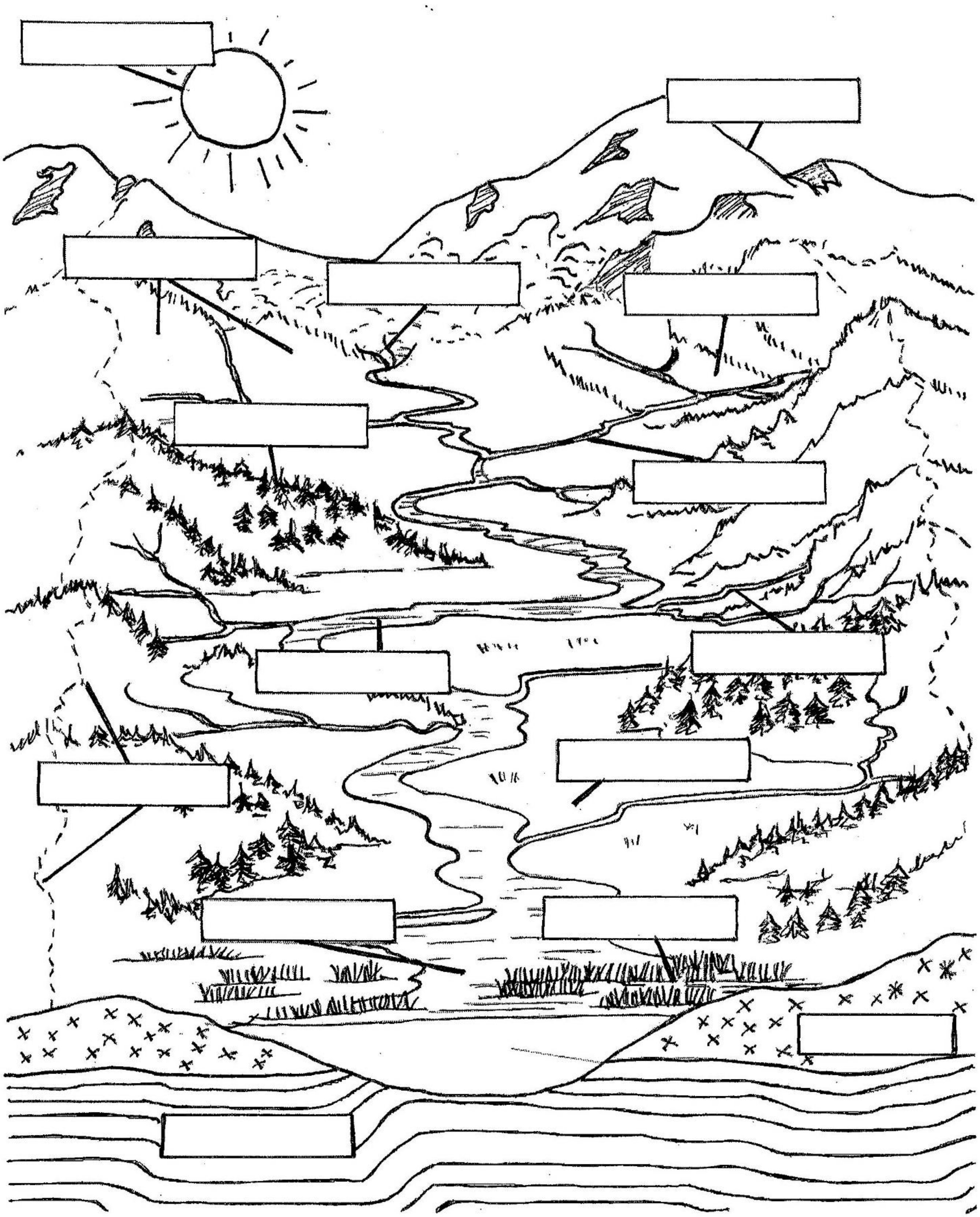


What is a Watershed?

A **WATERSHED** is a basin where water collects as it runs downhill. It includes all the water and land areas between ridges that drain to an outlet. The outlet could be a river, lake, or the ocean.

First, label the watershed diagram on the following page with these words:	**Second**, now that you know the natural features of a watershed, add and draw in these **human land uses**:
• Bedrock • Estuary • Floodplain • Foothills • Forest • Headwaters • Meander • Mountain • Ridge • River • Soil • Stream • Sun • Tributary • Wetland	• Boats • Cars • Cows • Factories • Farms • Horses • Houses • Parks • Roads • Stores • Anything else? Add others if you can think of more!

Watershed



1.4 A Wet Watershed

Subject

Earth and Space Science

Objectives

The students will:

- Predict where water will flow and collect in a watershed
- Reinforce the components of a watershed in a tangible way

Materials

- 1 spray bottle per class
- Water-soluble markers
- 1 plastic garbage bag or plastic sheet per student
- 1 piece 8.5" x 11" white cardstock per student

Size/Setting/Duration

Entire class/classroom/~45 minutes

Background

A **watershed** is an area of land that consists of all the water and land between ridges that drains to a particular outlet. The outlet could be a river, lake, bay, or the ocean. A watershed is drained by a system of **tributaries**. The place where two watersheds separate is called a divide. Bathtubs or sinks make good, simple analogies.

When cities and counties decide how to manage their watersheds, it's important to take into consideration the factors that affect the health of the watershed: soil, vegetation, rural and urban land uses, forest practices, and roadways.

Procedure

1. Make sure that the students have completed their *What is a Watershed* worksheet from the *Student Journal* before starting this activity. It gives the base knowledge for this activity and introduces the parts of a watershed that this activity will reinforce.

2. Review what a watershed is and tell the class that they will be making their own watershed model. Give each student a garbage bag to lay on their desk, under their "watershed" (crumpled paper) to later collect the "rain" water (and keep the desk from getting wet). Ask the students to loosely crumple their pieces of cardstock into a ball and then slightly un-crumple them so that they can see what looks like mountain ranges, ridges, rivers, and basins.

Explain to them that the high points on their models are mountains and that you can see where mountain ridges have formed. Discuss how the mountain peaks and the tops of hills separate one watershed from another, and that snow collects in the mountains during winter, storing water until it melts in the spring and summer. Discuss what the depressions in the paper might be (lakes and rivers).

3. Ask the students where they think the water from rain or snowmelt might flow and collect in their watershed. Have the students trace those routes on their watershed model with a water-soluble marker.

4. Tell the class that it is now going to rain on their watershed. Go around to each student and spray water on their watershed model long enough so that the water starts to flow to the lower elevations. As a class, discuss where the water flowed and ended up. Encourage students to use vocabulary from the *What is a Watershed* activity.

5. Finally, discuss how humans might impact the watershed. Students can draw in some human actions and development on their watershed model (logging, livestock, houses, roads, etc.) and decide what effects they may have on the flow of water. You can discuss how water will flow more quickly in an area with fewer plants or trees (because there is less to stop the water and no roots to soak some of it up). The water will also pick up more sedimentation in these areas, and you can decide as a class where that sediment will eventually settle out of the water by looking at the watershed models. The water may also pick up chemicals and bacteria which pollute the stream.

Next Generation Science Standards

Performance Expectations

4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features.

5-ESS2-1: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
▪ Developing and Using Models ▪ Planning and Carrying Out Investigations ▪ Using Mathematics and Computatational Thinking	▪ ESS2.A: Earth Materials and Systems ▪ ESS2.C: The Roles of Water in Earth's Surface Processes	▪ Cause and Effect: Mechanism and Explanation ▪ Systems and System Models ▪ Stability and Change

1.5 What A Map Tells Us

Watersheds of Whatcom County

Subject

Earth and Space Sciences

Objectives

The students will:

- Use a map to answer questions about Whatcom County's watersheds
- Use a map to observe and understand different scales of watersheds
- Locate their school on the watershed map and recognize how the location of their school fits into the entire watershed system
- Observe how the ocean receives water from many different watersheds

Materials

- Watersheds of Whatcom County, (large maps 3' X 4', available upon request from NSEA or access to map on NSEA's webpage)
- Art supplies—crayons, markers, pencils
- *Students for Salmon Journal*

Size/Setting/Duration

Entire class/classroom/~60 minutes

Background

A watershed is an area of land that drains to a common body of water. Watershed boundaries are not manmade and they do not follow state or international borders. In fact, Whatcom County has multiple watersheds that cross over into Canada. The boundaries of watersheds are dictated by landforms. Water will always travel downhill due to gravity, so watershed boundaries are formed at higher elevation ridges. Watershed boundaries can be drawn around a small creek, or can include multiple creeks as they drain into a larger waterbody. The map provided shows multiple scales of watersheds.

Procedure

With previous watershed activities completed, it will be easier to grasp this activity and how watersheds interconnect.

1. Take the large map of Watersheds of Whatcom County and hang it at the front of your classroom, or pull it up onscreen from NSEA's website. Break students into small groups—what observations can they make about this map? How is it different from other maps they've seen? How is it the same? After a class discussion of their observations, also explain details from

the *Background* section of this lesson.

2. First discuss with your students the major watersheds depicted on the map—they are the four color-coded drainage basins included in the key.
   - The yellow-green area drains to the Nooksack River before flowing into Bellingham Bay.
   - The green area drains to the coast (salt water).
   - The pink area drains to the Fraser River in Canada.
   - The blue area drains to the Samish River and into Skagit County.
   - The pink and blue areas are examples where rain falls in Whatcom County, but drains to waterways elsewhere (Canada and Skagit County), which are examples of watershed boundaries crossing political borders.

3. Have students work through the Watersheds of Whatcom County Map question sheet. This can be done individually (using computers to access the map file from NSEA's website) or in small groups (using hardcopy maps from NSEA).

4. Upon completion of this activity your students will be able to identify their watershed or sub-watershed in relation to other county watersheds and answer specific questions about it.

Next Generation Science Standards

Performance Expectation		
4-ESS2-2: Analyze and interpret data from maps to describe patterns of Earth's features		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Developing and Using Models	▪ ESS2.A: Earth Materials and Systems	▪ Scale, Proportion, and Quantity ▪ Systems and System Models

What a Map Tells Us - *Answer Key*
Watersheds of Whatcom County

1. What are the four major drainage basins in Whatcom County? The Salish Sea, Nooksack River, Fraser River, and the Samish River
2. What is the largest lake on the map? Lake Whatcom
3. What is the biggest river in Whatcom County? Nooksack River
4. Identify three tributaries to the Nooksack River: *This answer can vary*
5. Name the body of water into which the Nooksack River flows: Bellingham Bay
6. How many forks does the Nooksack River have? Three (North, Middle, and South)
7. Starting at the North Fork Nooksack River headwaters, list all seven of the towns that the Nooksack River flows through: Glacier, Maple Falls, Kendall, Deming, Everson, Lynden, and Ferndale
8. Which two streams flow into Washington from Canada? Bertrand Creek and Fishtrap Creek
9. Which stream flows into Canada from Washington? Saar Creek
10. Find your school on the map. What watershed is your school in? *Will depend on school*

What a Map Tells Us

Watersheds of Whatcom County

1. What are the four major drainage basins in Whatcom County?________________

____

2. What is the largest lake on the map? __________________________________

3. What is the biggest river in Whatcom County?

____

4. Identify three tributaries to the Nooksack River:

____

5. Name the body of water into which the Nooksack River flows:

____

6. How many forks does the Nooksack River have? __________________________

7. Starting at the North Fork Nooksack River headwaters, list all of the towns that the Nooksack River flows through: ___________________________________

____

8. Which streams flow into Washington from Canada?

____

9. Which streams flow into Canada from Washington? ______________________

10. Find your school on the map. What watershed is your school in?

____

1.6 Watershed Word Search

R	U	N	O	F	F	A	K	S	T	C	E	S	N	I
H	W	F	I	J	E	H	B	G	R	E	T	A	W	L
P	E	A	G	S	A	T	U	R	A	T	I	O	N	M
N	R	G	T	E	T	O	P	O	G	R	A	P	H	Y
O	A	E	F	E	P	O	C	F	Y	X	G	Q	E	N
I	O	I	C	O	R	Q	P	L	A	N	T	S	V	E
T	C	H	R	I	Z	S	R	A	Z	Y	S	P	A	R
A	M	I	D	A	P	A	H	K	Y	R	U	O	P	O
S	N	S	J	C	P	I	S	E	D	A	W	N	O	S
N	B	T	Z	K	B	I	T	U	D	T	V	O	R	I
E	T	R	E	E	S	L	R	A	T	U	T	M	A	O
D	A	E	L	X	Y	M	T	N	T	B	S	L	T	N
N	H	A	K	R	I	V	E	R	V	I	R	A	I	Q
O	G	M	I	J	W	V	U	O	W	R	O	S	O	P
C	F	E	D	C	Y	C	L	E	C	T	B	N	N	A

- cycle
- erosion
- evaporation
- insects
- lake
- plants
- precipitation
- riparian
- tributary
- watershed
- runoff
- salmon
- saturation
- river
- sea
- stream
- topography
- trees
- water

UNIT 2 - Salmon

Led by Classroom Teacher

What We Know	What We Want to Know

2.1 Salmon Nickname Game

Subject
Life Sciences

Objectives
The students will:

- Learn the common names and nicknames of the five species of Pacific salmon

Materials

- *Salmon Name cards,* laminated (made from following pages)
- Images of Pacific salmon—Chinook, coho, pink, chum, and sockeye (provided, print in color)

Size/Setting/Duration
Entire class working in small groups/classroom/~30 minutes

Background
The salmon common to the Pacific Northwest are known by many different names. One species of salmon can have several names. For example, the Chinook salmon is also known as King, Tyee, or Blackmouth. Some salmon names come from their physical characteristics or habitat requirements while others refer to their spawning season or cultural history.

Common Name	**Nicknames**
Chinook	Silver Bright, Spring, Jack, Summer, Tule, King, Tyee, Blackmouth
Chum	Dog, Calico, keta
Coho	Silver, Hooknose
Pink	Humpy, Humpback
Sockeye	Red, kokanee

Procedure

1. Put a drawing of each species of salmon up on the wall. Distribute various Salmon Name cards among groups of students.

2. Working in groups, have students tape each name below the salmon they believe has that name. Allow enough time for collaboration and discussion. Students should be prepared to defend their reasoning.

3. After each group is finished, introduce each species. Names will probably need to be moved around.

4. Another approach is to have students do some research to determine which names go with which salmon and the meaning behind the nicknames.

Extension

Ask students to draw the Pacific salmon of their choice and write a legend about how that salmon got its name (either common name or nickname).

Next Generation Science Standards

Performance Expectation		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Constructing Explanations and Designing Solutions		▪ Structure and Function

Salmon Nickname Game Set

Chinook

Sockeye

Coho

Chum

Pink

Spring

Silverbrite

Summer

Silver Tyee

King Calico

Blackmouth

Humpy Red

Humpback

Hooknose

Kokanee

Keta Dog

Jack Tule

2.2 Salmon Life Cycle

Subject
Life Science

Objectives
The students will:

- Learn the stages of the salmon life cycle
- Be able to fill in the life cycle diagram correctly

Materials

- *Students for Salmon Journal*
- Art supplies—crayons, markers, pencils

Size/Setting/Duration
Entire class/classroom/~45 minutes

Background
In Whatcom County there are five Pacific salmon species. They are part of a larger *Salmonidae* family (generally referred to as salmonids) that include other salmon and trout species. For this lesson, we will focus on the five Pacific salmon species: Chinook, chum, coho, pink, and sockeye.

The salmon life cycle is similar for all salmonids. However, the length of time spent in freshwater and saltwater varies to some extent for each species. Salmon are **anadromous**; this means that salmon are born in freshwater, spend most of their life in the ocean, and return to freshwater to spawn.

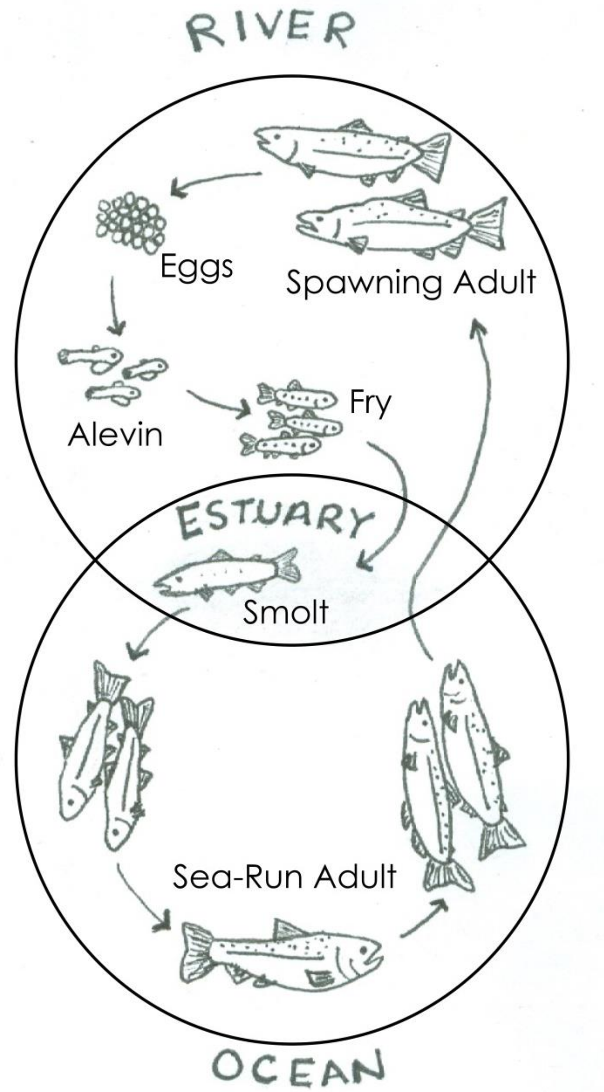
Salmon return from the ocean and enter the stream in the summer or fall to **spawn**. When spawning, the female lays her **eggs** in the streambed and the male fertilizes her eggs with **milt** (sperm). The eggs are laid in the gravel nest, called a **redd**, and hidden from predators and direct sunlight. Each female deposits approximately 3,000 eggs in the gravel. The eggs remain hidden in the streambed for two to four months before they "hatch" into **alevins.** The alevins acquire nutrients from the yolk sacs that are attached to their bodies, growing rapidly in the gravel for one to three months. It is very important during the egg and alevin stages of the salmonids' life cycle to have clean, clear, cold, flowing water and a clean gravel substrate. Clean gravel is imperative; the eggs and alevins will suffocate if there is too much suspended sediment in the stream.

Once the alevins have absorbed their yolk sacs, they surface from the gravel in spring and early summer as **fry**. Fry nourish themselves by feeding on plankton and small insects (**macroinvertebrates**) in the stream. At this stage of life it is important for the fry to have good streamside cover for protection from predators and to keep water temperatures cool. Different species spend differing time in the freshwater streams. Chum and pink salmon migrate to the ocean very soon after emerging from the gravel. Coho and sockeye remain in the stream for at least one year. Chinook are in the stream for three to eighteen months before migrating towards the ocean.

After spending time in fresh water, the juvenile salmon head downstream and undergo changes that allow them to live in saltwater. This process is called **smoltification**. The young salmon, called **smolts** at this stage, acclimate to the saltwater by staying in the **estuary** for one to three months. Here, the smolts feed on zooplankton, insects, shrimp, and small fish in the estuary. Once the adjustment from fresh water to saltwater is complete the smolts move into the open ocean. Ocean life for salmonids lasts one to seven years, depending on the species. During this stage of life, the **sea-run adults** grow large and feed on zooplankton (tiny animals), insects, and small fish such as herring.

When they're fully mature and strong (2-5 years depending on species), the Pacific salmon migrate from the ocean back to their natal stream (the stream where they were born) using their sense of smell. Once they've returned to the freshwater streams, we call them **spawning adults**, they swim upstream to reproduce, and the cycle begins again. Salmon usually spawn within 100 yards of the redd that they hatched from.

After the salmon have spawned, they die. Their bodies decompose and give nutrients to the animals and plants along the stream. These nutrients are very important to the health of the riparian zone, as well as the animals that eat dead salmon (macroinvertebrates, bears, eagles, bacteria, etc.).



Procedure

1. Continue your lecture by starting to demonstrate the salmon life cycle with spawning salmon and carry on with eggs, alevin, fry, smolt, and ocean-phase salmon. Have your students take notes. It would be helpful to demonstrate the salmon life cycle on the board along with your students.

2. Once you bring your lecture to a close, and the students have completed their notes on the salmon life cycle, the students should fill out the *Salmon Life Cycle Chart* from the *Student Journal*. Under the circle labelled "Drawing," include a drawing of the lifecycle stage (students could also add some of the habitat elements related to that stage, such as gravel, LWD, hiding places, etc.).

Extensions

Additional exercises to enhance student understanding of the salmon life cycle could include artwork, such as dioramas, posters, paintings, puppets, skits, and stories.

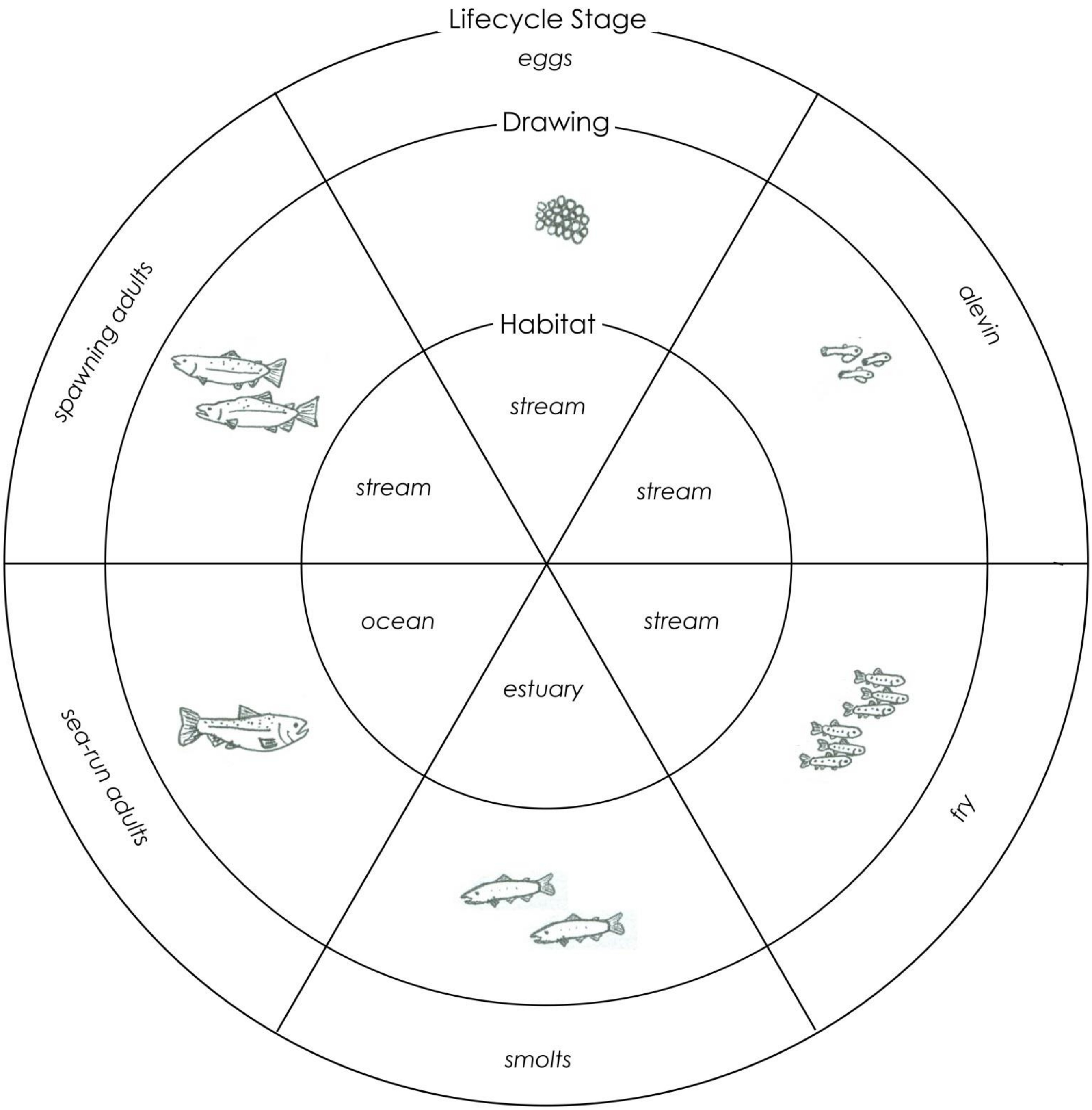
Create a salmon life cycle book. Describe each of the six stages of the salmon life cycle using one page for each stage. Include a drawing or picture for each (egg, alevin, fry, smolt, sea-run adult, spawning adult).

Create a song or a dance to explain or represent the salmon life cycle.

Next Generation Science Standards

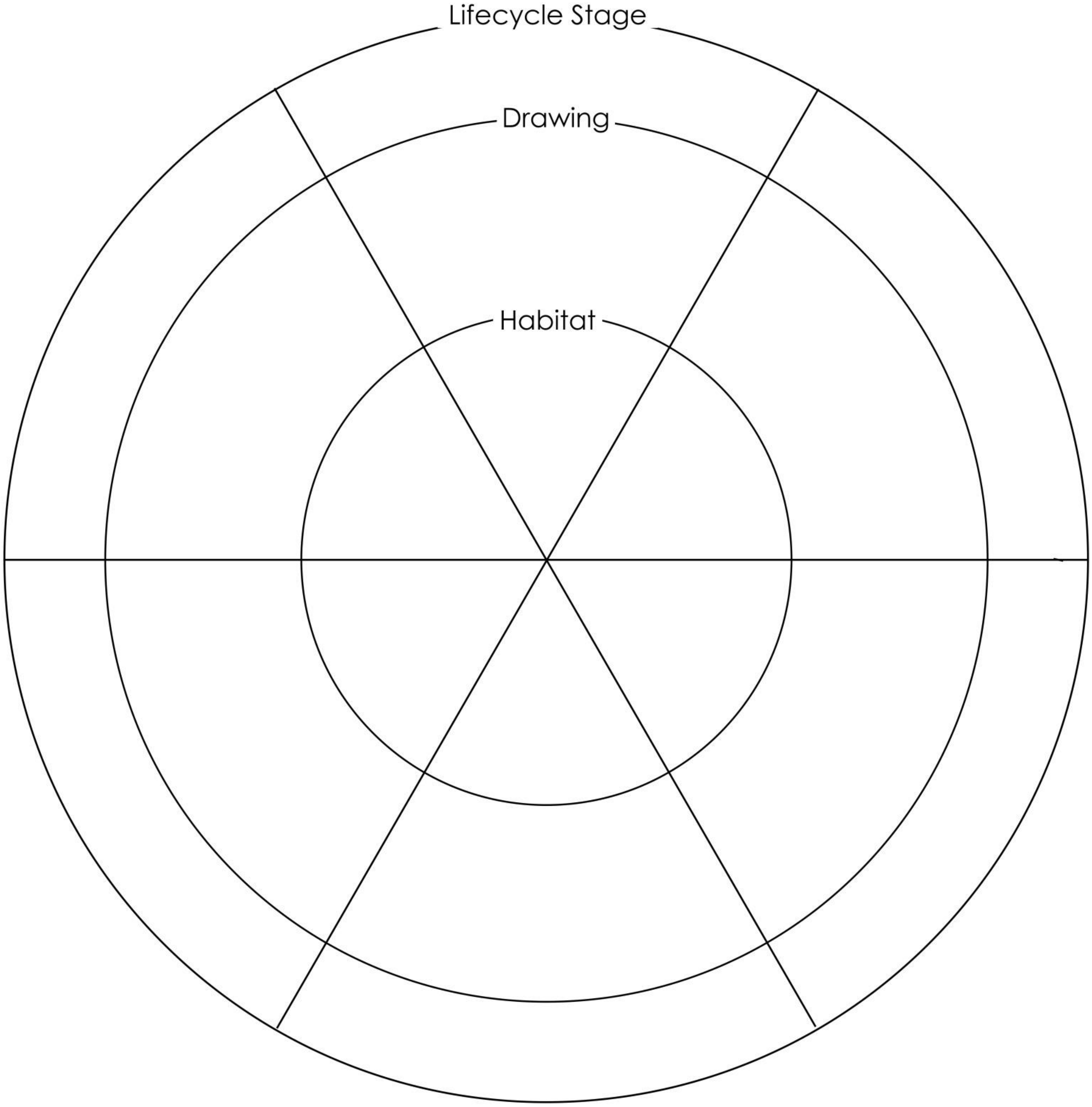
Performance Expectation		
3-LS1-1: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Developing and Using Models	▪ LS1.B: Growth and Development of Organisms	▪ Patterns

Salmon Life Cycle Diagram - *Answer Key*



Salmon Life Cycle Notes

Salmon Life Cycle Diagram



2.3 Local Pacific Salmon Species

Subject

Life Science

Objectives

The students will:

- Know names and facts about the five Pacific salmon species
- Complete the *Pacific Salmon Species of Whatcom County* chart

Materials

- *Students for Salmon Journal* (print this section in color)
- Art Supplies—crayons, markers, pencils

Size/Setting/Duration

Whole class/classroom/~60 minutes

Background

After understanding the salmon's anadromous life cycle, students are ready to learn about the differences between the five local Pacific salmon species. In addition to appearance, the five species have slightly different habitat requirements, including the season for spawning and the duration of time spent in fresh water and saltwater. There are many other species found locally that also belong to the family *Salmonidae* (*also known as salmonids*). We focus on Pacific salmon because they are considered the most culturally, ecologically, recreationally, and commercially important. Two other anadromous salmonids are the sea-run cutthroat trout and steelhead, a type of rainbow trout. These trout, unlike the Pacific salmon, do not die after spawning, and may spawn again multiple times.

Procedure

1. There are several pages of information on salmon included in the teacher handbook as well as the *Students for Salmon Journal*—Salmon Facts (general information about Pacific salmon) and a fact sheet for each of the five Pacific salmon (Chinook, coho, chum, sockeye, and pink). Students should read these to familiarize themselves with the Pacific salmon found in Whatcom County.

2. Once the salmon fact sheets have been read, have your students complete the *Five Pacific Salmon Species of Whatcom County* chart. This chart addresses the scientific and common name, weight, length, and interesting facts about each species. All information to fill out the chart can be found on the different fact sheets.

Next Generation Science Standards

Performance Expectation		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Asking Questions and Defining Problems	▪ LS1.A: Structure and Function	

Five Salmon Species of Whatcom County - *Answer Key*

Species Name (Common and *Scientific*)	**Weight**	**Length**	**Interesting Fact**
Chinook *Oncorhynchus tshawytscha*	10-24 lbs.	36-58 inches	*Answers for this column will depend on students.*
chum *Oncorhynchus keta*	9-15 lbs.	25-40 inches	
coho *Oncorhynchus kisutch*	6-12 lbs.	24-38 inches	
pink *Oncorhynchus gorbuscha*	2-5 lbs.	20-30 inches	
sockeye *Oncorhynchus nerka*	4-8 lbs.	25-33 inches	

Pacific Salmon Facts

How big is the biggest salmon? The smallest?
The largest salmon is a Chinook, which can grow to be 58 inches (147.3 cm) long and 100 pounds (45.5kg). The smallest salmon is the pink (3-5 pounds).

How fast can salmon swim?
A migrating sockeye salmon can swim for long periods at an estimated speed of one body length per second. For a 24 inch fish, the speed is 1.4 miles per hour. For short distances of burst swimming, the speed can be five or more body lengths per second, or at least 7.0 miles per hour. When swimming against a strong current in a river, the swimming speed can be less.

How high can a salmon leap?
Chinook, coho, and sockeye can jump as high as eight feet. Chum and pink salmon usually jump no more than three feet.

What predators eat salmon?
<u>Juvenile salmon:</u> larger trout, salmon, sculpins, squawfish, crows, northern pikeminnow, mergansers, osprey, kingfishers, terns, gulls, and other birds.
<u>Adult salmon:</u> eagles, gulls, seals, whales, halibut, dolphins, porpoises, wolves, and people.

Why do salmon turn different colors when they spawn?
Salmon lose their silvery color when leaving the ocean. The silver scales are absorbed and other skin pigments appear. Scientists think that spawning colors help salmon find members of their own species to mate with.

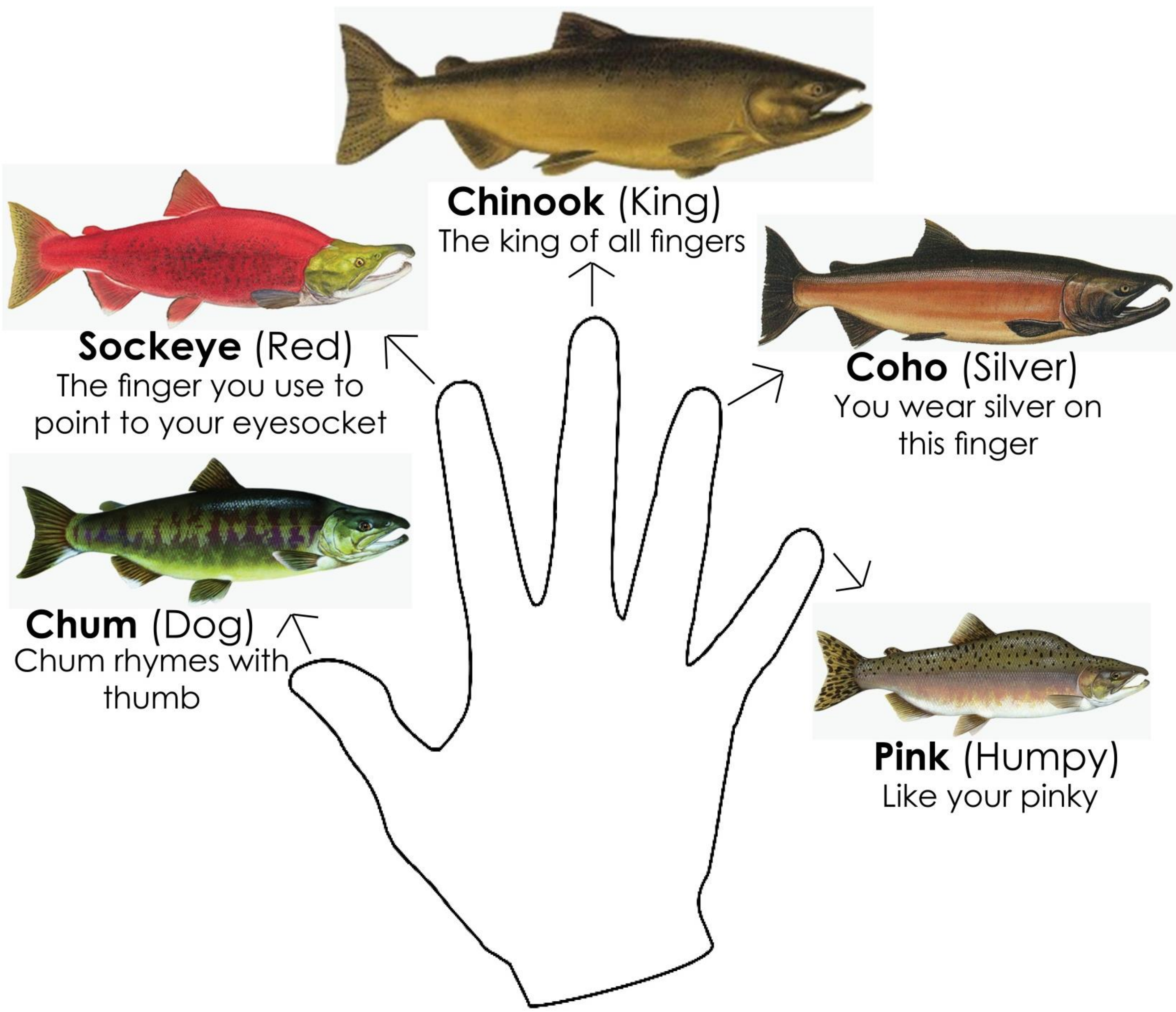
How does a salmon find its home stream?
Fisheries scientists believe that salmon navigate at sea with an inner magnetic compass. They can also sense day length, which lets them know when the seasons are turning as the length of day changes. As a migrating salmon approaches its home stream, its sense of smell comes into play and it follows the familiar smell of the stream it lived in as a juvenile. This migration back to

their home stream is a result of "home stream imprinting" that occurred as the juvenile salmon migrated to the ocean.

Salmon are anadromous fish. What is an anadromous fish?
Anadromous means that a fish spends part of its life cycle as a juvenile in fresh water where it was hatched, then migrates to the ocean to become an adult over a period of many months or years, and then returns to the fresh water to spawn and produce offspring.

Five Pacific Salmon Species in Whatcom County

Helpful hints to remember our Pacific salmon!



Chinook

Also known as: Blackmouth, King, Spring, Tyee
Scientific Name: *Oncorhynchus tshawytscha*
Average Weight: 10-24 lbs (4.5-10.9 kg)
Length at Maturity: 36-58 inches (91.4-147.32 cm
Status in Nooksack Watershed: Threatened

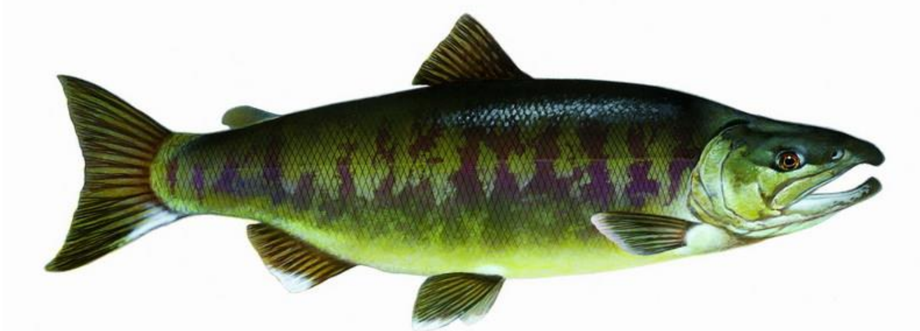
Chinook Life Cycle:

- There are two different types of Chinook in Whatcom County—Spring Chinook and Fall Chinook.
- Spring Chinook migrate upstream from April to July and spawn early August to September. Fall Chinook salmon spawn October to November.
- Spring Chinook spawn in the three forks (South, North, and Middle) of the Nooksack River and in a few larger tributaries (such as Canyon Creek).
- Fall Chinook spawn in the Nooksack's upper main stem, the North Fork, and larger tributaries (such as Bertrand Creek and Fishtrap Creek). They also spawn in Whatcom Creek.
- Chinook may be three to five years of age at the time of spawning.
- Juvenile spring Chinook migrate to the estuary after several months in fresh water (they are known as 'ocean type' Chinook) or after one year in fresh water ('they are known as 'stream type' Chinook). Fall Chinook are usually the ocean type, migrating to the ocean after several months.

Habitat Needs:

Chinook are most often found in rivers and occasionally in larger creeks. Spawning usually occurs in fast water side channels and main stem areas with fist-sized gravel.

Chum



Also known as: Dog, Keta, Calico, Silverbrite

Scientific Name: *Oncorhynchus keta*

Average Weight: 9-15 lbs, up to 40 lbs (4.1-6.8 kg, up to 18.1 kg)

Length at Maturity: 25-40 inches (63.5-101.6 cm)

Interesting Fact: Whatcom Creek in Maritime Heritage park is home to one of the largest recreational fisheries for chum in Washington State.

Status in Nooksack Watershed: Not warranted

Chum Life Cycle:

- Chum migrate and spawn in the mainstem, forks, and tributaries of the Nooksack River and in Chuckanut, Padden, Squalicum, and Whatcom Creeks between November and January.
- Chum may be three to five years of age at spawning
- The carcasses of chum are an especially important food source for bald eagles and this can be observed at sites along the Nooksack's north fork.
- Chum rear in the freshwater for up to one month and then migrate to estuaries.

Habitat Needs:

Chum can often be found spawning where groundwater upwells through the spawning gravel. Upon entering the estuary, juveniles prefer tidal sloughs and small estuaries associated with the nearshore.

Coho

Also known as: Silver
Scientific Name: *Oncorhynchus kisutch*
Average Weight: 6-12 lbs, up to 31 lbs (2.7-5.4 kg, up to 14.1 kg)
Length at Maturity: 24-38 inches (61.0-96.5 cm)
Status in Nooksack Watershed: Not warranted

Coho Life Cycle:

- Coho migrate back to freshwater to spawn between October and January in the Nooksack River and its tributaries. Coho also spawn in the Dakota and California Creek watersheds, and in Terrell, Squalicum, and Whatcom Creeks.
- Juvenile coho usually spend at least one year in freshwater before migrating to the ocean. They usually spend two years in the ocean and return to spawn at the age of three years.

Habitat Needs:

Spawning coho are often found in small, lowland creeks not used by other salmon.

Pink

Also known as: Humpy, Humpback
Scientific Name: *Oncorhynchus gorbuscha*
Average Weight: 2-5 lbs, up to 12 lbs (1.0-2.3 kg, up to 5.4 kg)
Length at Maturity: 20-30 inches (50.8-76.2 cm)
Status in Nooksack Watershed: Not warranted

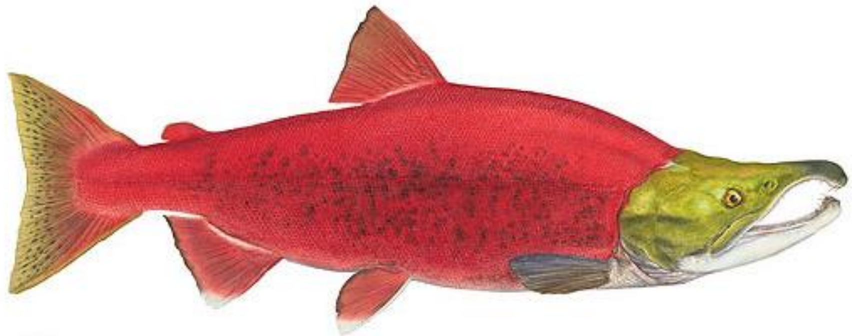
Pink Life Cycle:

- Pink spawn from August to September. At the time of spawning, pink are two years of age. Due to their short time spent in the ocean, pink are the smallest adult Pacific salmon. In the Nooksack, there are primarily odd year pink, meaning they will spawn every odd year (example: 2013, 2015, etc.), however there is a small population of even year pink (example: 2012, 2014, etc.).
- Pink salmon spawn in the Nooksack River and the larger tributaries of the Nooksack.
- After a few weeks, juveniles migrate from freshwater to the estuary. This means that of all five species of Pacific salmon, juvenile pink (as well as chum) are the least dependent on freshwater environments.
- In the summer, it is common to see schools of juvenile pink and chum salmon along the nearshore (area of the bay that is close to shore).

Habitat Needs:

Pink salmon often spawn closer to the sea than other species; sometimes they even spawn in the salty nearshore or in estuaries.

Sockeye



Also known as: Red, Blueback
Scientific Name: *Oncorhynchus nerka*
Average Weight: 4-8 lbs, up to 15 lbs (1.8-3.6 kg, up to 6.8 kg)
Length at Maturity: 25-33 inches (63.5-83.8 cm)
Status in Nooksack Watershed: Not warranted

Sockeye Life Cycle:

- Most sockeye spawn in the tributaries of a lake or along the lake shore at four years of age.
- The juveniles soon move from the tributary into the lake, where they spend one to two years before migrating to the ocean.
- There is no lake connected to the Nooksack River, however sockeye spawn in the North Fork of the Nooksack River.
- There are some sockeye, called kokanee, that stay in freshwater their entire lives instead of migrating to the ocean. Kokanee are present in Lake Whatcom, Lake Padden and Lake Samish.

Habitat Needs:

Most sockeye require the presence of a lake in their watershed. Sockeye have adapted to use lakes during the fry stage of their life cycle. However, sockeye in the Nooksack River have learned to survive without the need for a lake!

Five Salmon Species of Whatcom County

Species Name (Common and Scientific)	**Weight**	**Length**	**Interesting Fact**

2.4 Key It Out!

Subject
Life Science

Objectives
The students will:

- Become familiar with the five Pacific salmon species
- Use a dichotomous key to identify the five species

Materials

- *Students for Salmon Journal*
- Pencil
- Five Pacific salmon identification pages (provided), printed in color and laminated

Size/Setting/Duration
Whole class/classroom/~60 minutes

Background
After distinguishing between the five local salmon species, students are ready to identify the species by appearance. In addition to the differences in habitat requirements, spawning characteristics, and size, each species have distinguishing physical characteristics. This activity is designed to engage students in a sensory exploration of these species.

Procedure

1. Each student should have a copy of the Salmon Identification Key in their *Students for Salmon Journal*.

2. Position the five Pacific salmon identification sheets around the room as stations for the students to visit.

3. Explain to the class that they will use the identification key to discover the identity of the fish at each station. At each station, students will use the color pictures and clues given to answer the questions on the key. Once they have followed the questions and answered them correctly they will know the names of each fish.

4. Tell each student to start at question one for each station. Each question has two answers and only one will be true. Students will determine which answer is true and follow that question to the step indicated. They will repeat the process until they come to the name of the salmon

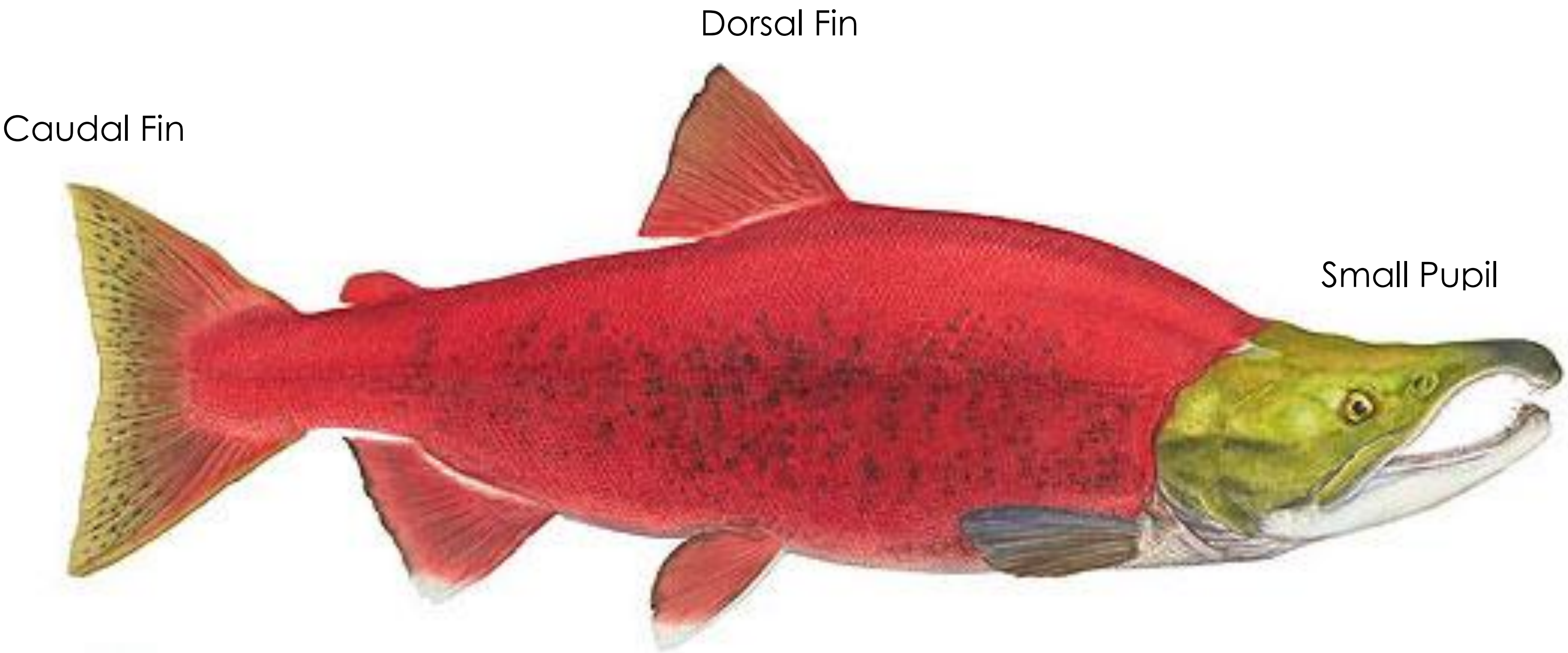
they are identifying.

5. Students should move to each station and identify all five of the species provided. When students find the name of the fish at each station they should write down the station number next to the name on the key so you can check their work.

Next Generation Science Standards

Performance Expectation		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Constructing Explanations and Designing Solutions	▪ LS3.B: Variation of Traits	▪ Structure and Function

Station #1

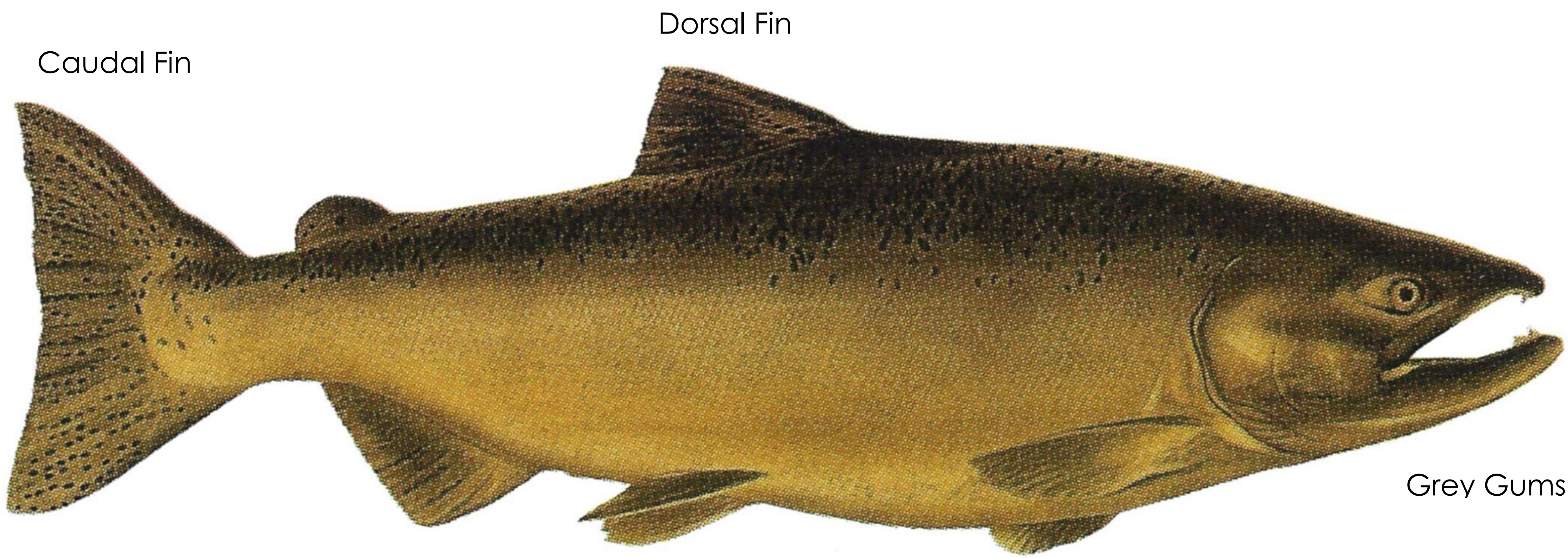


Red body when spawning

Average weight: 4-8 lbs

Average length: 25-33 inches

Station #2



Largest of all local Pacific salmon

Average weight: 10-24 lbs

Average length: 36-58 inches

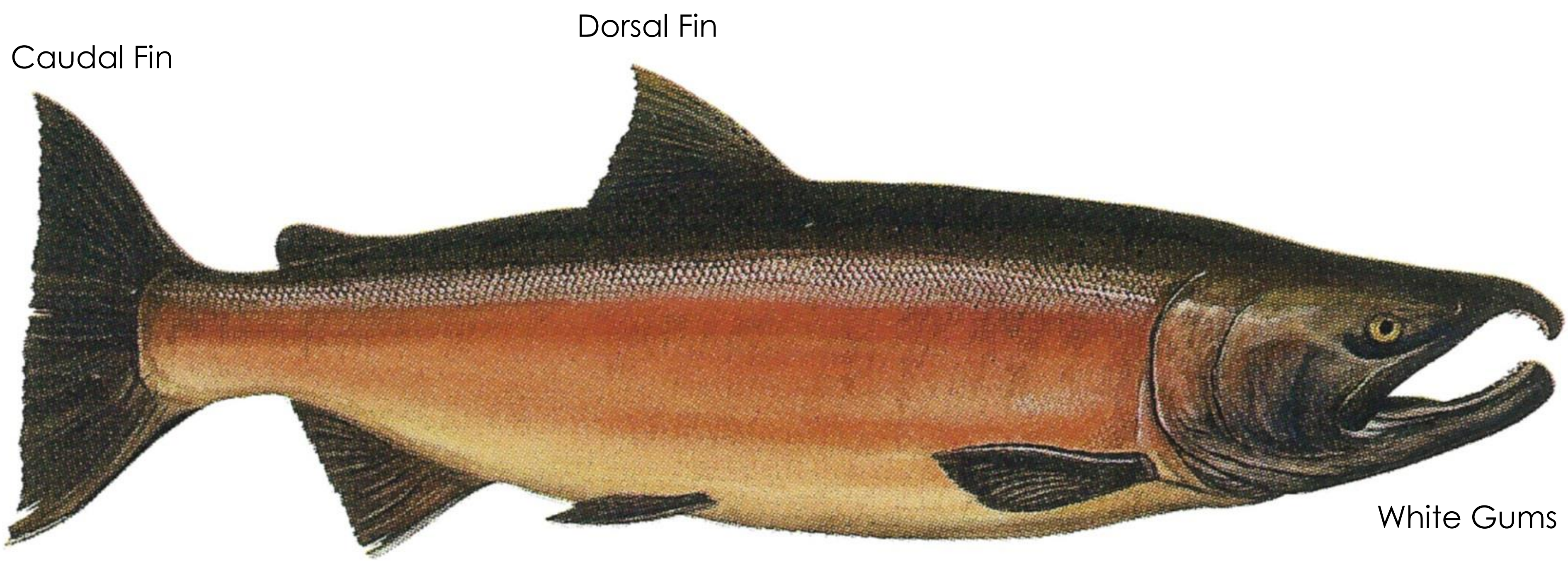
Station #3

Red or purple vertical bars on body when spawning

Average weight: 9-15 lbs

Average length: 25-40 inches

Station #4



Average weight: 6-12 lbs

Average length: 24-38 inches

Station #5

Develops large hump when spawning

Average weight: 2-5 lbs

Average length: 20-30 inches

Identify Five Local Pacific Salmon Species

Use this key and the pictures at each station to identify the different local salmon species that you have learned about.

Instructions:

1. Start at question 1.
2. Read the question, then look at the picture and read the clues on the station card.
3. Answer the question and follow the directions for the next step.
4. Go to the next step.
5. Repeat the process until you identify the fish

Question 1: Does salmon have spots on dorsal and caudal fins?

1a. Yes, salmon has spots on dorsal and caudal fin. **Go to 2**

OR

1b. No, salmon does not have spots on dorsal or caudal fin. **Go to 4**

Question 2: Does salmon have spots on entire caudal fin?

2a. Yes, salmon has spots on entire caudal fin. **Go to 3**

OR

2b. No, salmon has spots only on top half of caudal fin. Has white gums.

Station # ________, Coho Salmon (*Oncorhynchus kisutch)*

Question 3: Is salmon large or small in size?

3a. Largest Pacific salmon species (10-24 lbs, 36-58 in). Has grey gums.

Station # ________, Chinook Salmon (*Oncorhynchus tshawytscha)*

OR

3b. Smallest Pacific salmon species (2-5 lbs, 20-30 in). Develops a large hump when spawning.

Station # ________, Pink Salmon (*Oncorhynchus gorbuscha)*

Question 4: Does salmon have large or small pupils?

4a. Salmon has small pupil and develops bright red bodies when spawning.

Station # ________, Sockeye Salmon (*Oncorhynchus nerka)*

OR

4b. Salmon has large pupil and develops red or purple vertical bars on body when spawning.

Station # ________, Chum Salmon (*Oncorhynchus keta)*

2.5 Hooks and Ladders

Adapted from Project Wild Aquatic, by the Council for Environmental Education, 2005

Subject

Life Science

Objectives

The students will be able to:

- Identify the stages of the salmon life cycle
- Recognize salmon migrate as part of their life cycle
- Describe limiting factors affecting Pacific salmon as they complete their life cycle

Materials

- Jump rope (10-15 feet long)
- Flagging (about 500 feet for playing area boundaries, optional)
- Traffic Cones
- Cardboard boxes or heavy-duty plastic bins (2)
- Tokens or poker chips (100)
- Large playing area (about 100 feet x 50 feet)

Size/Setting/Duration

Whole class/play field or gymnasium/~45 minutes

Background

Many fish live part of their lives in one habitat and then migrate to another habitat. Pacific salmon are an example of one of the most spectacular of the migrating species, traveling from fresh water to the ocean and back again (800-1500 miles) to reproduce.

Pacific salmon are destined to spawn only once in their lifetime. Within their genetic fiber is an encoded instinct that drives them along a monumental journey from their freshwater spawning beds downstream to the ocean. Once in the marine environment, they spend several years reaching the maturity needed for the return journey to their original hatching ground. Once there, the salmon spawn and die.

Salmon must face a myriad of hazards that serve as limiting factors in the completion of their life cycle. Limiting factors determine the population size of living organisms. Sometimes the limiting factors are natural and sometimes they result from human impacts to natural systems.

The female Pacific salmon deposits 1,500 to 7,000 eggs. The eggs are deposited in a shallow gravel depression scooped out by the female called a redd. Once deposited, the male fertilizes the eggs and then both fish nudge the gravel back over the eggs to offer as much protection as possible.

Within a few days both the female and male salmon have completed their reproduction and soon die.

The **eggs**, before and after hatching, are susceptible to many limiting factors. Smothering silt can be washed in suddenly from watersheds damaged by a variety of land-use practices and events – including erosion following some road building, logging, and fires. Predators can eat some of the eggs and damage hatching populations. Dropping water levels can isolate salmon offspring in streamside depressions, sometimes resulting in starvation and death. After hatching, the small fish – called **alevins** – spend their first two weeks hiding in the gravel. Gradually they absorb their yolk sac and become known as **fry**. If they survive the first two weeks, then they begin their journeys.

Depending on the species, young salmon may swim directly to the ocean or spend several months to a year or more in the river before migrating to the estuary and then to the open ocean.

The small ocean-bound salmon, now called **smolts**, are immediately confronted by hazards on their downstream journey. Examples are dams, low water in streams, and predators—birds, mammals, and larger fish. Up to 90% of the salmon that hatch never reach the sea.

When in the ocean, the salmon grow rapidly by feeding on the ocean's rich food supply. Predators such as sharks, killer whales, and other marine mammals take their toll. In addition, humans fish for salmon commercially and for personal reasons, including food, recreation, and cultural purposes.

In two to five years, the Pacific salmon start the journey that will guide them back to the rivers and streams leading to their own hatching site. The upstream migration from the ocean is also a series of hazards. For example, dams hinder their journey and would block it completely if fish ladders were not installed. Fish ladders are water-filled staircases that allow the migrating fish to swim upstream and around the dam. Humans who fish, bears, and other predatory animals also reduce the numbers along the way to the spawning ground. Sometimes landslides and logjams provide unexpected new barriers. Additionally, salmon must also overcome the natural waterfalls and rapids. Once back at the spawning grounds the life cycle of the Pacific salmon begins anew. To maintain the Pacific salmon population, some biologists believe that only one pair of fish must return to deposit and fertilize the eggs.

All possible conditions are not covered by the design of this activity. However, the activity does serve simply and effectively to illustrate three important concepts – life cycle, migration, and limiting factors.

The major purpose of this activity is for students to gain an understanding of some of the complex characteristics of the life cycle of one representative aquatic species, the Pacific salmon.

Procedure

1. Begin by asking the students what they know about the life cycle of fish that live in their area. Do any local fish migrate to spawn? If yes, which ones? (Mullet, shad, lake trout, striped bass, suckers, carp, and salmon are examples of fish that migrate to spawn.) In this activity, students will learn about some of the characteristics of one species of fish that migrates as a part of its

life cycle – the Pacific salmon.

2. This is a physically involving activity! Set up a playing field as shown in the diagram on the following page, including spawning grounds, downstream, upstream, and ocean (if space is limited, the same stretch of playing area can be both the downstream and upstream channels). The area must be about 100 feet by 50 feet. Assign roles to each of the students. Some will be salmon; others will be potential hazards to the salmon. Assign the students roles as follows:
   - Choose two students to be the turbine team. These students will operate the jump rope, which represents the turbines in hydroelectric dams. Later in the simulation, when all the salmon have passed the turbine going downstream, these students move to the upstream side to become the waterfall-broad jump monitors.
   - Choose two students to be predatory wildlife. At the start of the simulation the predators will be below the turbines where they catch salmon headed downstream. Later in the activity when all the salmon are in the sea, these same two predators will patrol the area above the "broad jump" waterfalls. There they will feed on salmon just before they enter the spawning ground.
   - Choose two students to be human fishing boats catching salmon in the open ocean. These students in the fishing boats must keep one foot in a cardboard box to reduce their speed and maneuverability.
   - All remaining students are salmon.

NOTE: these figures are based on a class size of 25 – 30. If the group is larger or smaller, adjust the number of people who are fishing and predatory wild animals accordingly.

3. Begin the activity with all the salmon in the spawning ground. The salmon then start their journey downstream. The first major hazard is the turbines at the dam. At most dams there are escape weirs to guide migrating salmon past the turbines. The student salmon cannot go around the jump rope swingers, but they can slip under the swingers' arms if they do not get touched while doing so. A salmon dies if the turbine (jump rope) hits it. The turbine operators may change the speed at which they swing the jump rope. NOTE: Any salmon that "dies" at any time in this activity must immediately become part of the human-made ladders now used by migrating salmon to get past the barriers such as dams. The students who are the fish ladder kneel on the ground on their hands and knees with a body-wide space between them.

4. Once past the turbines, the salmon must get past some predatory wildlife. The predators below the turbine must catch the salmon with both hands – tagging isn't enough. Dead salmon are escorted by the predator to become part of the fish ladder. NOTE: Later the salmon that survive life in the open ocean will use the structure of the fish ladder -- by passing through it – to return to the spawning ground. NOTE: Both the predators in the last downstream area and the people fishing in the open ocean must take dead salmon to the fish ladder site. This gets the predators and the fishing boats off the field regularly, helping to provide a more realistic survival ratio.

5. Once in the open ocean, fishing boats can catch the salmon. The salmon must move back and forth across the ocean area in order to gather four tokens. Once each fish has four tokens (four years' growth), that fish can begin migration upstream. The tokens can only be picked up one token at a time on each crossing. Remember that the salmon must cross the entire open ocean area to get a token. The "four years" these trips take make the salmon more vulnerable and thus the fishing boats more readily catch them. For purposes of this simulation, the impact of this limiting factor creates a more realistic survival ration in the population before the salmon begin the return migration upstream.

6. Once four of the year tokens are gathered, the salmon can begin upstream. The salmon must walk through the entire pattern of the fish ladder. This enforced trip through the fish ladder gives the students a hint of how restricting and tedious the upstream journey can be. *In the fish ladder, predators may not harm the salmon.*

7. Once through the ladder, the salmon faces the broad jump waterfall. The waterfall represents one of the natural barriers the salmon must face going upstream. Be sure the jumping distance is challenging but realistic. The two former turbine students will monitor the jump. The salmon must jump the entire breadth of the waterfall to be able to continue. If the salmon fails to make the jump, then it must return to the bottom of the fish ladder and come through again.

8. Above the falls, the two predators who started the simulation as the predators below the turbines are now the last set of limiting factors faced by the salmon. They represent bears – one example of predatory wildlife. Again, remember that the predators must catch the salmon with both hands. If they do catch a salmon, they must then take the student they caught to become part of the fish ladder.

9. The activity ends when all the salmon are gone before the spawning ground is reached – or when all surviving salmon reach the spawning ground.

10. Next engage the students in a discussion. Explore such topics as:
    - The apparent survival-mortality ratio of salmon
    - The students' feelings throughout the activity
    - The role of the barriers
    - The role of the predatory wildlife and the people fishing
    - Where the losses were the greatest
    - Where the losses were least
    - What the consequences would be if all the eggs deposited made the journey successfully
    - What seemed realistic about this simulation and what did not

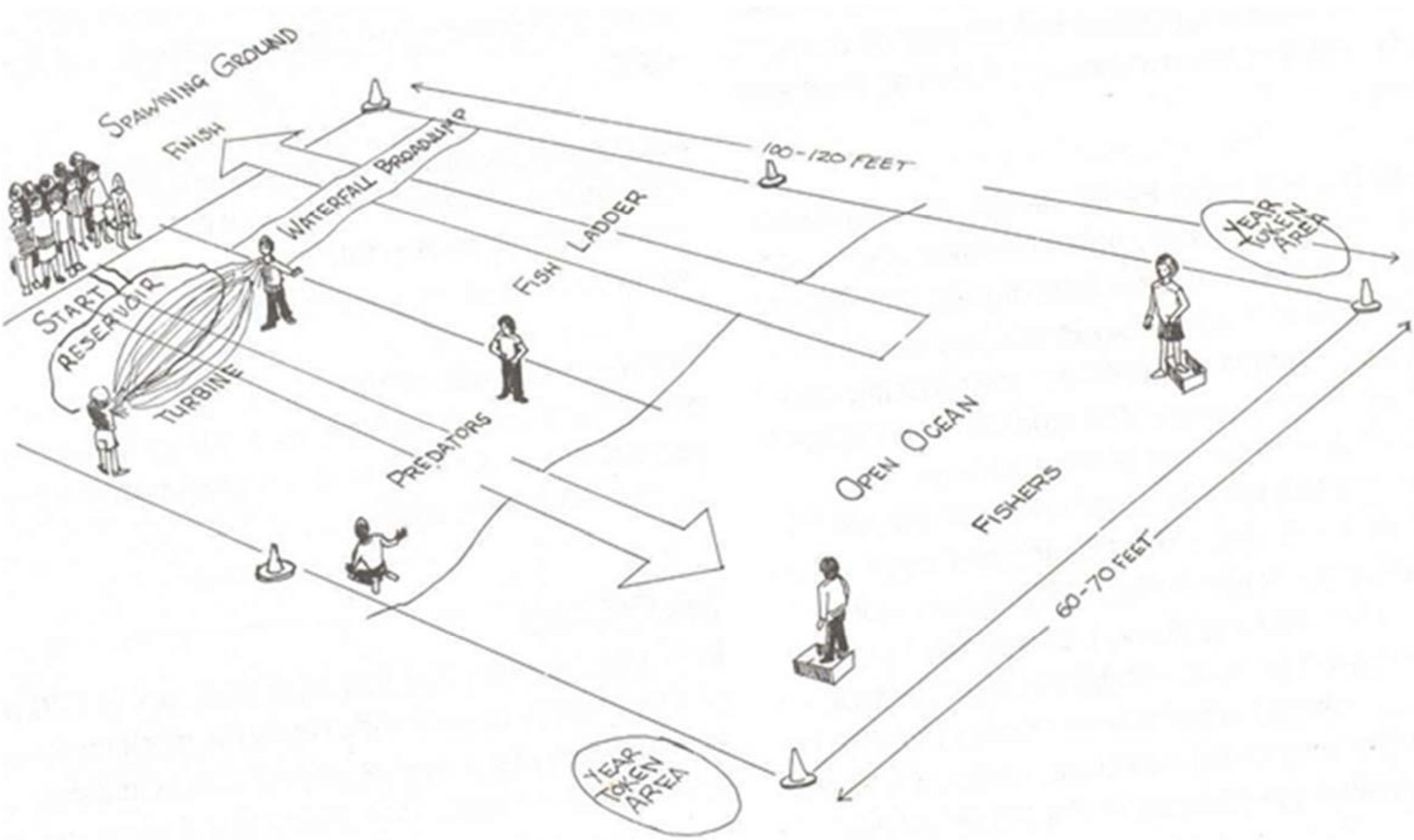
11. Ask the students to summarize what they have learned about the life cycle of salmon, the salmon's migration, and limiting factors that affect salmon. Make sure the students have a clear working definition of limiting factors. Encourage the students to make the generalization

that all animals – not just the Pacific salmon – are affected by limiting factors. Ask the students to give examples. They might mention availability of suitable food, water, shelter, and space; disease; weather; predation; and changes in land use as well as other human activities.

Suggestions from Experience

- Allow at least fifteen minutes for set-up.
- Start with all the students in a classroom or some other contained space with limited distractions. Using the chalkboard, draw a simple diagram of the playing field and describe the activity.
- Have aides or parents participate in "crowd control" and monitoring.
- Try to play two rounds of the activity. During the first, limit the barriers and limiting factors to those found in nature only (predators, waterfalls, etc). In the second round, add in human limiting factors (turbines, fishing boats, fish ladders, etc).
- At least during the first round of play, have all the salmon stop and wait after passing each hazard stretch. This way the salmon get a chance to regroup and contemplate the next barrier.

Play Area Diagram



Next Generation Science Standards

Performance Expectation		
3-LS1-1: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Developing and Using Models	▪ LS1.B: Growth and Development of Organisms	▪ Patterns ▪ Systems and System Models

UNIT 3 - Salmon Habitat

Led by Classroom Teacher

What We Know	What We Want to Know

3.1 The ABC's of the Riparian Ecosystem

Subject

Life Science

Objectives

The students will:

- Understand the meaning and components of a riparian ecosystem, including abiotic, biotic, and cultural elements

Materials

- *Students for Salmon Journal*
- Riparian cards (laminate for reuse)
- Tape, for hanging cards
- Open white board space

Size/Setting/Duration

Entire class/classroom/~45 minutes

Background

The **riparian zone** is a term used to define the area that borders either side of a stream and the stream itself. It includes all of the abiotic, biotic, and cultural elements in this area. **Biotic** elements include any living or once-living things: plants, trees, decomposers, insects, birds, leaf litter, dead trees, and animals. **Abiotic** elements are any nonliving substances including soil, rocks, air, and water. All of these things together make up a healthy ecosystem. If any one component were missing, all other parts of the ecosystem would be affected. A healthy riparian ecosystem is very important in providing habitat for wildlife by supplying food, water, and shelter.

The riparian ecosystem has many functions. A riparian area is essential for flood control. Well-vegetated stream banks provide bank stabilization, thereby reducing bank erosion and the associated increase of suspended sediments in the stream. Riparian vegetation also intercepts rain, yielding an increase in groundwater/aquifer recharge. Aquifer recharge is very important to year-round stream flow.

Humans have altered natural riparian ecosystems by adding cultural elements. Cultural elements include anything made or added to an environment by humans: houses, roads, telephone poles, bridges, etc. It is important to understand that all cultural elements were created from biotic or abiotic elements found in natural ecosystems. Cultural elements may compete with the natural environment. For example, culverts under roads can block fish passage. Cultural elements can also put the natural environment at risk when too much of a biotic/abiotic element is used by humans; such as the clear-cutting of a forest for paper and building materials.

Procedure

1. Ask your students what they think a riparian ecosystem is. Write their ideas off to one side of the board. Once some ideas have been suggested, provide the students with the definition of the ecosystem. Stress that the riparian ecosystem includes not just the trees and plants that border the stream, but the stream itself and all the living and nonliving things in that area. Tell them about the important functions of a healthy riparian ecosystem.

2. Now that a definition has been established, split the class up into groups of about five. Draw three columns on the other side of the board—one for Abiotic, Biotic, and Cultural then distribute the Riparian Cards evenly between the groups. Students will work in their small teams to identify if their card is an Abiotic, Biotic, or Cultural element, and then tape the card under the category of their choosing.

3. Once everyone has their cards on the board, ask students to take a moment to read the columns. Are there any that they disagree with? Facilitate a discussion with your students around the placement of the cards—how did they decide where to put them? Were there any they were unsure about or found challenging? Should any of these cards be rearranged? Are any key ecosystem elements missing?

4. After all the items have been correctly placed, let the class fill out *The ABC's of The Riparian Ecosystem* table from their journals.

Extension

Use the cards from this activity to create a game. Remove cards from the board and have students remain in their small group. Hold up one Riparian Card at a time and choose the team that raises their hand first. Have the student say which category it belongs under (abiotic, biotic, or cultural). If they are right, they get a point. If not, the next team gets an opportunity to guess. Place the card back up on the board under the correct column.

Next Generation Science Standards

Performance Expectation		
3-LS4-3: Construct an argument that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Constucting Explanations and Designing Solutions ▪ Engaging in Argument from Evidence	▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience	▪ Systems and System Models

Air (oxygen)	Minerals
Gravel	Sun
Pools	Water
Riffles	Soil

Rocks	Plants
Birds	Trees
Fish	Insects
Mammals	Amphibians

Reptiles	Worms
Mushrooms & Fungi	Algae
Dams	Pets
Ditches	Litter

Roads	Buildings
Houses	Oil
Pesticides	Culverts
Fences	Bridges

Farms	People
Rain	Mud
LWD	

The ABC's of the Riparian Ecosystem - *Answer Key*

A = Abiotic	B = Biotic	C = Cultural
This means the nonliving parts of the ecosystem, including:	*This means the living parts of the ecosystem, including:*	*This means human uses of the stream and land surrounding the stream, including:*
Air (oxygen)	Algae	Bridges
Gravel	Amphibians	Buildings
Mud	Birds	Culverts
LWD	Fish	Dams
Minerals	Insects	Ditches
Pools	Mammals	Farms
Rain	Mushrooms & Fungi	Fences
Riffles	People	Houses
Rocks	Plants	Litter
Soil	Reptiles	Oil
Sun	Trees	Pesticides
Water	Worms	Pets

The ABC's of the Riparian Ecosystem

Take the cards given to you by your teacher. Read the words on the card and decide which category it falls in: abiotic, biotic, or cultural. Go to the front of the class and place your card under the correct category.

A = Abiotic	B = Biotic	C = Cultural
This means the nonliving parts of the ecosystem, including:	*This means the living parts of the ecosystem, including:*	*This means human uses of the stream and land surrounding the stream, including:*

3.2 Riparian Restoration

Subject

Earth and Space Sciences
Life Science

Objectives

The students will:

- Be able to label the Riparian Ecosystem diagrams with the correct features of a natural, disturbed, and restored riparian ecosystem

Materials

- *Students for Salmon Journal*
- Art Supplies—crayons, markers, pencils, pens

Size/Setting/Duration

Entire class/classroom/~1 hour

Background

(Same background as Lesson 3.1)

The **riparian zone** is a term used to define the area that borders either side of a stream and the stream itself. It includes all of the abiotic, biotic, and cultural elements in this area. **Biotic** elements include any living or once-living things: plants, trees, decomposers, insects, birds, leaf litter, dead trees, and animals. **Abiotic** elements are any nonliving substances including soil, rocks, air, and water. All of these things together make up a healthy ecosystem. If any one component were missing, all other parts of the ecosystem would be affected. A healthy riparian ecosystem is very important in providing habitat for wildlife by supplying food, water, and shelter.

The riparian ecosystem has many functions. A riparian area is essential for flood control. Well-vegetated stream banks provide bank stabilization, thereby reducing bank erosion and the associated increase of suspended sediments in the stream. Riparian vegetation also intercepts rain, yielding an increase in groundwater/aquifer recharge. Aquifer recharge is very important to year-round stream flow.

Humans have altered natural riparian ecosystems by adding cultural elements. Cultural elements include anything made or added to an environment by humans: houses, roads, telephone poles, bridges, etc. It is important to understand that all cultural elements were created from biotic or abiotic elements found in natural ecosystems. Cultural elements may compete with the natural environment. For example, culverts under roads can block fish passage. Cultural elements can also put the natural environment at risk when too much of a biotic/abiotic element is used by humans; such as the clear-cutting of a forest for paper and building materials.

Procedure

1. Have students define in their own words a riparian ecosystem and a degraded riparian ecosystem in the spaces provided on the Riparian Restoration pages in their *Students for Salmon* Journal.

2. Using the degraded ecosystem drawing and a brightly colored pen, have students circle and label the areas of the drawing that are degraded.

3. Next, have students define a restored riparian ecosystem in their own words. Using the restored riparian ecosystem drawing, art supplies, and their riparian ABC's list, students should create and label a restored habitat that includes things salmon need to survive—a bridge for cows, trees, large woody debris, gravel, salmon, pieces of the food chain, etc…

4. On the lined page, students should write about their stream's transformation, from degraded riparian ecosystem to a healthier, restored riparian ecosystem.

Next Generation Science Standards

Performance Expectation		
3-LS4-3: Construct an argument that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **5-ESS3-1**: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Constructing Explanations and Designing Solutions ▪ Engage in Argument from Evidence ▪ Obtaining, Evaluating, and Communicating Information	▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience ▪ ESS3.C: Human Impacts on Earth Systems	▪ Systems and System Models

Riparian Restoration

A Stream is More Than Water

What is a **Riparian Ecosystem?**

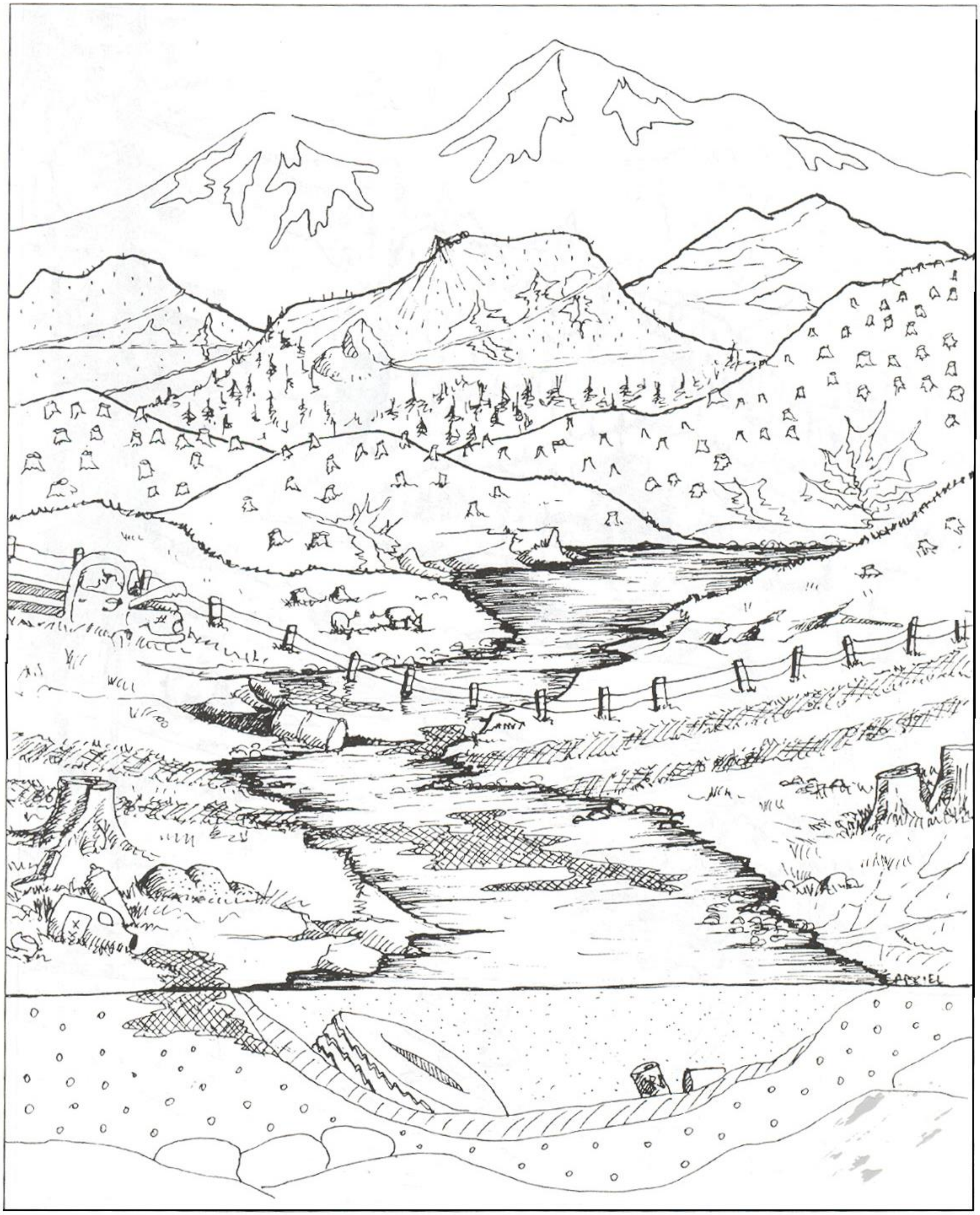
What is a **Degraded Riparian Ecosystem?**

- Using the Degraded Riparian Ecosystem drawing and a brightly colored pen, circle and label the areas of the drawing that are degraded.

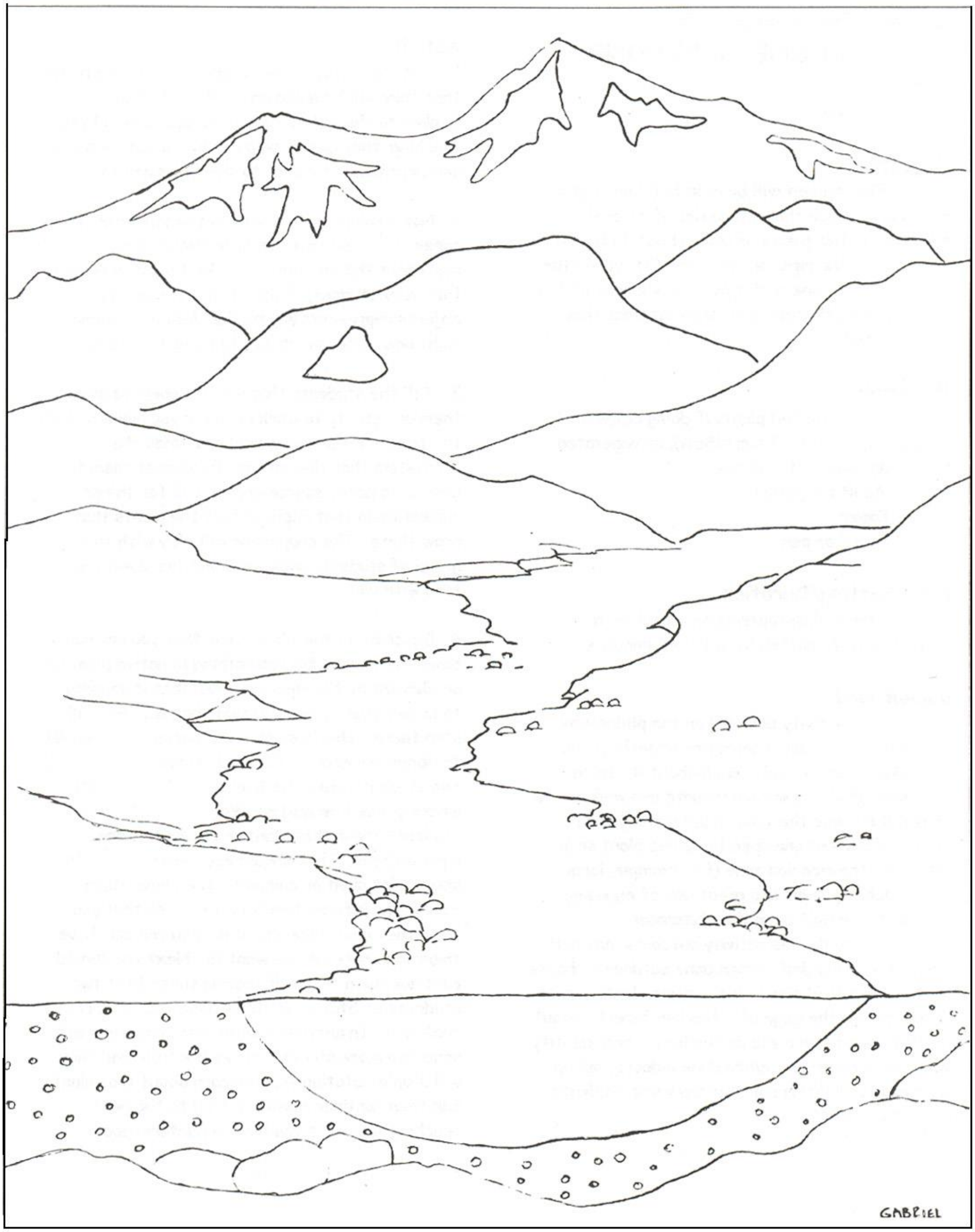
What is a **Restored Riparian Ecosystem?**

- Using the Restored Riparian Ecosystem drawing, art supplies, and your Riparian ABC's list, create and label a restored habitat that includes things that salmon need to survive. Check out the Riparian ABC's list you've already created—which of these things should you include?

A Degraded Riparian Ecosystem



A Restored Riparian Ecosystem



Riparian Restoration

A Salmon Stream Restoration Story

Use the space below to write about your stream's transformation from a degraded riparian ecosystem to a healthier, restored riparian ecosystem.

3.3 Salmon Forest

Subject
Earth and Space Science

Objectives
The students will:

- Take notes from The Salmon Forest video
- Model nutrient cycling through a forest ecosystem

Materials

- *Students for Salmon Journal*
- Computer with access to internet for video: *The Salmon Forest* with Richard Nelson
- Art Supplies—crayons, markers, pencils

Size/Setting/Duration
Entire class/classroom/~45 minutes

Background
The following website provides a great article about the interconnectedness of salmon and the forest ecosystem. You'll find the video for this activity on this webpage as well. While you watch this video be thinking about connections used in order to inspire students' thinking throughout the activity.

http://www.encountersnorth.org/wildexplorer/salmon/forest-and-sea-salmon.html

Procedure

1. Have students get out their *Students for Salmon Journal*. Explain that they will be taking notes while watching a video about salmon and their connection to their habitat. Play video from the website listed above, or from YouTube ("*The Salmon Forest with Richard Nelson*")

2. After the video, students will work on the prompts under their note-taking section. This can either be done individually, or in small group discussions.

3. Once students have had the opportunity to discuss, they will use the back of their journal page to create a visual. Can they come up with a model that displays the transfer of nutrients described in the video?

4. Share discussions and diagrams as a class.

Next Generation Science Standards

Performance Expectations		
5-LS2-1: Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. **5-ESS2-1**: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Developing and Using Models ▪ Obtaining, Evaluating, and Communicating Information	▪ LS2.A: Interdependent Relationships in Ecosystems ▪ LS2.B: Cycles of Matter and Energy Transfer in Ecosystems	▪ Systems and System Models

The Salmon Forest

During the Video:
Take notes on interesting facts and new ideas from the video below:

After the Video:
The narrator focuses mostly on bears in this video. Can you name 3 (or more) other living things in the forest that depend on salmon?

List two ways salmon help the forest:

List two ways forests help salmon:

With the information you gathered from the video, create a diagram below that shows how salmon nutrients move and cycle through the forest.

UNIT 4 - Stream Exploration Field Trip

Led by NSEA

What We Know	What We Want to Know

Led by NSEA staff during the field trip

Salmon Habitat Assessment

Subject

Earth and Space Science
Life Science

Objectives

The students will:

- Take notes based on their observations of the field trip site
- Create a hypothesis based on evidence

Materials (*all provided by NSEA*)

- *Students for Salmon* Field Journal
- Pencils

Size/Setting/Duration

Small Group/Local Watershed Field Trip/~10-15 minutes

Background

This is the first activity students do once they've split into their small groups during their stream exploration field trip. NSEA staff or volunteers lead students through site observations to become acquainted with their study site.

Procedure

1. Gather small group together and introduce yourself. Tell students that today we are stream scientists studying the creek's habitat. Hand out clipboards, *Students for Salmon* Field Journals, and pencils.

2. Take students to an area where they can see the creek to complete the first page in the *Students for Salmon* Field Journal. Fill out the location, date and time of day. Make scientific observations about the weather. Different times of the day, days of the year, and weather conditions can give us different results and we need to consider these factors today when we are looking at our results. Ask students, what is our overall question? What are we here to find out today? (Is this creek a healthy habitat for salmon?)

3. Explain to students that we will each be coming up with our own hypothesis—ask them what a hypothesis is. In order to make an educated guess, tell students we'll first be making some

observations.

4. As a group, walk through each item in their field journal one by one and discuss:

- **Large woody debris** creates calm pools and hiding places for fry
- **Gravel** at the bottom of a stream:
  - The adult salmon lay their eggs in the gravel, and macroinvertibrates live in the gravel as well!
- **Garbage:** Explain that garbage doesn't necessarily have to be IN the stream to be harmful to the salmon
- **Plants** along the stream:
  - Shade for cool water/more oxygen, roots hold together soil and prevents erosion, acts as a buffer zone/natural barrier keeping chemicals or other things from getting to the stream
- **Riparian Zone** is the area around a creek with plants and trees
- **Shade** keeps water cold, and salmon need cold water to survive!
- **Roads or buildings** near a stream can increase the amount of harmful runoff possibly full of pollutants that can get into the stream
- **Animals:** Can you hear birds? Any signs of animal life around, like footprints, beaver chewed trees? Some animals are an indication of habitat health.
- **Cars** emit pollutants into the air and can leak oil onto the roads that can then possibly get into streams in the form of runoff.
- **Moving water:** Moving water means more oxygen in the water!
- **Erosion:** where an area of the stream bank has fallen or slid into the stream, or has been cut away by the stream.

5. Now students are ready to write a hypothesis. Have them share if time allows.

Next Generation Science Standards

Performance Expectations		
3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Constructing Explanations and Designing Solutions	▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience	▪ Cause and Effect: Mechanism and Explanation ▪ Systems and System Models

Salmon Habitat Assessment

Today you are all salmon scientists! Our mission is to use our observation skills and explore our stream to determine if it is good habitat for Pacific salmon!

Name of Location:	**Date:**	**Time:**
What's the weather like today?		

Question: (What are we here to find out today?)

Observations: (What do you see? Gather information)

- ☐ Large woody debris
- ☐ Gravel on the bottom of the stream
- ☐ Garbage
- ☐ Plants
- ☐ Riparian Zone
- ☐ Shade
- ☐ Roads
- ☐ Buildings
- ☐ Animals
- ☐ Cars
- ☐ Moving water
- ☐ Erosion

Other Observations:

Hypothesis: (Based on your observations do you think this stream will be healthy salmon habitat? Why or why not?)

Led by NSEA staff during the field trip

Water Quality Investigation

Subject

Earth and Space Science

Objectives

The students will:

- Carry out a series of water quality measurements and record data for temperature, turbidity, and dissolved oxygen
- Understand how these measurements relate to the health of their stream

Materials (*all provided by NSEA*)

- *Students for Salmon* Field Journal
- Pencils
- Water Quality materials: thermometer, turbidity tube, HACH Dissolved Oxygen kit, rubber gloves, chemical safety goggles, waste containers

Size/Setting/Duration

Small Group/Local Watershed Field Trip/~30 minutes

Background

This is one of three stations students rotate through during their NSEA field trip. Students will measure temperature, turbidity, and dissolved oxygen.

Temperature: Salmon can survive best in water between 5-20 °C (40-68 °F) in temperature. Water temperatures higher than 20 °C or lower than 5 °C can kill or decrease chances of survival for salmon. Cold water can hold more oxygen than warm water.

Turbidity: Turbidity is a measure of water clarity, or how much sediment is suspended in the water. Sediment can damage fish gills and make it hard for fish to see or breathe in their freshwater habitat. Sediment can also suffocate salmon eggs.

Dissolved Oxygen: Dissolved oxygen (DO) is a measure of the amount of oxygen in the water. We measure this because salmon need oxygen in their water, which they take in through their gills, to survive. Dissolved oxygen is measured in parts per million (ppm) and salmon need measurements of at least 6 ppm in order to survive. In some cases, salmon can tolerate levels as low as 4 ppm, but this reduces their chance of survival greatly. The colder the water is, the more oxygen it can hold, which is one reason salmon love cold water. This is called an inverse relationship—as temperatures decrease, the dissolved oxygen concentrations increase.

Procedure

1. Discuss why health of the stream's water (water quality) is important for salmon and how water quality is affected by the riparian ecosystem. Describe the tests you will be conducting to determine the quality of the water in the stream
   -Dissolved Oxygen (DO)
   -Temperature
   -Turbidity
   Transition: If students are coming from a different station, discuss how their last station relates to the water quality.
   Fill in information in their *Students for Salmon* Journal (Scientists always document their data!)
   Instruct students to put goggles on for safety! You should wear goggles and gloves at all times as well. Give students gloves who are helping you with the experiment.

2. Collect water sample from the creek in a collection jar. Only allow students to assist if conditions are safe.

3. Explain that we will be measuring temperature, stick thermometer into sample jar, and set aside. Begin Dissolved Oxygen (DO) test. Explain that this test will tell us if there is enough oxygen in the water for salmon to live because they need oxygen to breathe, too! Using the HACH DO kit, empty packets 1 and 2 into DO vial. Stop vial with lid and shake. Students love to participate and having a volunteer do small tasks like shake the vial for you is a really good way to keep them engaged! Show students the yellow precipitate – this means oxygen is in the sample. Let the sample sit until precipitate settles, set aside.

4. Take the thermometer out of water sample, have the students pass it around, and instruct them to record the temperature on their data sheets. Hold up the temperature poster: Salmon like their water temperature to range from 5-20 degrees C. Low temperatures also allow more oxygen to be dissolved in water, what do we think our temp results will mean for our DO levels? Will salmon like this water? How can we make sure the temperature stays low? Point out that the DO sample has settled. Shake one more time.

5. Explain turbidity to students: Turbidity is a measure of the sediment suspended in water. Too much turbidity makes it hard for fish to breathe, damaging their gills, especially smaller (juvenile) fish such as alevin and fry. Think about a volcanic eruption: it would be hard for us to breathe with all the ash. The same goes for salmon in highly turbid water. Pass turbidity tube around the group, what do they see? Have students record turbidity on their data sheets. How can we make sure that turbidity stays low?

6. Add DO packet 3, shake, observe the color change, and pour sample into the plastic tube. Explain that the tube holds one million parts of water so we can measure how many parts-per-million are oxygen molecules. You can relate the plastic tube to a measuring cup you use when baking. Pour contents of tube into square mixing vial. Explain to the students that they

will be doing a titration: they will be adding a final chemical into the sample until a reaction occurs. Add drops one at a time until the sample turns clear. The students will need to help you count the number of drops and tell you when the sample is clear. Have students record the number of drops on their data sheets. Each drop represents one part-per-million (ppm) of oxygen. Salmon need 6 ppm of dissolved oxygen or higher to survive. Will salmon thrive here in our stream? How can we ensure that we have good levels of dissolved oxygen in the future?

7. Looking at all of the information on their data sheets, ask students if the water in this stream is good enough for salmon to be living in. Why or why not?

8. If time allows, discuss with students things we can do to keep our water cold, clean, and clear for salmon.

Next Generation Science Standards

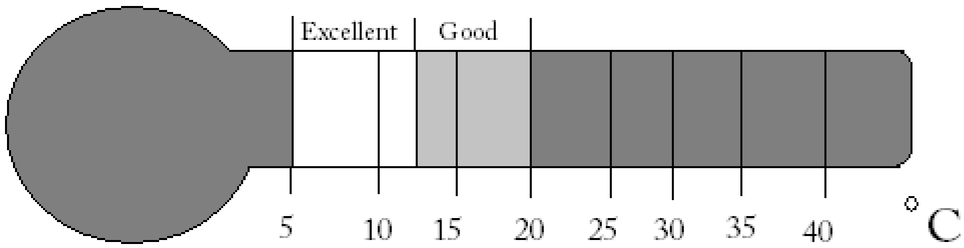
Performance Expectations		
3-LS4-3: Construct an argument wih evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Analyzing and Interpreting Data ▪ Constructing Explanations and Designing Solutions	▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience	▪ Cause and Effect: Mechanism and Explanation

Water Quality Investigation!

Hypothesis: (Based upon your observations, do you think this stream's water quality will be excellent, good, or poor? Remember to write in full sentences!)

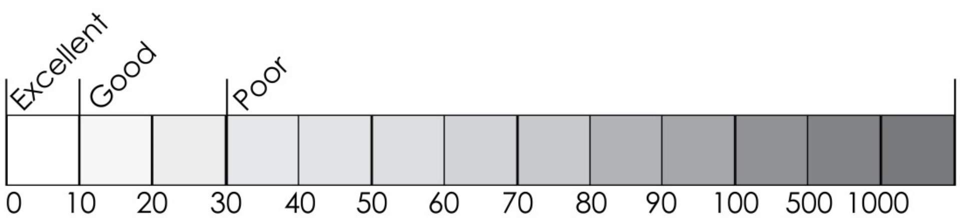
Results:

TEMPERATURE



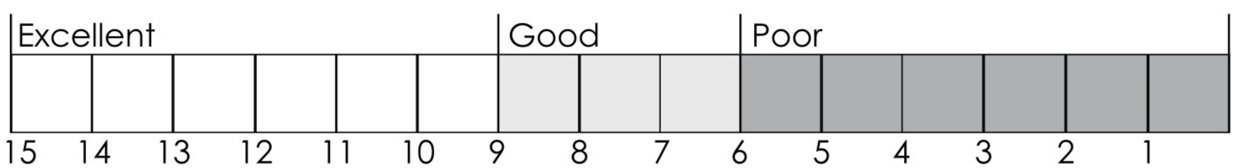
_______ **in degrees Celsius, °C** Is this **EXCELLENT GOOD POOR** ?

TURBIDITY



What do you see? ________ Is this **EXCELLENT GOOD POOR** ?

DISSOLVED OXYGEN



_______ **in parts per million (ppm)** Is this **EXCELLENT GOOD POOR ?**

Conclusion: Based on your data, do you think the water quality of the stream is...

EXCELLENT or **GOOD** or **POOR**

List one thing YOU and your family can do to help improve your watershed's health!

Led by NSEA staff during the field trip

Macroinvertebrate Mission

Subject

Earth and Space Science
Life Science

Objectives

The students will:

- Collect and identify a macroinvertebrate sample using a dichotomous key
- Match identified macroinvertebrates to pollution tolerance groups to determine the health of their stream

Materials (*all provided by NSEA*)

- *Students for Salmon* Field Journal
- Pencils
- Macroinvertebrate Sample Materials: Kick-net, collection trays, magnifying boxes, plastic spoons, aquatic invertebrate dichotomous keys, pollution tolerance group charts

Size/Setting/Duration

Small Group/Local Watershed/~30 minutes

Background

Macroinvertebrates are animals that are large enough to see with the unaided eye (without a microscope) and have no backbone. These animals include: insects, worms, snails, crayfish, leeches, clams, mussels, etc. These aquatic insects live in the stream at different stages of their lives (larvae, nymph, and/or adult). Macroinvertebrates can tell us a lot about the stream's water quality without ever having to test turbidity, Dissolved Oxygen, or water temperature. Macroinvertebrates are good indicators because they are sensitive to physical changes in their habitat, they do not travel long distances in their lifetime like some fish can, and they are easy to collect in the stream.

Procedure

1. Start off by explaining the station. Include what are macroinvertebrates and why are they important, the procedure for collecting our sample, and what the expectation is during the observation and identification of our macroinvertebrates.

2. At the streamside station, collect macroinvertebrates from the stream. Using a large net called a kick-net, two to three people will carefully collect the macroinvertebrate sample.

Each student should have a job (carry the net, carry and fill the collection trays, place sample into trays, assist with obtaining sample in the creek). Bring trays back to station tables. Students should use the plastic spoons to gently scoop their insects from the trays into the magnifying boxes. Work in pairs on each tray to find their insects. Tip: let the dirt settle in your trays and you will see the bugs moving around!

3. Give students a few minutes to find and catch one macroinvertebrate each. Students then sketch their macroinvertebrate in their field journal, including notes on the following characteristics: number of legs, number of tails, movement, antennae, mouthparts, suction cups, and gills.

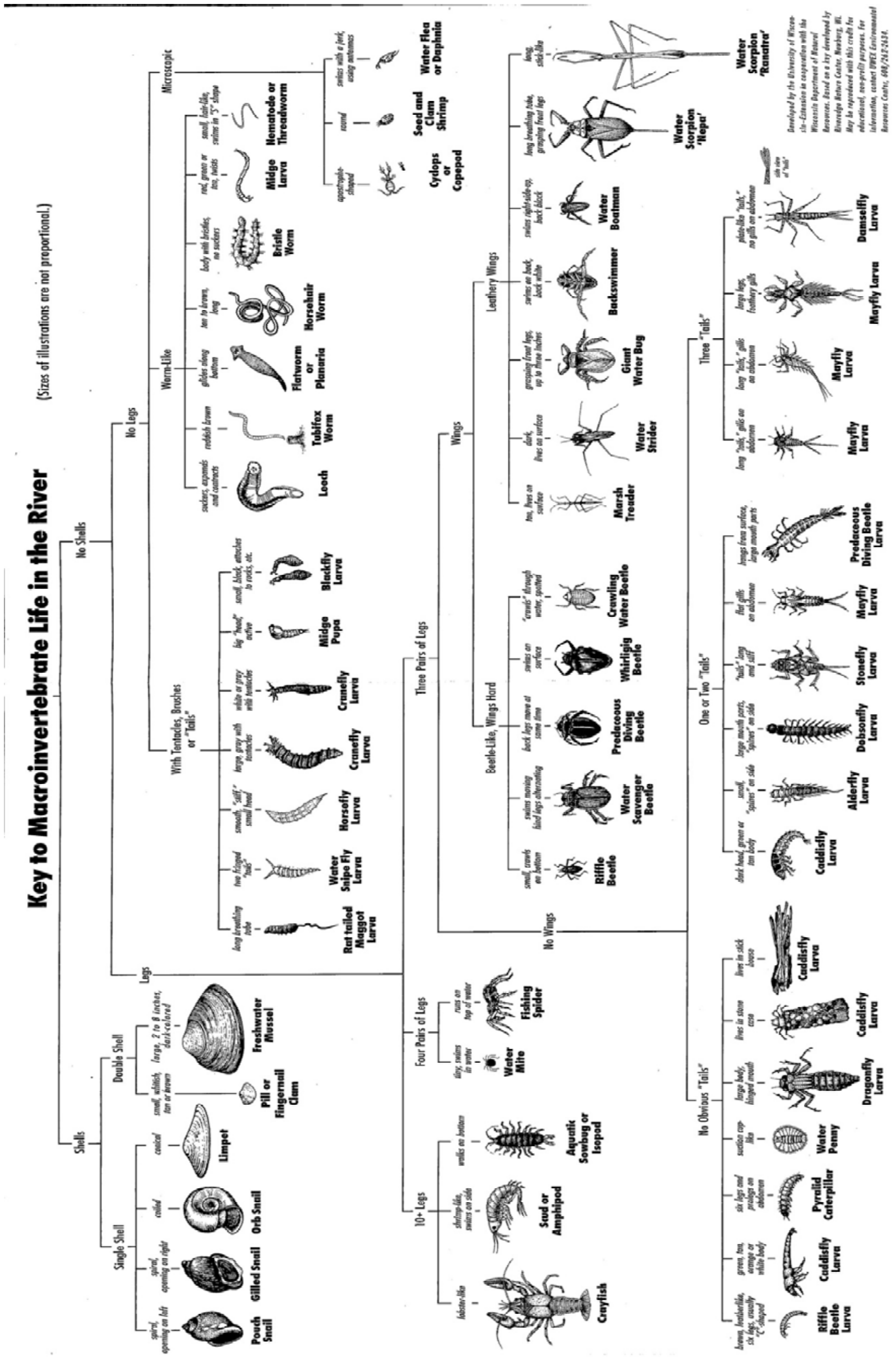
4. After students finish sketching (should take no more than 5 minutes), show them how to use the dichotomous key to identify their bug. If they are confused between two similar looking bugs, let them use the macroinvertebrate book. Encourage them to figure it out! Once they've identified it, write the name down in their field journal.

5. At this time, revisit the concept of indicator species. Because indicators are sensitive to changes in their environment, they are often used to determine the health of an ecosystem. Different insects have different tolerance levels to pollution, allowing us to determine our stream's health based on the insects that the students find in the stream. Use the macroinvertebrate pollution tolerance index to help students figure out which tolerance rating their insect has, then they should write the number down in their field journal. Have them include a description of what their group number means.

6. Ask students to raise hands if they found a macroinvertebrate in group 1, group 2, then group 3. Ask them what these results tell us about their stream. Discuss the fact that all bugs can live in healthy water, but the bugs in group 3 can tolerate pollution, so if we find all three types that means our stream is healthy and diverse!

Next Generation Science Standards

Performance Expectations		
3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Analyzing and Interpreting Data ▪ Constructing Explanations and Designing Solutions	▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience ▪ LS4.C: Adaptation	▪ Cause and Effect: Mechanism and Explanation


Key to Macroinvertebrate Life in the River
(Sizes of illustrations are not proportional.)
Shells
Single Shell
Double Shell
Pouch Snail
Gilled Snail
Orb Snail
Limpet
Pill or Fingernail Clam
Freshwater Mussel
No Shells
Legs
No Legs
Worm-Like
Microscopic
With Tentacles, Brushes or "Tails"
Leech
Tubifex Worm
Flatworm or Planaria
Horsehair Worm
Bristle Worm
Midge Larva
Nematode or Threadworm
Cyclops or Copepod
Seed and Clam Shrimp
Water Flea or Daphnia
Rat tailed Maggot Larva
Water Snipe Fly Larva
Horsefly Larva
Cranefly Larva
Midge Pupa
Blackfly Larva
10+ Legs
Four Pairs of Legs
Three Pairs of Legs
Crayfish
Scud or Amphipod
Aquatic Sowbug or Isopod
Water Mite
Fishing Spider
Wings
No Wings
Beetle-Like, Wings Hard
Leathery Wings
Riffle Beetle
Water Scavenger Beetle
Predaceous Diving Beetle
Whirligig Beetle
Crawling Water Beetle
Marsh Treader
Water Strider
Giant Water Bug
Backswimmer
Water Boatman
Water Scorpion 'Nepa'
Water Scorpion 'Ranatra'
No Obvious "Tails"
One or Two "Tails"
Three "Tails"
Riffle Beetle Larva
Caddisfly Larva
Pyralid Caterpillar
Water Penny
Dragonfly Larva
Alderfly Larva
Dobsonfly Larva
Stonefly Larva
Mayfly Larva
Predaceous Diving Beetle Larva
Damselfly Larva

Macroinvertebrate: Pollution Tolerance Index

Group 1:

Caddisfly Larva

Stonefly Larva

Mayfly Larva

Dobsonfly Larva

Group one macroinvertebrates **CANNOT** tolerate pollutants in the water. They need **cold**, **clean** and **clear** water to survive.

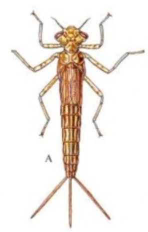
Group 2:

Dragonfly Nymph

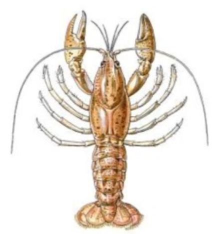
Scuds or Amphipods

Alderfly Larva

Clams and Mussels



Damselfly Nymph



Crayfish

Water Mites

Crawling water Beetles

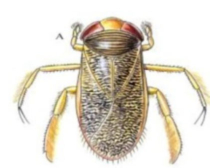
Group two macroinvertebrates can tolerate **SOME** pollutants in the water and can live in **medium** water quality conditions

Group 3:

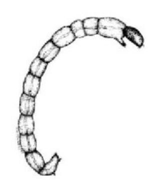
Aquatic Earthworms

Leeches

Snails



Water Boatmen



Midge Larva

Group three macroinvertebrates **CAN** tolerate pollutants in the water and **poor** water quality conditions.

MACROINVERTEBRATE Mission!

*Scientist's Name:*____

1) Make a scientific drawing of your macroinvertebrate in the box below, clearly labeling the following characteristics of your bug:

- Legs? Tails? How many?
- What does it look like?
- How does it move?
- Antennae? Gills?

2) Figure out the scientific name of the bug you've drawn using the dichotomous key

***My Macroinvertebrate is a:____.**

3) Use the pollution tolerance index chart to determine your insect's level of tolerance to pollution.

***My macroinvertebrate's pollution tolerance group number is ________.**

This means

____

____.

4) Overall, the insects that we found as a group show that the stream's health is:

POOR	**FAIR**	**EXCELLENT**
Found bugs mostly from group 3	Found bugs mostly from groups 2 and 3	Found a good diversity of bugs from groups 1, 2, and 3

Led by NSEA staff during the field trip

Native Plants: Each One Teach One

Subject

Earth and Space Science
Life Science

Objectives

The students will:

- Be able to define native and invasive plants
- Learn the names and unique characteristics of several native plants
- Learn how the riparian zone helps keep streams healthy
- Teach other students about one native plant to reinforce what they've learned

Materials (*all provided by NSEA*)

- *Students for Salmon Field Journal*
- Pencils
- Native Plant Cards

Size/Setting/Duration

Small Group/Local Watershed Field Trip/~30 minutes

Background

The riparian ecosystem includes the stream and the area along the stream. A healthy riparian ecosystem includes native plants. Native plants are indigenous to a given area—they have developed or occur naturally in an area. These native plants help provide shade to keep the water cool, contribute woody debris to the stream to serve as hiding places for young salmon, prevent erosion of soil into the stream as the roots hold the stream banks in place, and serve as the base of the food chain as their leaves are eaten by macroinvertebrates (which are food for juvenile salmon). A major element of salmon habitat restoration is the planting of native trees and shrubs in the riparian ecosystem.

Some riparian ecosystems are threatened by invasive plant species. These are plants that come from someplace else, and can take over an ecosystem. Examples in Whatcom County include Himalayan blackberry, English ivy, Japanese knotweed, reed canarygrass, and Scotch broom. Part of salmon habitat restoration includes removing invasive species to make way for the native plants that provide the crucial ecosystem functions mentioned above.

Procedure

1. Before the students arrive, locate an area to hold this station. You'll need at least 8 (or as many as you can!) different, easily identifiable plant specimens to ensure that each student gets their own plant. Hang the Native Plant Cards on their corresponding plants. It's important to make sure that the plants you choose are in a safe location. All plants should be within sight of one another, especially if you don't have parent volunteers to walk with the students.

2. Once the station has begun with your group of scientists, introduce native plants. Choose an area that has a good view of the stream's riparian ecosystem and possibly some invasive species to help illustrate the importance of native plants. Ask students which station they just came from and connect what they learned to native plants (results from macros and WQ are in part, a reflection of the health of our stream's riparian zone). Why is the riparian ecosystem so important to keeping the stream cold, clean, and clear?

3. Discuss native plants vs. non-native and invasive plants. Ask students to think about what it means for a plant to be native vs. invasive. Explain the problems that invasive plants pose for the health of the stream – lack of shade, lack of root stabilization, out-competing native plants that provide the shade and bank stabilization.

4. Explain that they will each be studying one plant in depth, which includes drawing a scientific sketch (with labels!) and then they will be teaching the rest of the group about their plant. Assign each student to their own plant (If you are short on time, or the site lacks plant diversity, have them work in pairs). Tell them they will have the next five minutes (or so) to quietly study their plants and fill out the first page of their native plant worksheet. Go around to each student to check their progress, giving them helpful encouragement and ideas on which interesting facts to tell their peers about.

5. Bring the group back together and briefly discuss what it means to be respectful listeners, prepping them for their sharing time. Walk around to each plant, having the student who studied that plant take a couple of minutes to show us their plant's interesting physical characteristics and tell the group one fun fact about it. Have students feel the leaves, bark, smell flowers – try to make it a sensory experience.

6. Ask them to sketch the plant or write down a fun fact about it as they listen to each of their peers teach.

7. Wrap up the station by asking students what they think about the health of this riparian ecosystem, and discuss.

Next Generation Science Standards

Performance Expectations		
3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Constructing Explanations and Designing Solutions	▪ LS4.D Biodiversity and Humans	▪ Cause and Effect: Mechanism and Explanation

Native Plant Each One Teach One

Fill out the boxes, recording your answers in **your own words** and get ready to share!

#1. PLANT NAME: ____

#2. ZOOM in on your plant... make a detailed scientific sketch:	**#3. SENSE your plant...** List one interesting characteristic you observe:
#4. TELL us about your plant... Choose the fun fact from the *Plant Fact Card* that benefits salmon in their freshwater habitat and explain how!	**#5. DISCOVER the Native American uses behind your plant...** located on the *Plant Fact Card*

Why are plants important for Salmon? *How many ways can you list below?*

Take notes on four or more plants in the boxes below.

Sketch the plants and/or write an interesting fact about them!

PLANT NAME ____________________	PLANT NAME ____________________
PLANT NAME ____________________	PLANT NAME ____________________
PLANT NAME ____________________	PLANT NAME ____________________

How would you rate the health of this riparian zone? Circle one.

EXCELLENT GOOD POOR

UNIT 5 - Save Our Salmon

Led by Classroom Teacher

What We Know	What We Want to Know

5.1 Field Trip Extensions

Subject
Life Science

Objectives
The students will be able to:

- Use a diagram to connect the 3 C's (cold, clean and clear) to the water quality data collected during the field trip
- Create a graph to visually display macroinvertebrate data
- Communicate information, visually and orally, about a native plant, working in a small group

Materials

- *Students for Salmon Field Journal* (from NSEA field trip)
- Art supplies—crayons, markers, pencils
- Paper—graph paper and poster board

Size/Setting/Duration
Entire class/classroom/~30-60 minutes per activity

Background
After a day out in the field with NSEA, your students have packets full of data, observations, and information. Here are some fun ways to use them!

Procedure
Water Quality Diagram

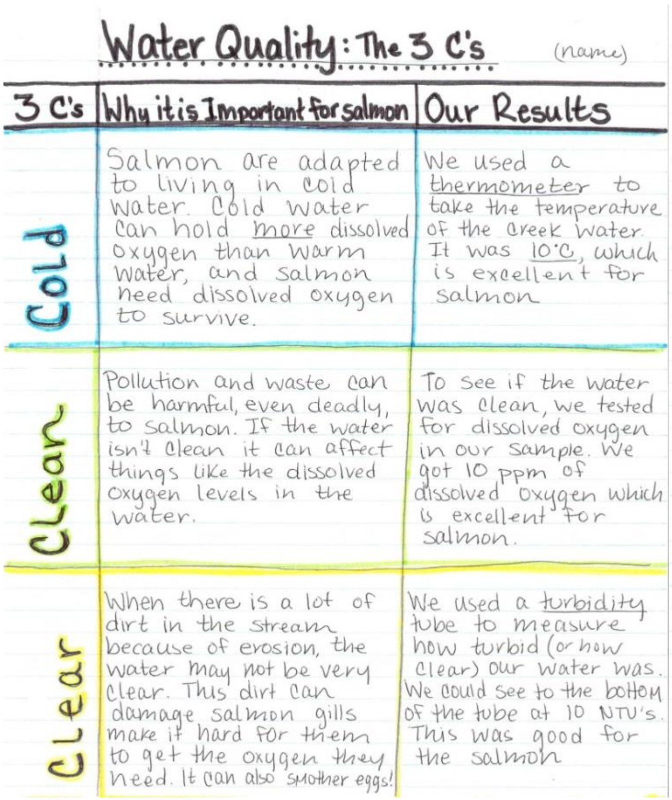
1. On a blank piece of paper, have students draw three columns with three rows. The columns should be titled: "3 C's", "Why it is Important for Salmon", and "Our Results".
2. Under "3 C's" column, students should write Cold, Clean, and Clear. Under "Why it is Important for Salmon", students should write why each 'C' is important for salmon health. Finally, under "Our Results", students should use the data from their journal, including *how* they measured each water quality parameter, and discuss how they rated it for salmon.

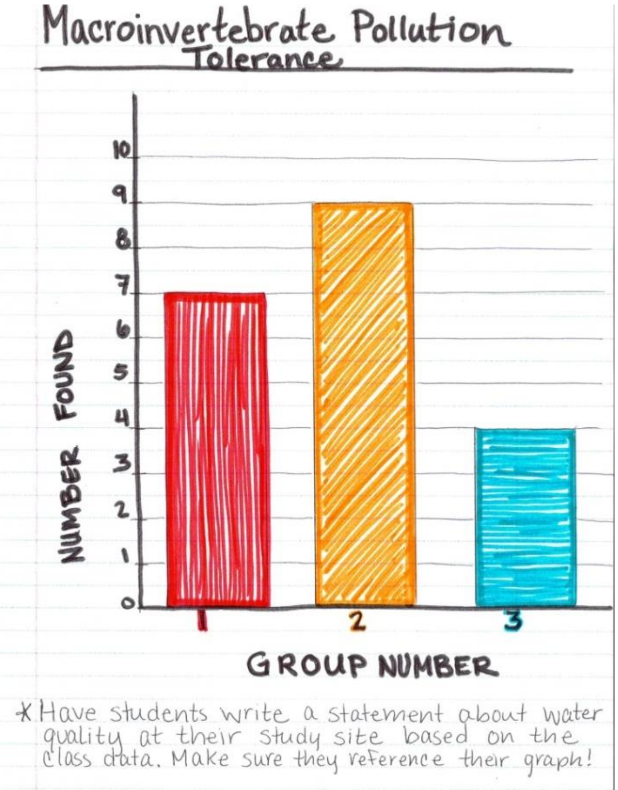
Macroinvertebrate Graph

1. As a whole class, tally how many macroinvertebrates were found from each group (1, 2, 3).
2. Have students create a bar graph to represent this data visually. At the bottom of their graph paper, each student should write a statement about the data displayed in their graph.
3. For further graphing activities, students could also create bar graphs by species, using the number of mayflies, scuds, worms, etc.

Native Plant Group Poster

1. Divide students into groups based upon the plant they studied during the field trip. For instance, the students that studied vine maple would all work together.
2. Each group must create a poster that represents the information they gathered at the native plant station. Additional research could be used.
3. Upon completion, have students present their poster to the class.





Examples of the water quality diagram and macroinvertebrate graph, but so many alternatives are possible! You could even keep a copy of activities like this to have future students compare year after year.

Next Generation Science Standards

Performance Expectations		
3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Using Mathematics and Computational Thinking ▪ Engaging in Argument from Evidence ▪ Obtaining, Evaluating, and Communicating Information	▪ LS2.A: Interdependent Relationships in Ecosystems ▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience ▪ LS4.C: Adaptation ▪ ESS2.A: Earth Materials and Systems	▪ Cause and Effect: Mechanisms and Explanation ▪ Systems and System Models

5.2 Comparing Life Cycles

Subject
Life Science

Objectives
Students will be able to:

- Model, compare, and contrast the life cycle of a Pacific salmon with the life cycle of one organism of their choosing
- Show that all organisms have birth, growth, reproduction and death in common
- Communicate their observations and research visually, verbally and in written form

Materials

- Ledger size paper (11" x 17"), or larger
- Pens, markers, colored pencils
- Books and computers for student research

Size/Setting/Duration
Entire class/classroom/several sessions

Background
Salmon have an interesting life cycle (see lesson "Salmon Lifecycle" in the *Students for Salmon Curriculum*), but of course they aren't the only living things with a life cycle. All living things have their own life cycle. Life cycles of organisms, though unique and diverse, have in common birth, growth, reproduction, and death.

This lesson aims to expose students to different life cycles and provide them with the opportunity to model and compare them. This lesson can be used to further assess student knowledge of the salmon life cycle. As for the additional organisms for comparison, we suggest using the student's native plant or macroinvertebrate from their field trip experience, found in their field journal. However, any other organism that students can research will do, and could be a great opportunity to tie in any previous life science units your class has explored.

Procedure

1. Ask students to define "life cycle". Tell students they are going to be comparing life cycles of other living things to the life cycle of Pacific salmon.

2. There are many interesting life cycle videos on YouTube, reviewing the life cycle of various species in a few short minutes. Consider picking out two or three short videos to show the class. This will help generate some discussion. Ideas (plenty of others out there to explore!):

Mosquito: http://youtu.be/wFfO7f8Vr9c
Apple Tree: http://youtu.be/0DDDBwk_-bM
Frog: http://youtu.be/_MupYQMAaKA
Sea Turtle: http://youtu.be/7RLcUWu_QfA
Dragonfly: http://youtu.be/Ezq_JWd1Sd8
Pumpkin: http://youtu.be/iXLnCd4JMH4

3. Brainstorm ways that these life cycles are different, and in what ways they are similar. Is there anything that all of our examples have in common (birth, growth, reproduction, death)?

4. Explain to students that we will be creating posters to show the life cycle of Pacific salmon and one other organism of their choosing (you can allow their choice to be open ended, connect to a species from a previous unit of study, or use the plant or macroinvertebrate from their *Students for Salmon* Field Journal). Depending on the selection of organism, students may need to conduct some research to learn more about the life cycle of their organism and take notes on their findings.

5. Once research has been completed, students start working on their posters. Students fold their paper into thirds—they can add a title along the side, too (see example). Each third is a different section of their life cycle comparison.

6. In the first section, students will draw out the salmon life cycle beside the life cycle of their organism of choice. In the second section, students will create a Venn diagram to compare and contrast Pacific salmon with their organism of choice. In the third section, students will give a written response to the questions—How are the two life cycles similar? How are they different?

7. This activity works well over a period of several days. Incorporate research and note-taking, alter any of the sections to best fit your classroom, and add a presentation at the end for students to practice verbal communication as well.

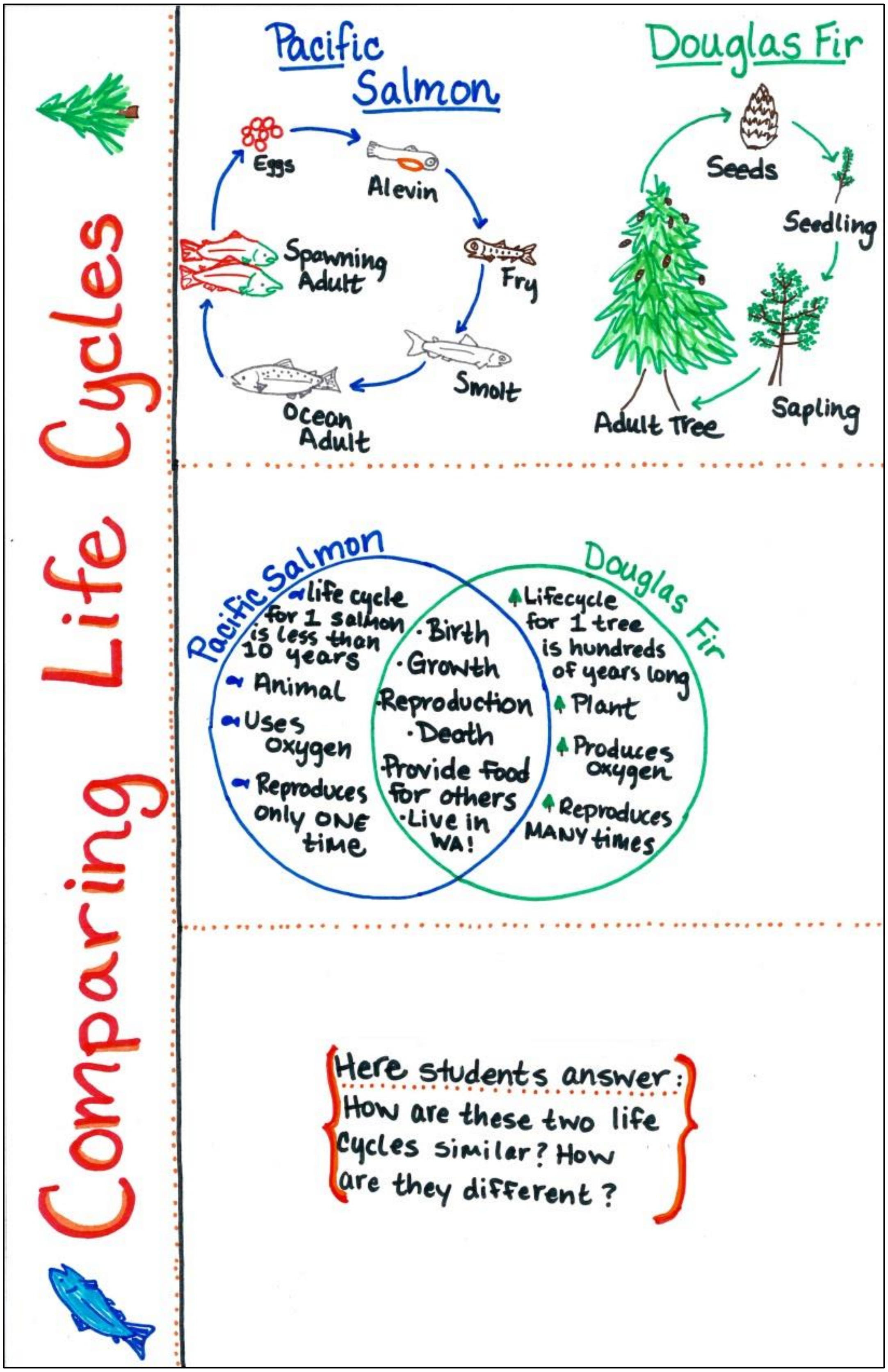
Additional Resources

(go to www.n-sea.org for additional resources)

Next Generation Science Standards

Performance Expectations		
3-LS1-1: Develop models to describe that organisms have unique and diverse life cycles but all have in common birth, growth, reproduction, and death.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Developing and Using Models ▪ Obtaining, Evaluating, and Communicating Information	▪ LS1.B: Growth and Development of Organisms	▪ Patterns ▪ Systems and System Models

Example Poster



5.3 Sharing the Planet

Provided by Sheryl Binning and Beckey Candini, Bellingham School District

Subject

Life Science

Objectives

The students will be able to:

- Identify pollution sources and how they affect the riparian zone health
- Explain how environmental changes can affect salmon habitat
- Describe ways that humans can reduce their impact on watersheds

Materials

- *Students for Salmon* Field Journal (from NSEA field trip)
- Research worksheets (provided)
- Prompt Handout (provided)
- Presentation materials—paper, markers, PowerPoint, props, pens, etc.

Size/Setting/Duration

Entire class working in small groups/Classroom/Several class sessions

Background

This activity was designed for the end of the *Students for Salmon* unit as a way for students to synthesize what they've learned and consider what it means to share the planet. Human activities affect salmon habitat. Throughout the course of the Students for Salmon program, students will have gained this understanding and have knowledge of the various ways humans contribute to the degradation of salmon habitat, but also the ways humans can contribute to the restoration of their critical habitats.

For more information, visit http://www.nmfs.noaa.gov/pr/species/fish/salmon.htm
http://www.thinksalmon.com/learn/item/habitat_loss_threatens_salmon/

Procedure

1. After opportunities to learn about and discuss human impacts on riparian habitats, introduce Sharing the Planet activity and the hypothetical situation.

2. Tell students that a new business park is scheduled to be built next to their Students for Salmon field trip site. Their job is to explain the many factors (changes) that may now affect the health

of the riparian ecosystem in this watershed during and/or after construction.

3. Have students work in groups to fill out their pollution investigation research worksheets*. Each group is assigned a pollution type to investigate, then groups take turns sharing their findings to the other groups. Students take notes from other groups to complete their investigation tables. Students may use prior knowledge, any notes, or newly conducted research to complete their investigation.

4. Students may choose the format for presenting their compiled information—essay, poster, PowerPoint, skit, etc. Allow time for them to develop their product, following guidelines on the prompt handout (attached).

5. Give students the opportunity to share their findings and final products with their classmates—for peer review!

*Pollution types from City of Bellingham's 5th grade Environmental Education Program, *Sharing Our Watersheds*.

Next Generation Science Standards

Performance Expectations		
3-LS4-3: Construct an argument with evidence that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all. **3-LS4-4:** Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change.		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Constructing Explanations and Designing Solutions ▪ Engaging in Argument from Evidence ▪ Obtaining, Evaluating, and Communicating Information	▪ LS2.C: Ecosystem Dynamics, Functioning, and Resilience ▪ LS4.D: Biodiversity and Humans	▪ Cause and Effect: Mechanism and Explanation

Sharing the Planet

Pollution Investigation Notes

Type of Pollutant	How does it get into the ground or water?	What problems does this cause?	What can we do to prevent this source of pollution?	Name a few things we could do to teach others how to prevent pollution.
Oil and Gas				
Soap				
Litter				
Sediment				

Type of Pollutant	How does it get into the ground or water?	What problems does this cause?	What can we do to prevent this source of pollution?	Name a few things we could do to teach others how to prevent pollution.
Dog Poop				
Pesticides				
Fertilizers				
Phosphorous				

Sharing the Planet

Task:

A new business park is scheduled to be built next to our creek (where we had our Nooksack Salmon Enhancement field trip). Explain the many factors (changes) that may now affect the health of the creek ecosystem in this watershed during and/or after construction.

Presentation:

You may present the information in a format of your choice (essay, mini-poster, PowerPoint, skit, etc.).

Resources:

You may access all of the resources in your student journals. You may also conduct additional research.

Criteria:

Include the information you gathered on the water quality and the health of the riparian ecosystem during the field trip.

Describe each factor that could change the health of our creek and include how each factor impacts the health of the riparian ecosystem as well as the creek itself.

Describe the many ways that we as “Salmon Stewards” can reduce the amount of pollutants in any watershed to ensure a healthy habitat.

5.4 Watercolor Connections

Subject

Art
Life Science

Objectives

Students will be able to:

- Share connections between salmon and their ecosystems through their artwork

Materials

- 1 5.5"x8.5" white paper per student and 2 4"x5.5" white paper per student (these can be larger if you'd like)
- 1 piece black construction paper
- Crayons
- Watercolors
- Sharpies
- Glue sticks

Size/Setting/Duration

Entire class/classroom/~1 hour

Background

This art project works well towards the end of *Students for Salmon* as a means of assessing student understanding of connections within ecosystems and as a way for students to share their knowledge. It involves painting watercolor over crayon drawings—the lines drawn with crayon will resist the paint.

Students may have used this technique with crayons and watercolors before. Especially if they haven't, we recommend giving them a practice sheet of paper to play with the effects of the watercolors resisting the crayon markings, which is especially fun with lighter colored crayons.

Procedure

1. Start by brainstorming two lists on the board with students: (1) things salmon need to survive and (2) things that depend on salmon for survival.

2. Explain that each student will choose something from each list to draw in addition to a Pacific salmon of their choosing. Show an example of the project and demonstrate what happens when you watercolor over crayons.

3. Pass out materials to students, allowing them time to practice some strokes on scrap paper.

4. After some practice, have students continue with project. On one of the smaller rectangles with a sharpie, have student write "Salmon need…" across the top. On the second small rectangle, have students write "…need salmon" across the bottom. Across the bottom of the larger rectangle, have students write a statement about salmon—this is open-ended and can include their favorite thing about salmon, something new they learned, something they think everyone should know about salmon, a message they have for salmon, etc…you can make it more guided to fit your class best.

5. With crayons, have students draw pictures to correspond with these themes. On the first rectangle students should draw something that salmon need to survive (below "Salmon need…" title). On the second rectangle students should draw something that depend on salmon for survival (above "…need salmon" title). On the large rectangle students should draw a Pacific salmon at any stage of its lifecycle (above their "statement about salmon"). See examples on following pages.

6. When students have finished their crayon drawings, they transition to watercolors—have students paint all across their rectangles with watercolors.

7. Allow paint to dry, then glue onto the black background. Display for fun, informational color in your classroom or school's hallways!

Next Generation Science Standards

Performance Expectations		
Scientific and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
▪ Obtaining, Evaluating, and Communicating Information	▪ LS1.B: Growth and Development of Organisms ▪ LS2.A: Interdependent Relationships in Ecosystems	▪ Systems and System Models

Example Posters

(Salmon need gravel, Eagles need salmon, Salmon are important to our ecosystem!)

(Salmon need stoneflies, Fishers need salmon, Salmon make the world a better place!)

(*Before* watercolors: Salmon need trees, Bears need salmon, We need to keep salmon around!)

Glossary & Resources

Students for Salmon Glossary

Abiotic	a physical, instead of a biological, factor in an environment (light, water, oxygen, carbon dioxide, temperature).
Acid	a substance when in aqueous (watery) solution creates a pH below 7.0. See the definition of pH. Examples: citric acid in lemon juice, acetic acid in vinegar.
Adapt or Adaptation	a physiological, behavioral, ecological or anatomical modification or trait in an organism that makes it better suited to survive under the conditions of the environment.
Adipose Fin	the small, fleshy (no stiff rays) fin between the caudal fin and the dorsal fin in salmonids. This fin is often clipped off at a hatchery before a juvenile is released. It doesn't grow back and its absence will identify an adult salmon as having its origin in a hatchery as opposed to an adult with an intact adipose fin having been produced naturally in the wild.
Alevin	newly hatched fish with the yolk sac attached; also called a sac-fry that remains in the gravel until the yolk is entirely consumed.
Algae	a large and diverse group of small (microscopic), single cell (phytoplankton) to large, multi-cellular organisms (generally referred to as plant-like) usually capable of photosynthesis and have no roots, stems, or leaves. Mostly found in water, marine or fresh, but also found in moist conditions on land.
Phytoplankton	(microalgae) forms the food base (the producers) for marine and freshwater ecosystems and are a major producer of the oxygen we require. Example: seaweeds such as kelp.

Anadromous	a fish hatched in fresh water, spends time as a juvenile in fresh water before migrating to the saltwater ocean for growth into an adult that migrates back to freshwater to spawn. For example Pacific salmon, steelhead and sea-run cutthroat.
Anal Fin	the ventral unpaired fin located between the anal pore and the caudal fin.
Anterior	at the front of the body.
Aquatic	a plant or an animal living in water.
Atmosphere	the layer of gases (air) surrounding the Earth; mostly nitrogen (78%) and oxygen (21%), carbon dioxide (0.04%), small amounts of other gases and variable amounts of water vapor.
Base (Alkaline)	a substance when in aqueous (watery) solution creates a pH above 7.0. see definition of pH. For example; ammonia in water, lye (sodium hydroxide) and baking soda (sodium bicarbonate).
Basin	the entire land and water region between two ridgelines.
Bedrock	solid rock underlying loose deposits of soil or alluvium.
Biotic	the organisms in an environment, including bacteria, fungi, plants and animals.
Caudal Fin	the tail fin on a fish.
Condensation	conversion of water from gas (water vapor) to liquid water; occurs in the atmosphere when warm air containing water vapor rises, cools and the air loses its capacity to hold as much water vapor. The water vapor condenses to form water droplets in clouds.

Crustacean	the mostly small, usually aquatic animals such as shrimp, crabs, lobsters, barnacles and crayfish. Most breathe through gills and have a hard outer shell (exoskeleton) and paired legs with joints. Salmon in the ocean feed on krill or zooplankton; small crustaceans that float or drift (planktonic) in the ocean.
Culvert	a tunnel for carrying a stream under a road, trail or sidewalk.
Cycle	a repeated sequence of events (see water cycle).
Dam	a barrier constructed across a body of water, usually a flowing stream, to retain water and raise its level. Example: a reservoir or beaver dam.
Dichotomous Key	to divide into two parts to separate and identify items in the natural world based on identifiable differences; for example, different species of fish, mammals and trees or types of rocks and minerals.
Dissolved Oxygen	amount of oxygen dissolved in the water that is available for respiration in aquatic organisms.
Dorsal	upper side of body.
Dorsal Fin	the large, unpaired fin on the back of a fish.
Downstream	in the direction of a stream's current.
Ecology	the science of the relationship between organisms and their environment.
Ecosystem	a community of organisms (biotic) in a given area combined with their physical environment and its characteristic climate (abiotic).
Egg	spherical, pinkish-orange reproductive structure produced by a female salmonid and is deposited in a gravel nest for sperm from a male to fertilize for development and the subsequent hatching of an alevin.

Erosion	movement of soil by water and wind.
Estuary	an area where freshwater and saltwater meet to create brackish (salt and fresh mixed) water; the size of an estuary changes with the tides, becoming larger at high tide and smaller at low tide. Estuaries are unique ecosystems containing organisms adapted to brackish water. Estuaries are important nurseries for juvenile salmon of certain species.
Evaporation	conversion of water from liquid to water vapor (see water cycle).
Fish	a vertebrate (animal with a backbone) that lives in water, breathes through gills, has fins (no limbs) and scales; its body temperature is the same as the water in which it lives.
Fish Passage Barriers	blockages in a stream that prevent fish from swimming farther upstream to an area suitable for spawning. For example; dams, improperly placed culverts and excess wood causing log jams.
Fork (River)	a place where the river divides into two or more branches.
Fry	the stage in a young salmon's life after it uses all the nutrients in its yolk sac, leaves the gravel to be in open water and begins feeding on zooplankton, small crustaceans, and insects. Often called fingerlings or parr when parr marks are distinct.
Glaciers	a persistent and large, slowly moving mass of ice of compacted snow on a mountain or the ice sheets at the earth's two polar regions.
Groundwater	water that infiltrates (seeps) beneath the earth's surface and is located in the spaces in soil, sand and fractured rock; supplies springs, wells, streams, lakes and ocean. Often stored and moves in geologic formations named aquifers.
Groundwater Flow	groundwater flowing into streams, lakes, or oceans.

Habitat	an area that provides for an organism's basic needs, including food, water, and shelter.
Homing Behavior	the inherent and learned behavior of an adult salmon to return to the steam (the natal stream) in which it was once a juvenile.
Hydropower	a turbine (like a propeller) converts the energy of water flow to electrical energy. Examples: the hydropower produced at dams on the Skagit River and on the Columbia River.
Infiltration	entry of water into soil.
Inorganic	not consisting of or derived from living matter; generally substances not containing carbon.
Insect	a group of invertebrates having a three-part body (head, thorax and abdomen), three pairs of jointed legs and one pair of antennae. The earth's most numerous animals and the most different kinds. Larval (juvenile) insects such as mayflies, caddisflies and stoneflies are important food source for juvenile salmon. These insects are referred to as "macroinvertebrates", an invertebrate visible with an unaided eye.
Invasive Species	an organism that causes ecological or economic harm in a new environment where it is not Native.
Invertebrate	an animal without a backbone; for example, insects (flies, bees, ants, beetles) mollusks (octopus, clams, snails) crustaceans (crabs, shrimp, lobster), spiders, corals, worms, jellyfish, sea urchins, starfish.
Lake	a large, inland basin of water that may or may not have a stream outlet as a drain.
Land Use	the ways in which humans have used and/or changed the natural landscape.

Large Woody Debris	sizable pieces of trees (trunks and root wads) in a river or stream to increase complexity by providing riffles and pools and divert water to side channels; common acronym is LWD.
Life Cycle	the series of changes an organism undergoes from hatching or birth throughout the remainder of its life, including reproduction.; example, the life cycle of a salmon.
Limiting Factor	an environmental condition that limits (restricts or keeps under control) the abundance, the survival and the growth or distribution of an organism or a population of organisms in an ecosystem; examples, lack of food, space, extreme temperatures, too little oxygen, predators.
Litter	trash that is discarded onto land and into water; can be transported by wind and water and can harm plants and animals.
Macroinvertebrate	see Insect and Invertebrate.
Migration	to move from one area to another; this movement is often connected with a changing of seasons, the availability of food and the onset of sexual maturity.
Milt	the fluid (semen) containing sperm; a male salmonid releases milt with sperm to fertilize the eggs a female deposits in the gravel nest.
Mineral	a naturally occurring substance (often referred to as inorganic) with a specific chemical composition and having a crystal structure. Rocks can be aggregates of minerals and do not have a specific chemical composition.
Natural Resource	something supplied by nature such as water, fish, mineral deposit, forest and fertile land and is valuable to humans.

Native Species	organisms that came to an ecosystem naturally and have been there for a long time, adapting together to keep the ecosystem in balance.
Ocean	a huge body of salt water; oceans cover 71% of the earth's surface and contain 97% of the earth's total water.
Ocean Acidification	the oceans have been slightly basic with a pH (see definition) of about 8.2 for millions of years. Over the past two centuries, beginning with the "industrial revolution", the pH has decreased. Now it is about 8.1, a decrease of 0.1 pH units or is slightly less basic. Another way of stating is the ocean is slightly more acidic but it is still basic (above pH 7.0). The main cause is the increased release of carbon dioxide into the atmosphere. The carbon dioxide dissolves in the ocean's water to form carbonic acid, a weak acid, that increases the ocean's acidity (less basic) and lowers the pH below 8.2. Thus we refer to this as the "acidification" of the ocean even though the ocean's pH is above 7.0 and continues to be slightly basic.
Oil	a thick liquid that does not mix (immiscible) with water but can mix with other oils; oils are often considered as vegetable, animal or petro-chemical in origin; oils have a high content of hydrogen and carbon and thus are important for energy production in animals' bodies but also for human use. In water, petrochemicals can be hazardous to organisms.
Organic	consisting of or derived from living matter. Generally substances containing carbon.
Oxygen	a chemical element with the symbol O; two atoms of oxygen when combined form a colorless, odorless gas constituting about 21% of the earth's atmosphere. During photosynthesis in plants, oxygen (as the gas) is released into the atmosphere and is used in respiration by animals.

Parr	the life cycle stage of a juvenile salmon when parr marks are distinct and between being a fry and a smolt.
Parr Marks	dark, vertical bars along the sides of the body in juvenile salmonids. Parr marks are lost during smoltification and when resident trout become older.
Pectoral Fins	a pair of fins at the ventral (lower) and anterior (nearer the front) part of a salmonid's body.
Pelvic Fins	a pair of fins at the ventral (lower) and posterior (nearer the rear) part of a salmonid's body.
Pesticide	chemical substance that is used to kill insects or other animals harmful to other animals or to plants; an **herbicide** is a pesticide that is toxic to plants and is used to eliminate unwanted plants.
pH	a scale from 1 through 14 that indicates the acidity of a solution. A solution with a pH below 7.0 is acidic; a solution with a pH above 7.0 is basic; a solution with a pH of 7.0 is neutral, neither acidic nor basic.
Photosynthesis	the process by which plants utilize and convert the energy of sunlight into chemical energy by using the relatively simple substances of carbon dioxide and water to produce a sugar. Thus, plants are the primary producers in an ecosystem.
Polar Ice Caps	huge sheets of ice found at the earth's North and South Polar Regions; they contain the majority of the Earth's freshwater.
Pool	deeper and slower water in a stream or river; a portion of a stream where the current is slow, often with deeper water than surrounding areas and with smooth surface texture; pools often occur above and below riffles and generally are formed around stream bends or obstructions such as logs, root wads, or boulders; pools provide important feeding and resting areas for fish.
Posterior	at or near the rear or hind end of a body.

Parts per Million (ppm)	unit of measure often used to describe the amount of oxygen in the air or the amount dissolved in water. It is the proportion of the number of molecules of oxygen in a million (1,000,000) molecules of air or water.
Precipitation	rain, snow, hail, or sleet falling from clouds to the earth's surface.
Pupil (Eye)	the dark opening in the center of an eye's iris; varies in size to regulate how much light enters the eye to reach the retina.
Redd	the series of nests containing fertilized eggs of spawning salmon; the female salmon creates a nest by facing upstream, lies on her side and uses her tail to excavate gravel to an appropriate depth, then lowers the posterior part of her body into the depression and releases eggs, the male has moved alongside and releases milt containing the sperm to fertilize the eggs. Moving slightly upstream, the female and male repeat the process and the gravel from digging the second nest covers the eggs in the first nest. This is repeated until all the eggs have been released; a series of several nests built by a female is a redd.
Restoration	the process of returning an area of land or a stream to as close to the former conditions as possible after a disturbance such as a flood, fire, or timber harvest.
Riffle	shallow areas of fast moving, highly oxygenated water with a stream bottom of gravel and cobble that provides the optimal conditions for stream macroinvertebrates and spawning salmonids. A riffle is often just upstream of LWD and a pool is just downstream.
Riparian Zone	The terrestrial area adjacent to a river, creek, lake, pond, marsh, bog or estuary (the wetland complex) and in which rooted plants (primarily trees and shrubs) can grow. These plants may be dependent on the water table provided by such waters.

River	a large, natural stream emptying into an ocean, lake, or other body of water.
Runoff	water that drains over the earth's surface and moves into a stream or lake without entering the ground.
Salmonid	fish belonging to the family Salmonidae: Pacific salmon (Chinook, Coho, Chum, Pink and Sockeye), trout (steelhead and resident rainbow trout; sea-run cutthroat and resident cutthroat trout), and char (Dolly Varden and bull trout) are native (indigenous) salmonids in Whatcom County
Sea-run adult	life stage after smolt; an anadramous fish that has gone to the ocean and will be there for 2-5 years of growth before returning to freshwater to spawn.
Sediment	natural materials (silt, sand and small pebbles) from weathering and erosion and carried in suspension by water and deposited out of the water by the process of sedimentation. Fine sediments are harmful to incubating salmon eggs and can cause suffocation.
Smolt	a juvenile salmonid that undergoes changes in the transition from living in freshwater to living in seawater. The process is smoltification (see definition).
Smoltification	the series of changes a juvenile salmonid undergoes in order to adapt (see definition) from living in freshwater to living in saltwater. Obvious changes are the loss of parr marks and the silvering of the body, especially ventrally.
Surface Water	water that has not seeped into the ground; includes lakes and swamps that hold water, and rivers that transport water.
Soils	loose upper layers of the earth in which plants grow and water infiltrates; made up of inorganic material, organic material, air, and water.

Spawning	in terms of salmon behavior, the act of laying eggs in a gravel nest, fertilizing the eggs, covering the eggs with gravel and repeating the process to complete the spawning redd (see redd definition).
Spawning Adult	stage when female and male salmon return from the ocean to their home streams to lay/fertilize eggs and then die. The salmon carcass is an important source of nutrients in the ecosystem.
Species	A group or population of anatomically similar organisms that interbreeds or have the potential to interbreed (genetically similar), share a common ancestry and are reproductively isolated from all other such groups.
Sperm	contained in the milt of a male salmon and fertilizes the egg to produce an embryo that will become an alevin upon hatching.
Stormwater Runoff	water from a storm event (rain/snow) that does not soak into the ground, but instead flows across impervious surfaces such as roads and sidewalks, picking up potential pollutants on its way to nearby streams or other bodies of water.
Stream	any body of running water; for example a creek or a river.
Surface Water	water that has not seeped into the ground; includes lakes and swamps that hold water, and rivers that transport water.
Topography	the surface features of a region.
Toxic	poisonous, harmful to living things.
Transpiration	water moves from a plant's roots to the underside of the leaves where it leaves through small pores and evaporates, as water vapor, into the atmosphere.
Tree	A tall, woody plant with a main stem or trunk and large root system.
Tributary	a stream flowing into another stream that is usually larger.

Turbidity	measurement of the clarity of a stream or river; the condition of a body of water that contains suspended materials such as clay or silt particles (sediment), dead organisms, or small living plants and animals.
Vegetation	the plants (trees, shrubs, grasses, sedges, rushes, ferns and flowers) that use energy from the sun for photosynthesis.
Vertebrate	an animal with a backbone (the vertebrae or vertebral column of the spine).
Ventral	the underside or bottom of a body.
Water	a clear, colorless liquid; there are two hydrogen atoms and one oxygen atom bonded together in one water molecule.
Water (Hydrologic) Cycle	the continual movement of water on, above and below the earth's surface. Water is continually changing states between liquid, vapor and solid (ice). The cycle has no beginning or ending point but think of it as starting in the ocean (contains 97% of the earth's total water). The sun's energy drives the water cycle. It causes the evaporation of the ocean's water to become water vapor. As the water vapor from the oceans rises in the atmosphere, it cools and condenses into water droplets in clouds. Winds drive the clouds over land where the clouds, depending on the temperature release rain or snow that eventually can return to the ocean to continue the cycle. The water we have today is as old as the earth itself. The glass of water you drink today is possibly the same water in a lake where a dinosaur drank.
Watershed	the entire area of land that drains surface and groundwater to a common outlet such as a creek, river, lake, bay or ocean. For example, the watershed of a creek where a student lives or the much larger watershed of the Nooksack River that might contain the creek's watershed.

Wetland	a habitat that is characterized by soils that are saturated with water, or has shallow standing water, for part of the growing season. Example: a marsh or a bog.
Zooplankton	tiny animals found drifting near the surface in aquatic environments. The primary consumers in the aquatic food chain are Zooplankton that feed on phytoplankton, the primary producers. Examples: very small crustaceans (krill), jellyfish, sea snails (pteropods), numerous kinds of larval invertebrates and larval fishes.

Students for Salmon

Elementary Environmental Science Program: Grades 3-6

Student Journal

Name:_______________________________

Nooksack Salmon Enhancement Association
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Students for Salmon
Student Journal Table of Contents

UNIT 1 - Our Watershed

Led by Classroom Teacher

What We Know	What We Want to Know

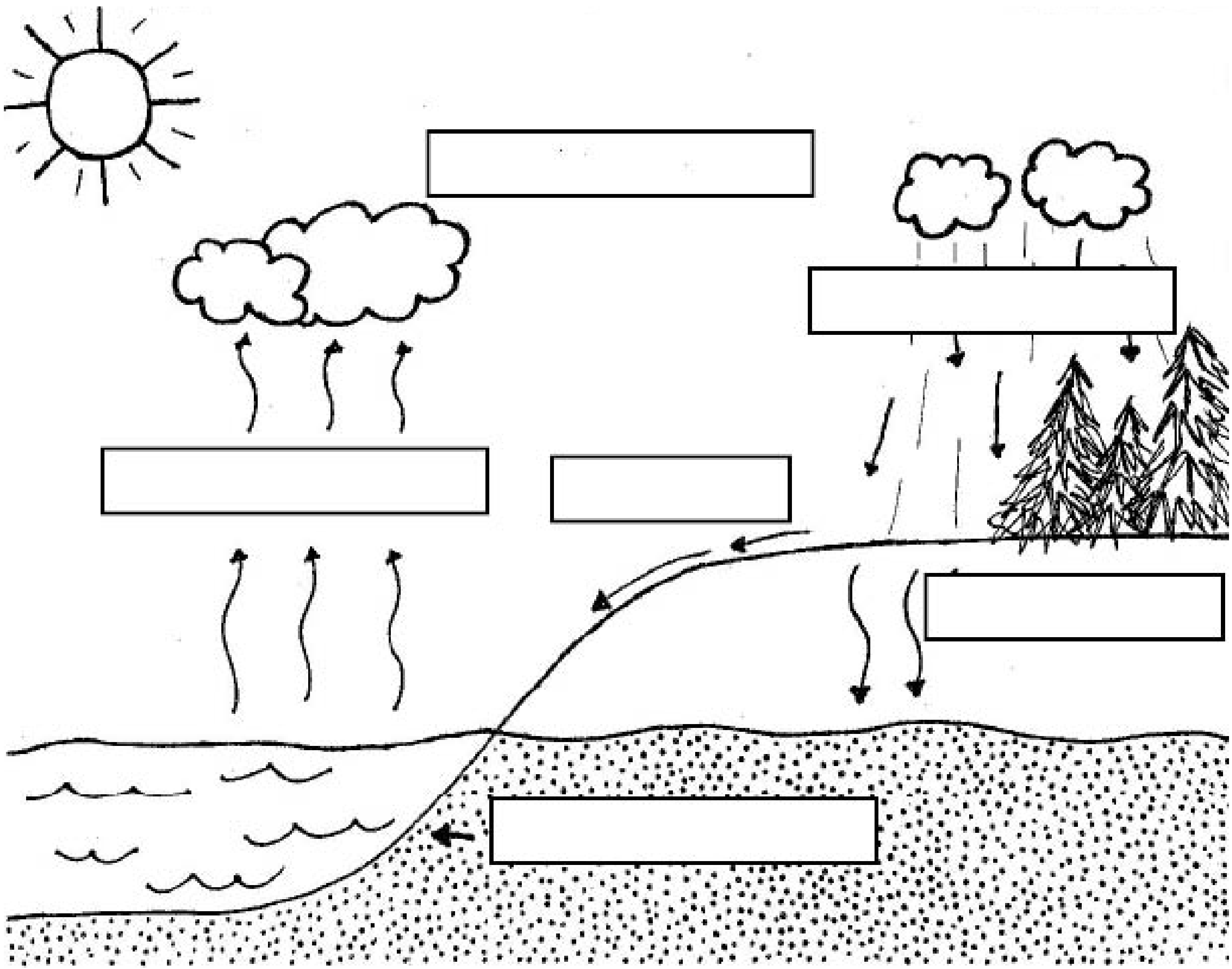
Where in the World is our Water?

Draw a diagram that shows where Earth's water is stored. Include labels!

Where in the World is our Water?

The Water Cycle

Fill in the Water Cycle diagram as a class, then answer the questions below!



The Water Cycle

1. The process when liquid water becomes gas in the atmosphere is called __________________.

2. The movement of water underground is called ______________________.

3. ____________________ is the water that falls from clouds as rain or snow.

4. Water on the earth's surface which moves into a stream or lake without absorbing into the soil is called ______________________.

5. _________________________ is the downward movement of water through the spaces of rock or soil; when surface water becomes groundwater.

6. The process when gas condenses to form clouds is called ___________________.

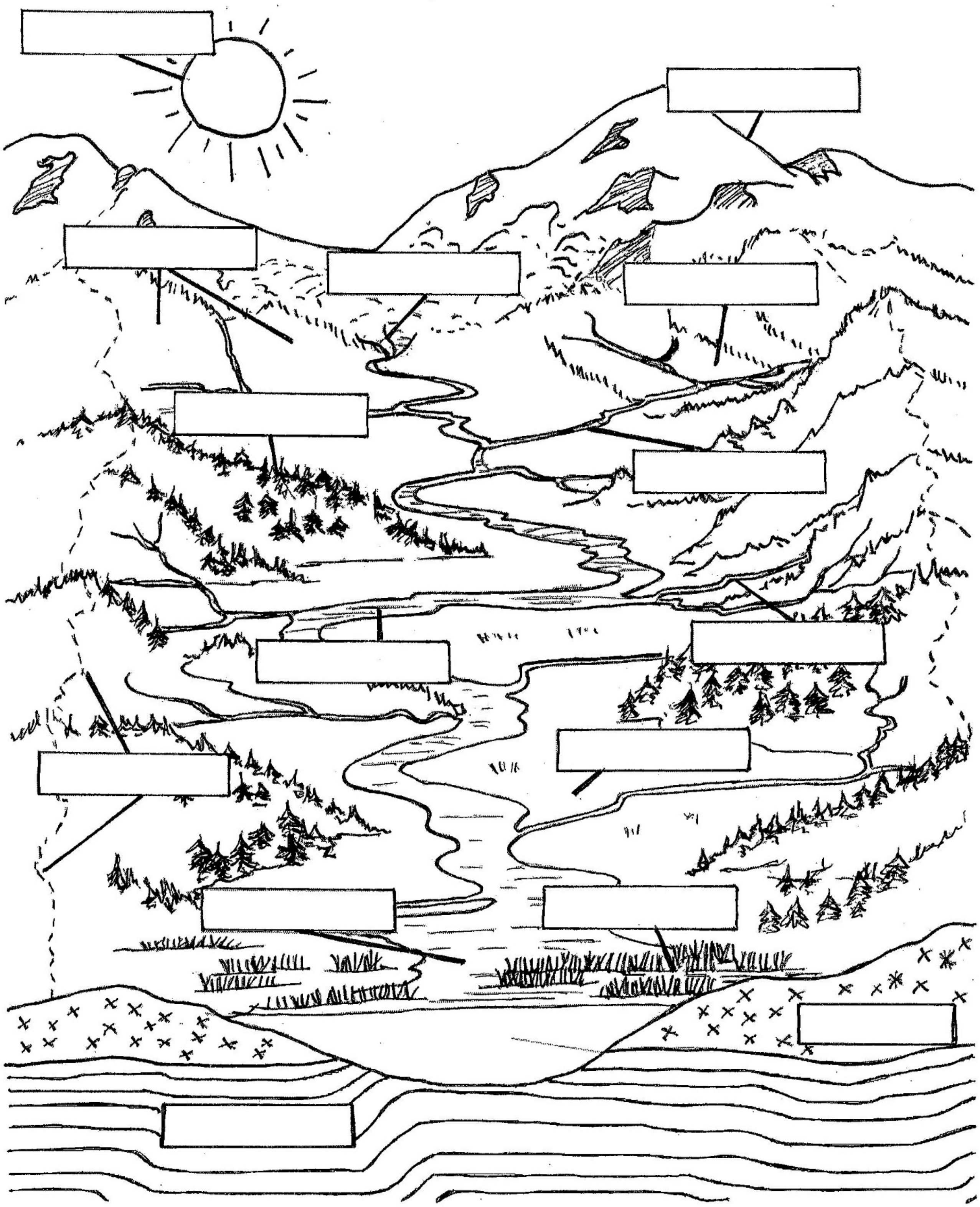
7. BONUS QUESTION (not a word from your diagram):
What drives the entire water cycle? ________________________

What is a Watershed?

A **WATERSHED** is a basin where water collects as it runs downhill. It includes all the water and land areas between ridges that drain to an outlet. The outlet could be a river, lake, or the ocean.

First, label the watershed diagram on the following page with these words:	**Second**, now that you know the natural features of a watershed, add and draw in these **human land uses**:
• Basin • Bedrock • Estuary • Floodplain • Foothills • Forest • Headwaters • Meander • Mountain • Ridge • River • Soil • Stream • Sun • Tributary • Wetland	• Boats • Cars • Cows • Factories • Farms • Horses • Houses • Parks • Roads • Stores • Anything else? Add others if you can think of more!

Watershed



Watershed Word Search

R	U	N	O	F	F	A	K	S	T	C	E	S	N	I
H	W	F	I	J	E	H	B	G	R	E	T	A	W	L
P	E	A	G	S	A	T	U	R	A	T	I	O	N	M
N	R	G	T	E	T	O	P	O	G	R	A	P	H	Y
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E	T	R	E	E	S	L	R	A	T	U	T	M	A	O
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O	G	M	I	J	W	V	U	O	W	R	O	S	O	P
C	F	E	D	C	Y	C	L	E	C	T	B	N	N	A

- cycle
- erosion
- evaporation
- insects
- lake
- plants
- precipitation
- riparian
- tributary
- watershed
- runoff
- salmon
- saturation
- river
- sea
- stream
- topography
- trees
- water

What a Map Tells Us

Watersheds of Whatcom County

1. What are the four major drainage basins in Whatcom County?________________

____

2. What is the largest lake on the map? ____

3. What is the biggest river in Whatcom County?

____

4. Identify three tributaries to the Nooksack River:

____

5. Name the body of water into which the Nooksack River flows:

____

6. How many forks does the Nooksack River have? ____________________________

7. Starting at the North Fork Nooksack River headwaters, list all of the towns that the Nooksack River flows through: ____

____

8. Which streams flow into Washington from Canada?

____

9. Which streams flow into Canada from Washington? ___________________________

10. Find your school on the map. What watershed is your school in?

____

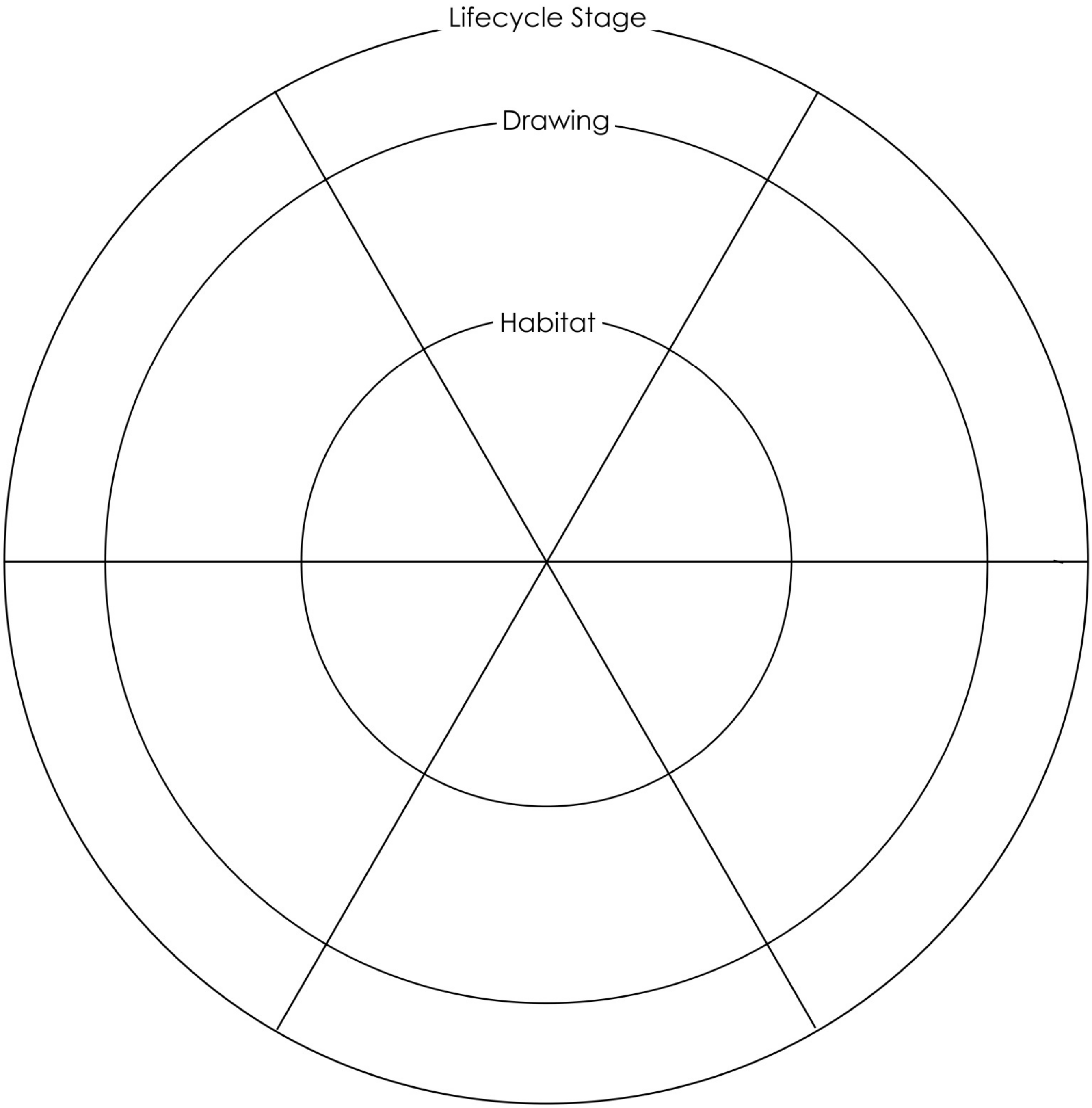
UNIT 2 - Salmon

Led by Classroom Teacher

What We Know	What We Want to Know

Salmon Life Cycle Notes

Salmon Life Cycle Diagram


Lifecycle Stage
Drawing
Habitat

Pacific Salmon Species

How big is the biggest salmon? The smallest?
The largest salmon is a Chinook, which can grow to be 58 inches (147.3 cm) long and 100 pounds (45.5kg). The smallest salmon is the pink.

How fast can salmon swim?
A migrating sockeye salmon can swim for long periods at an estimated speed of one body length per second. For a 24 inch fish, the speed is 1.4 miles per hour. For short distances of burst swimming, the speed can be five or more body lengths per second, or at least 7.0 miles per hour. When swimming against a strong current in a river, the swimming speed can be less.

How high can a salmon leap?
Chinook, coho, and sockeye can jump as high as eight feet. Chum and pink salmon usually jump no more than three feet.

What predators eat salmon?
<u>Juvenile salmon:</u> larger trout, salmon, sculpins, squawfish, crows, northern pikeminnow, mergansers, osprey, kingfishers, terns, gulls, and other birds.
<u>Adult salmon:</u> eagles, gulls, seals, whales, halibut, dolphins, wolves, and people.

Why do salmon turn different colors when they spawn?
Salmon lose their silvery color when leaving the ocean. The scales are absorbed into the skin and other skin pigments appear. Scientists think that spawning colors help salmon find members of their own species to mate with.

How does a salmon find its home stream?
Fisheries scientists believe that salmon navigate at sea with an inner magnetic compass. They can also sense day length, which lets them know when the seasons are turning as the length of day changes. As a migrating salmon approaches its home stream, its sense of smell comes into play and it follows the familiar smell of the stream it lived in during its juvenile phase of life. This

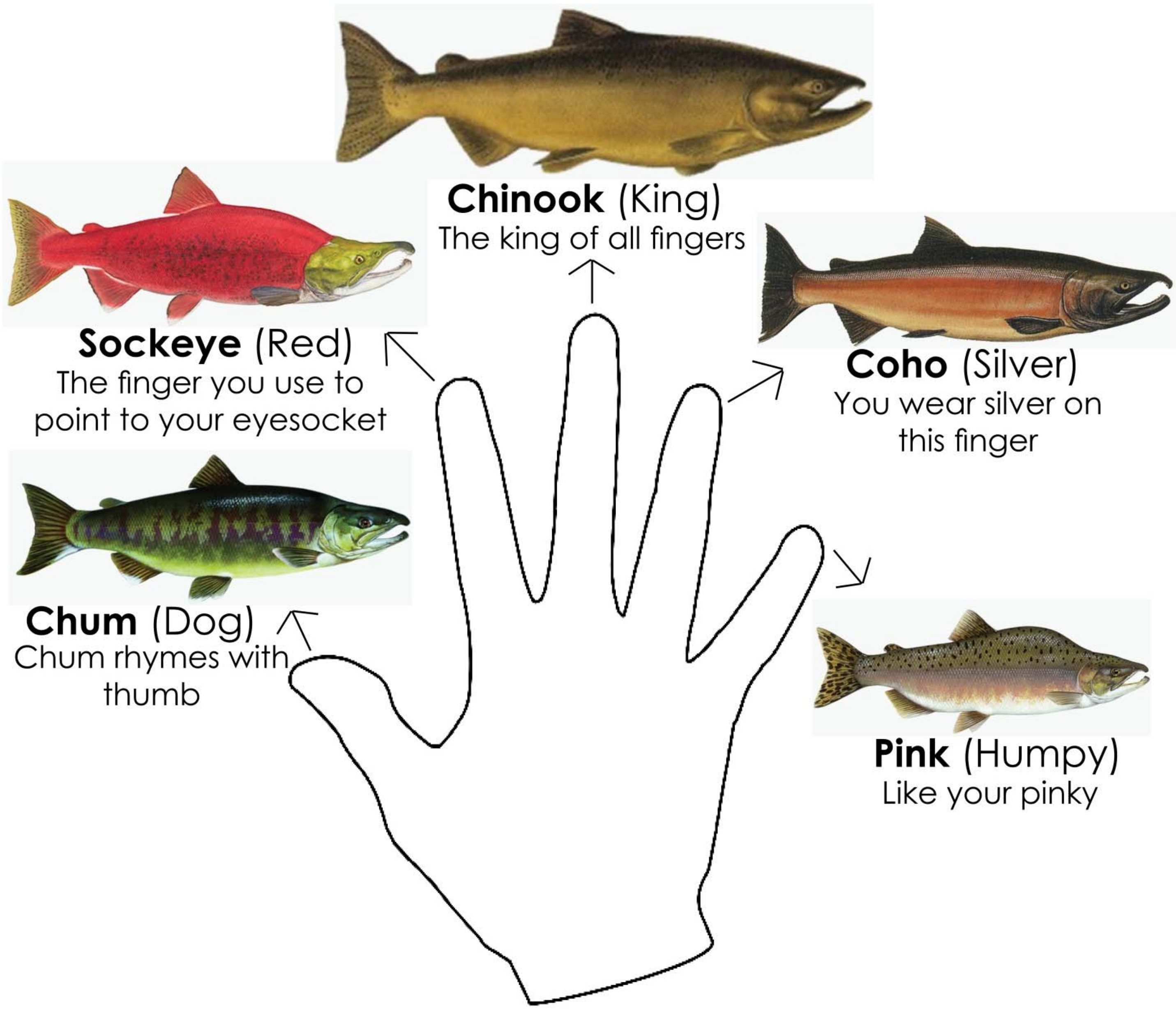
migration back to their home stream is a result of "home stream imprinting" that occurred as the juvenile salmon migrated to the ocean.

Salmon are anadromous fish. What is an anadromous fish?

Anadromous means that a fish spends part of its life cycle as a juvenile in fresh water where it was hatched, then migrates to the ocean to become an adult over a period of many months or years, and then returns to the fresh water to spawn and produce offspring.

Five Pacific Salmon Species in Whatcom County

Helpful hints to remember our Pacific salmon!



Chinook

Also known as: Blackmouth, King, Spring, Tyee
Scientific Name: *Oncorhynchus tshawytscha*
Average Weight: 10-24 lbs (4.5-10.9 kg)
Length at Maturity: 36-58 inches (91.4-147.32 cm
Status in Nooksack Watershed: Threatened

Chinook Life Cycle:

- There are two different types of Chinook in Whatcom County—Spring Chinook and Fall Chinook.
- Spring Chinook migrate upstream from April to July and spawn early August to September. Fall Chinook salmon spawn October to November.
- Spring Chinook spawn in the three forks (South, North, and Middle) of the Nooksack River and in a few larger tributaries (such as Canyon Creek).
- Fall Chinook spawn in the Nooksack's upper main stem, the North Fork, and larger tributaries (such as Bertrand Creek and Fishtrap Creek). They also spawn in Whatcom Creek.
- Chinook may be three to five years of age at the time of spawning.
- Juvenile spring Chinook migrate to the estuary after several months in fresh water (they are known as 'ocean type' Chinook) or after one year in fresh water ('they are known as 'stream type' Chinook). Fall Chinook are usually the ocean type, migrating to the ocean after several months.

Habitat Needs:

Chinook are most often found in rivers and occasionally in larger creeks. Spawning usually occurs in fast water side channels and main stem areas with fist-sized gravel.

Chum

Also known as: Dog, Keta, Calico, Silverbrite
Scientific Name: *Oncorhynchus keta*
Average Weight: 9-15 lbs, up to 40 lbs (4.1-6.8 kg, up to 18.1 kg)
Length at Maturity: 25-40 inches (63.5-101.6 cm)
Interesting Fact: Whatcom Creek in Maritime Heritage park is home to one of the largest recreational fisheries for chum in Washington State.
Status in Nooksack Watershed: Not warranted

Chum Life Cycle:

- Chum migrate and spawn in the mainstem, forks, and tributaries of the Nooksack River and in Chuckanut, Padden, Squalicum, and Whatcom Creeks between November and January.
- Chum may be three to five years of age at spawning
- The carcasses of chum are an especially important food source for bald eagles and this can be observed at sites along the Nooksack's north fork.
- Chum rear in the freshwater for up to one month and then migrate to estuaries.

Habitat Needs:

Chum can often be found spawning where groundwater upwells through the spawning gravel. Upon entering the estuary, juveniles prefer tidal sloughs and small estuaries associated with the nearshore.

Coho

Also known as: Silver

Scientific Name: *Oncorhynchus kisutch*

Average Weight: 6-12 lbs, up to 31 lbs (2.7-5.4 kg, up to 14.1 kg)

Length at Maturity: 24-38 inches (61.0-96.5 cm)

Status in Nooksack Watershed: Not warranted

Coho Life Cycle:

- Coho migrate back to freshwater to spawn between October and January in the Nooksack River and its tributaries. Coho also spawn in the Dakota and California Creek watersheds, and in Terrell, Squalicum, and Whatcom Creeks.
- Juvenile coho usually spend at least one year in freshwater before migrating to the ocean. They usually spend two years in the ocean and return to spawn at the age of three years.

Habitat Needs:

Spawning coho are often found in small, lowland creeks not used by other salmon.

Pink

Also known as: Humpy, Humpback

Scientific Name: *Oncorhynchus gorbuscha*

Average Weight: 2-5 lbs, up to 12 lbs (1.0-2.3 kg, up to 5.4 kg)

Length at Maturity: 20-30 inches (50.8-76.2 cm)

Status in Nooksack Watershed: Not warranted

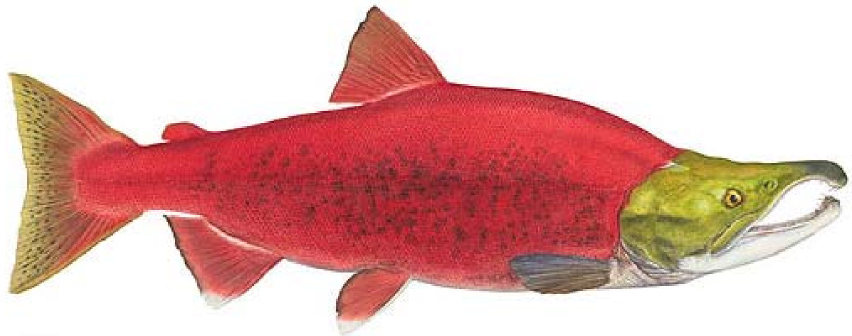
Pink Life Cycle:

- Pink spawn from August to September. At the time of spawning, pink are two years of age. Due to their short time spent in the ocean, pink are the smallest adult Pacific salmon. In the Nooksack, there are primarily odd year pink, meaning they will spawn every odd year (example: 2013, 2015, etc.), however there is a small population of even year pink (example: 2012, 2014, etc.).
- Pink salmon spawn in the Nooksack River and the larger tributaries of the Nooksack.
- After a few weeks, juveniles migrate from freshwater to the estuary. This means that of all five species of Pacific salmon, juvenile pink (as well as chum) are the least dependent on freshwater environments.
- In the summer, it is common to see schools of juvenile pink and chum salmon along the nearshore (area of the bay that is close to shore).

Habitat Needs:

Pink salmon often spawn closer to the sea than other species; sometimes they even spawn in the salty nearshore or in estuaries.

Sockeye



Also known as: Red, Blueback
Scientific Name: *Oncorhynchus nerka*
Average Weight: 4-8 lbs, up to 15 lbs (1.8-3.6 kg, up to 6.8 kg)
Length at Maturity: 25-33 inches (63.5-83.8 cm)
Status in Nooksack Watershed: Not warranted

Sockeye Life Cycle:

- Most sockeye spawn in the tributaries of a lake or along the lake shore at four years of age.
- The juveniles soon move from the tributary into the lake, where they spend one to two years before migrating to the ocean.
- There is no lake connected to the Nooksack River, however sockeye spawn in the North Fork of the Nooksack River.
- There are some sockeye, called kokanee, that stay in freshwater their entire lives instead of migrating to the ocean. Kokanee are present in Lake Whatcom, Lake Padden and Lake Samish.

Habitat Needs:

Most sockeye require the presence of a lake in their watershed. Sockeye have adapted to use lakes during the fry stage of their life cycle. However, sockeye in the Nooksack River have learned to survive without the need for a lake!

Five Salmon Species of Whatcom County

Species Name (Common and Scientific)	**Weight**	**Length**	**Interesting Fact**

Identify Five Local Pacific Salmon Species

Use this key and the pictures at each station to identify the different local salmon species that you have learned about.

Instructions:

1. Start at question 1.
2. Read the question, then look at the picture and read the clues on the station card.
3. Answer the question and follow the directions for the next step.
4. Go to the next step.
5. Repeat the process until you identify the fish

Question 1: Does salmon have spots on dorsal and caudal fins?

1a. Yes, salmon has spots on dorsal and caudal fin. **Go to 2**

OR

1b. No, salmon does not have spots on dorsal or caudal fin. **Go to 4**

Question 2: Does salmon have spots on entire caudal fin?

2a. Yes, salmon has spots on entire caudal fin. **Go to 3**

OR

2b. No, salmon has spots only on top half of caudal fin. Has white gums.

Station # _______, Coho Salmon (*Oncorhynchus kisutch)*

Question 3: Is salmon large or small in size?

3a. Largest Pacific salmon species (10-24 lbs, 36-58 in). Has grey gums.

Station # _______, Chinook Salmon (*Oncorhynchus tshawytscha)*

OR

3b. Smallest Pacific salmon species (2-5 lbs, 20-30 in). Develops a large hump when spawning.

Station # _______, Pink Salmon (*Oncorhynchus gorbuscha)*

Question 4: Does salmon have large or small pupils?

4a. Salmon has small pupil and develops bright red bodies when spawning.

Station # _______, Sockeye Salmon (*Oncorhynchus nerka)*

OR

4b. Salmon has large pupil and develops red or purple vertical bars on body when spawning.

Station # _______, Chum Salmon (*Oncorhynchus keta)*

UNIT 3 - Salmon Habitat

Led by Classroom Teacher

What We Know	What We Want to Know

The ABC's of the Riparian Ecosystem

Take the cards given to you by your teacher. Read the words on the card and decide which category it falls in: abiotic, biotic, or cultural. Go to the front of the class and place your card under the correct category.

A = Abiotic	B = Biotic	C = Cultural
This means the nonliving parts of the ecosystem, including:	*This means the living parts of the ecosystem, including:*	*This means human uses of the stream and land surrounding the stream, including:*

Riparian Restoration

A Stream is More Than Water

What is a **Riparian Ecosystem?**

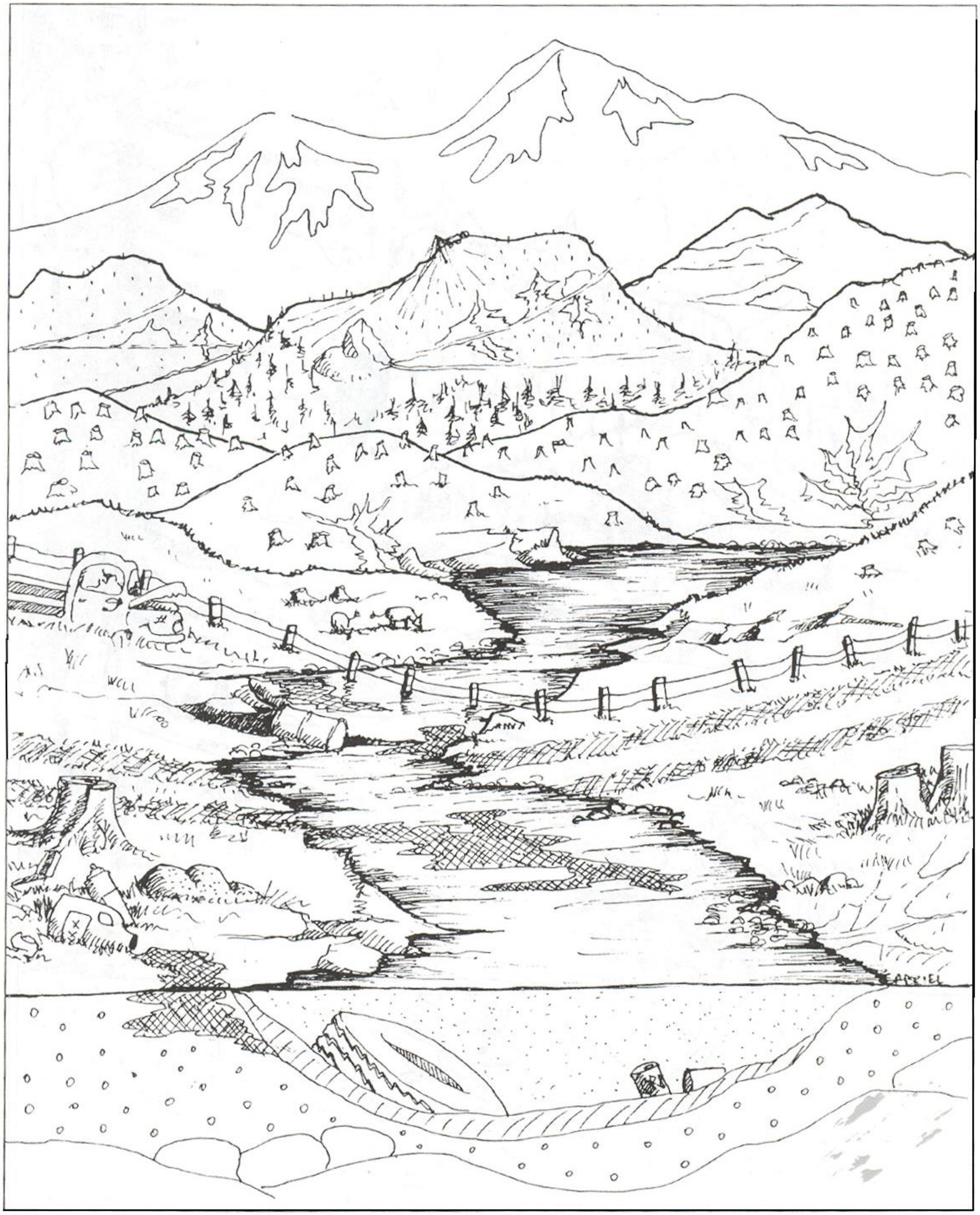
What is a **Degraded Riparian Ecosystem?**

- Using the Degraded Riparian Ecosystem drawing and a brightly colored pen, circle and label the areas of the drawing that are degraded.

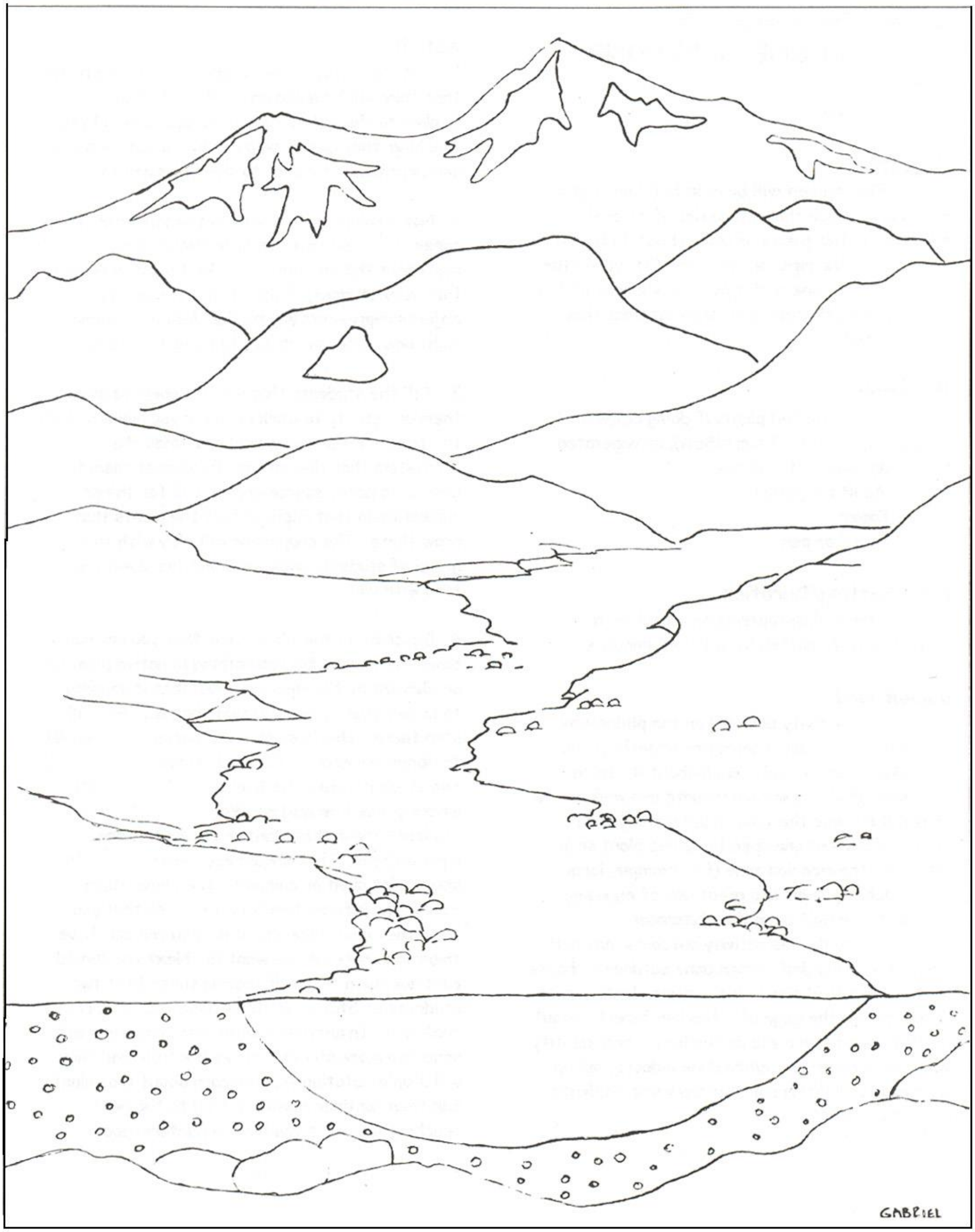
What is a **Restored Riparian Ecosystem?**

- Using the Restored Riparian Ecosystem drawing, art supplies, and your Riparian ABC's list, create and label a restored habitat that includes things that salmon need to survive. Check out the Riparian ABC's list you've already created—which of these things should you include?

A Degraded Riparian Ecosystem



A Restored Riparian Ecosystem



Riparian Restoration

A Salmon Stream Restoration Story

Use the space below to write about your stream's transformation from a degraded riparian ecosystem to a healthier, restored riparian ecosystem.

The Salmon Forest

<u>During the Video</u>:

Take notes on interesting facts and new ideas from the video below:

<u>After the Video</u>:

The narrator focuses mostly on bears in this video. Can you name 3 (or more) other living things in the forest that depend on salmon?

List two ways salmon help the forest:

List two ways forests help salmon:

With the information you gathered from the video, create a diagram below that shows how salmon nutrients move and cycle through the forest.

UNIT 4 - Stream Exploration Field Trip

Led by NSEA

What We Know	What We Want to Know

UNIT 5 - Save Our Salmon

Led by Classroom Teacher

What We Know	What We Want to Know

Sharing the Planet

Pollution Investigation Notes

Type of Pollutant	How does it get into the ground or water?	What problems does this cause?	What can we do to prevent this source of pollution?	Name a few things we could do to teach others how to prevent pollution.
Oil and Gas				
Soap				
Litter				
Sediment				

Type of Pollutant	How does it get into the ground or water?	What problems does this cause?	What can we do to prevent this source of pollution?	Name a few things we could do to teach others how to prevent pollution.
Dog Poop				
Pesticides				
Fertilizers				
Phosphorous				

Sharing the Planet

Task:

A new business park is scheduled to be built next to our creek (where we had our Nooksack Salmon Enhancement field trip). Explain the many factors (changes) that may now affect the health of the creek ecosystem in this watershed during and/or after construction.

Presentation:

You may present the information in a format of your choice (essay, mini-poster, PowerPoint, skit, video, etc.).

Resources:

You may access all of the resources in your student journals. You may also conduct additional research.

Criteria:

Include the information you gathered on the water quality and the health of the riparian ecosystem during the field trip.

Describe each factor that could change the health of our creek and include how each factor impacts the health of the riparian ecosystem as well as the creek itself.

Describe the many ways that we as "Salmon Stewards" can reduce the amount of pollutants in any watershed to ensure a healthy habitat.