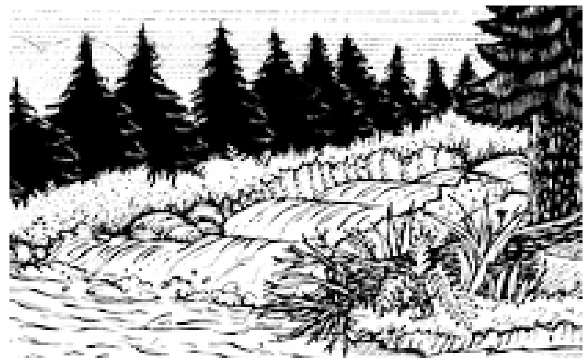
UNIT 5. LIFE IN A WATERSHED



INTRODUCTION

Why do you live in your neighborhood? Is it a matter of livability? A job? The beauty of the region? Something brought you here, something told you that “this is the right place.” Do salmon have this experience of knowing when they’re in the right place? If so, how can we find this out?

You may not have consciously applied criteria to possible places to live. However, when you chose your place, you knew it was the right place. So it is with our salmon friends. No matter how old they are, they know the right place. What makes a place “right” for them? In this unit, we examine the places where salmon choose to live, and attempt to understand why. Understanding why is not easy -- we can’t interview a salmon!

After completing this unit, students will better understand watersheds. They should know the characteristics of good habitat for salmon, and understand how physical and biotic activities up- and downstream affect this habitat. They should also be aware of the concept that the presence of an organism in an environment is an indication of its ability to adapt to the range of physical and biotic parameters presented by its environment. Thus, the organisms that live in a habitat are a good indication of its condition.

OBJECTIVES:

Students will:

- know and understand physical features, functions and management of watersheds.
- ascertain the characteristics and qualities of good salmon habitat.
- know and understand how salmon are a key indicator species of watershed health.
- learn how to use aerial photos and maps to learn about watersheds.
- develop and demonstrate how watersheds work.
- know and understand the relationship between wetlands and salmon.
- know and understand the properties and benefits of wetlands.
- identify and understand the physical characteristics of streams.

SECTIONS

A. Watersheds
B. Water quality and quantity
C. The role of wetlands
D. Physical structure of streams
E. Salmon as an indicator of the health of a watershed

UNIT 5A. WATERSHEDS

ACTIVITIES	TIME	LEVEL
Watershed Reading & Discussion	30-45 minutes	Advanced
Bird's Eye View of a Watershed	60-90 minutes	All
Creating a Watershed Model	2-4 class periods	Introductory

BENCHMARKS	
Next Generation Science Standards	MS-ESS2-4 MS-LS2.C MS-ESS2.C HS-ESS2.E HS-ESS3.A
Common Core-State Standards-ELA/Literacy	CCRA.R.1 CCRA.R.4
Common Core-State Standards-Speaking&Listening	CCRA.SL.1
Science & Engineering Practices	-Asking questions and defining problems. -Developing and using models. -Engaging in argument from evidence. -Obtaining, evaluating & communicating information.
OR Social Sciences Academic Content Standards	HS.63

INTRODUCTION

We are all familiar with our own neighborhood. We know the homes and their inhabitants. We become less familiar as we consider what lies outside the neighborhood. Neighborhoods are part of a larger structure: city, county, and region. Watersheds, large and small, and their connections, are the salmon's cities, counties and regions. Just as our larger civic bodies provide our neighborhoods' needs, watersheds provide a salmon's needs. The watershed provides the water at the site; what happens upstream affects this water; what happens at the site affects water downstream.

In this section, we learn what watersheds are, the different kinds, the effects upon them, and how they are managed. Students read about watersheds, then explore them using aerial photographs and maps, engaging in a discussion of watersheds and their place in providing for the needs of organisms who live in or depend upon the stream.

OBJECTIVES:

- Students will gain a full understanding of the physical features and functions of watersheds, with salmon as the key indicator of watershed health.

KEY QUESTIONS

- ➔ What is the difference between a stream and a watershed?
- ➔ How do watersheds fit into the life of a salmon?
- ➔ What are a salmon's habitat needs and how does land uses affect them?

VOCABULARY (Brief definitions of vocabulary terms are found in the Glossary.):

watershed	precipitation	contour
stream flow	in situ	topographic
stream channel	channel area	run off
channel movement	ecological	watershed management
channel gradient	temperature	

ACTIVITIES:

WATERSHED READING AND DISCUSSION

MATERIALS:

- Reference material
- STUDENT HANDOUT 5A-1: Watersheds, Stream Scene

PROCEDURE:

1. Assign STUDENT HANDOUT 5A-1: Watersheds, Stream Scene, which describes the types of watersheds.

2. Engage the class in a discussion about their own watershed.
    - What is it?
    - Can they find it on a map?
    - How can we tell that what we see on a map is our watershed?
    - Where do your students get their drinking water?
    - Where does water and sewage go when they flush their toilet?

Note: Oregon Dept. of Environmental Quality Water Laboratories has water quality reports on file for many watersheds in the state. These reports are available for classroom use. They contain measurement records for a number of water quality parameters. Use these in the classroom to learn more about your own watershed. Obtaining these reports makes a good student project.
(503-229-5696; http://www.oregon.gov/DEQ/WQ/Pages/default.aspx)

BIRD'S EYE VIEW OF THE WATERSHED

(This activity was developed by Paula Minear, Oregon State University)

MATERIALS:

- Aerial photos of your site:
  - Recent low elevation
  - Within last 10 years at higher elevation
- Historical maps of your site:
  - Recent of site
  - Pre-World War II
  - Original survey maps (1800)
- Overhead pens

Note: aerial photos can be borrowed from resource agencies and city/county governments or university map libraries.

PROCEDURE:

1. Introduce the bird's eye view activity by talking with the students about how they observe tiny little things, then larger and larger objects. How do they see things differently as they pull away and look from a distance? Ask them what their classroom might look like if they were looking down from the ceiling. You might have them sketch an aerial view of their home or neighborhood or of their school and grounds. Depending upon the readiness of your students, you may want to introduce the idea of different scales (micro to mega; not metric versus English).

2. Present each team with the first aerial photograph. You might explain that aerial photos may be taken from a variety of aircraft, including ultralights and spy planes, and have many uses. Aerial photos were first used extensively in the 1930s. Natural resource agencies like B.L.M. and the Forest Service use them to spot landslides, identify diseased trees, map roads, and measure vegetation, among other things. Private timber companies like Weyerhauser will also use aerial photos to keep track of their lands.

3. Ask them to pick out a major feature of your choice, perhaps the river or the school. Have each student put their finger on the object you have asked them to identify, so you are sure they are with you. Now have each team orient themselves and their aerial photo with the real world, holding it flat in front of them as they turn appropriately. Check them for comprehension. Can they point to objects on the ground that they have identified in the photo?

4. Give each team 5 minutes to identify other features in the photo, by discussing it within their teams. You may wish to point out that conifer trees show up somewhat darker green and pointy at the top, while deciduous trees are lighter green and fluffier-looking in the color aerial photos. If you wish, you could have the students actually label the features on the aerial photo using the overhead pens (non-permanent). At the end of the time have each team show one interesting thing they see in the photo. Does this new view of the world give them an interesting perspective they didn't have before?

5. During the analysis of this aerial photo, make sure the students have discussed conditions of special importance to salmon, for example: Where is the nearest stream? (Have them put their finger on it to check.) Does it have a riparian area? Are there places where the riparian vegetation is missing? (Review the importance of riparian vegetation to stream conditions.) Can they identify bridges, houses, and roads near the stream? What other land uses are nearby?

6. Now give them the second photo, taken at a higher altitude, and again have them orient themselves, identify major features, and then discuss in their teams and present additional features they have found and differences they have seen from the first photo. What has been gained by taking the picture from a higher altitude? What has been lost? If the photo was taken several years previously, they may also notice differences in buildings, roads, and vegetation.

7. What major land uses do they notice in this aerial photo (#2)? If you are at your Salmon Watch site, you may see agriculture, forestry, and roads. In an urban setting, you may notice that the stream disappears into culverts, has been forced to bend around buildings, etc. Talk about how each of these land uses has a potential impact upon salmon or their habitat. Alternatively, you may give each team one land use to discuss and have them share with the class how they think that land use would affect salmon. Also point out that land uses upstream of the stream will affect salmon habitat downstream. Have them show you some examples of upstream land uses on the photos.

8. Let them keep the original photos for comparison, and hand them the last aerial photo, the one taken a long time ago. It will probably be black and white, so help the students make the adjustment from seeing vegetation and features in color to black and white. Again, give them time in their groups to discuss similarities and differences and then share with the class. How have conditions in this watershed changed over time? Is the riparian area wider or narrower? Rather than tell them what year the photo was taken, have them guess first. You will be reminded that their understanding of the concept “old” is different from yours!

Time is another important scale. (You may want to include a full discussion of this concept). It is critical to evaluate how watershed land uses have changed over time in order to understand the decline in our salmon populations.

9. What would it look like if someone could have taken an aerial photo back before the settlers and trappers came to this area? Perhaps the students would like to draw what they imagine it would have looked like. You may wish to use students' knowledge of early pioneers to discuss how settlers changed the landscape (clearing and burning land for fields, clearing rivers for navigation, cutting riparian timber and creating splash dams to float logs to market, damming and diverting water for irrigation, building roads, etc.) Native Americans were known to have set fires in the valleys to reinvigorate the grasslands. How would a fire pattern look different from a cultivated field?

10. If you have located old maps, show them to the students, help them orient to the maps, and have them point out features as they did with the aerial photos. Maps are somewhat more abstract than aerial photos, so it is possible that not all students will comprehend the meaning of the symbols on the maps. You may be able to go back as far as the 1850s with the original plat maps, drawn after the survey that divided the land into sections, ranges and townships. This survey established the major north-south; east-west grid pattern that we see imposed upon the landscape in the aerial photos and in the land ownership. Have the students observe or measure the difference in plot size between present times and the original survey. These plat maps show major river channels, land ownership, towns, sections, and describe vegetation, Students may recognize names that have persisted locally since the 1800s.

CREATING A WATERSHED MODEL

OBJECTIVES:

Students will be able to:

- explain and demonstrate how contour lines on a topo map are related to the features on the three dimensional map
- show the following on a model: the boundary of a watershed
- the course that water takes over the land
- the stream(s) and/or river that watershed drains into
- identify, in general, how the land within a watershed is used and how those uses may effect water quality in a stream.

MATERIALS:

- Topographic map of a watershed (your own if possible)
- Sheets of ¼ or ½ inch Styrofoam (4x8 feet is a standard size, they may be cut to the size you need)
- Butcher paper
- Pencils and marking pens
- Burnishing instrument
- Serrated butter knives
- Masking tape
- Rulers
- Overhead projector
- Paper mache
- Paints and paint brushes
- Push pins
- Pitchers and buckets

BACKGROUND INFORMATION TO RELATE TO STUDENTS:

A watershed is a place, which receives and stores water. It is made up of rock, soil, leaves, grasses, trees, brush and many other forms of life. Acting much the same as a sponge, it absorbs water and releases it slowly. The key to a healthy watershed is topsoil. Topsoil is more than dirt; in nature it does not exist separate from vegetation, which builds it, nor from animals, which live in it and refine it. The watershed's contributions to life forms are oxygen, a mellowing influence on climate, plentiful food and shelter, pleasant scenery and water.

PREP:

Make a transparency of the watershed from the topo map or use an opaque projector to enlarge it. If you are in a hilly area, you will probably not trace every contour line. You should trace at intervals so that the scale is about 2-" units vertical to one unit horizontal.

It may be easiest to blow up the map until the contour lines are big enough that they could be cut out into the Styrofoam. Look for little fingers of the land that may cause problems. Now figure out what the new scale is. If it was 1 inch = 1 mile, and you have increased the size by five, then 5 inches = 1 mile. (Horizontal)

PROCEDURE:

1. CUT THE STYROFOAM SHEETS. Begin at the lowest elevation. This will be the innermost contour line on the map, and will have the least amount cut out of the Styrofoam. This section will be placed on a base sheet. Continue to trace and cut each level. The Styrofoam will break, so warn students to be careful when they are cutting around fingers of land or other narrow pieces.

2. STACK THE LAYERS AND GLUE. As you cut out each elevation level, put in on top of the one below it. When you are done, look at the slope to see if it looks reasonable. It is still not too late to make adjustments, such as adding or taking out a few sheets to give the proper scale. When it looks right, glue the sheets together. Begin at the bottom. You will need plenty of glue, and several workers for this task!

The glue will take a couple of days to dry. Put heavy books or boards on the top of the model to assure good contact between all surfaces.

3. ROUND OFF SHARP EDGES. Once the model has dried, you should round off the edges of the Styrofoam layers, so the land doesn't look like staircases. Usually, landforms are more sloping, but his will depend on the geology in your area. Use a knife to shave off the sharp corners.

4. FINAL TOUCHES. Once the basic model is a complete, challenge student to use their creativity to make the watershed a comprehensive model. Use any number and kinds of materials as symbols representing and designating vegetation, land use, etc. Soil, sticks, leaves, legos, matchsticks, etc. make great symbolic materials. Discuss the kinds of activities that occur in this watershed and relate them to the condition of the streams. Label all geographic features and parts of the watershed. Place materials in the stream or river like gravel, sand, root wads, woody debris, etc.

5. WATERSHED IN ACTION. Place a bucket at one end of the watershed model. Have a student slowly pour water down a several sides of the watershed. Lead a discussion about how the watershed functions and problems that can occur like flooding. How do roads, development, etc. affect the watershed? How should the watershed be managed?

EXTENSION ACTIVITIES:

- As a homework exercise, you might have students check out the aerial photos or maps to show to long time residents and report back their findings. Students could research aspects of area history they have discovered in the photos/maps.

- Each team could compile and present a report on a particular land use in the watershed, how this land use affects salmon habitat, when it first started, how widespread it is, whether it is expected to increase or decrease in the future, and what could or should be done about it.

- Have your students study pre-settlement conditions in their watershed. Create a pre-settlement map or representation of an aerial photo. How do they think the land and river looked in the 1700s? Be sure they consider natural processes such as floods and fire in their representation.

- Create a salmon timeline, marking off the major events from the first salmon ancestors to the use by Native Americans, the coming of the settlers, major canning operations, extensive log drives on the rivers, construction of hydroelectric dams, first listings of endangered salmon runs, etc. Have your students reflect on the length of time salmon have existed, the conditions to which they adapted during that time, and the relative length of time humans have impacted those conditions.

- If you have access to a satellite image of your watershed, have students find major landmarks, then compare relative amounts of each kind of vegetation (depending upon what information is available with the image). Talk about the use of satellite imagery in monitoring the environment (or invite a guest speaker). What is gained or lost in using this new scale for observation of your watershed?

- Pass out worksheets from Stream Scene, Does the earth wear a raincoat? pp. 37-40 to the class. Students then use the worksheet to analyze the Umatilla Watershed. After they have finished, discuss the concept of watersheds with the class.

- Find a map with local rivers and streams and have your students find a stream near their house. Then, ask them to find streams that drain into it. What happens if someone pollutes the stream or if the student pollutes? Use this approach to adapt the Stream Scene watershed curriculum to your class. As the year progresses, encourage your students to pin out events on the map. Keep track of rainfall, and ask your students to contribute their observations about their stream during periods of high or low rainfall. They can make turbidity observations once a week, and add them to the rainfall data. If you do this on a large poster, students will begin to see relationships between the weather and events near their home.

EXTENSION CURRICULUM:

A. Watershed, Project Wild Aquatic, pp. 132-139, involves an activity in which students measure the area of a small watershed using a local site approximately 100 ft x 100 ft. They calculate the amount of water received by this area each year, and then explore the role watersheds play in human and wildlife habitat. This can be done in any schoolyard.

B. California's Salmon and Steelhead, Our Valuable Natural Heritage, pp. 116-117, uses an outline of a river and drawings of physical and biotic stream components to teach how to make a river map. Pp. 124-126 teaches how to interpret graphs of data. Pp. 127-132 contain reading, map-making and modeling activities to teach about watersheds.

C. INTERDISCIPLINARY INTEGRATION IDEA: Have a math teacher help students learn how to calculate irregular areas. Then, they can apply this to the measurement of watersheds, slopes, etc. Locate and do this for your school ground watershed. Review this section with the math teacher and provide as much information as you can about the watershed of your field site. Coordinate this lesson with a social studies unit on early settlers, the Homestead Act, or Native Americans.

Watersheds

4

"The study of rivers is not a matter of rivers, but of the human heart."
— Tanaka Shozo

All land on earth is a **watershed**. Humans and their activities play an important and essential role in watersheds, yet few people understand them. Still fewer know how a watershed works or can describe the boundaries of the ones in which they live.

A watershed is often called a drainage basin. It is the land area drained by a network of channels, called **tributaries**, that increase in size as the amount of water, sediment, and dissolved materials they must carry increases. Each watershed is an interconnected land-water system that conveys water to its outlet—a larger stream, an inland lake, a wetland, an estuary, or the ocean.

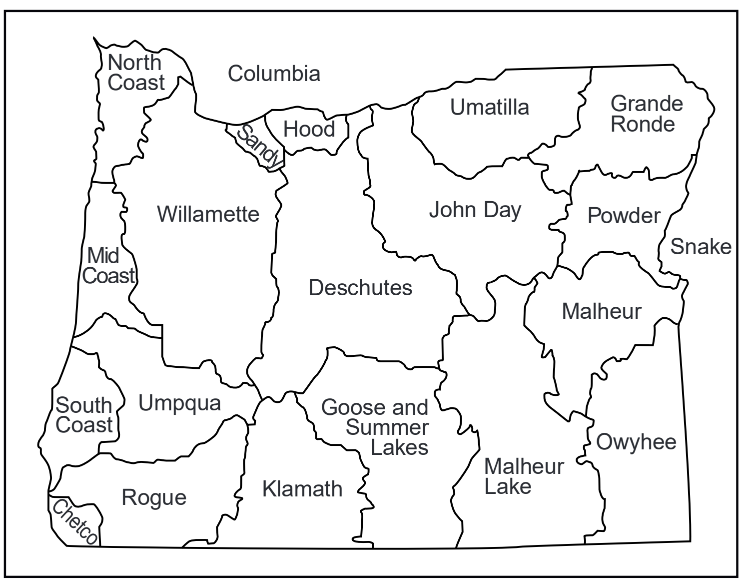
A watershed may be the drainage area surrounding a lake that has no surface outlet, such as Malheur and Harney Lakes in southeast Oregon or a river basin as large as that of the Columbia River. A puddle even has its own watershed.

Within a large watershed tributaries form smaller watersheds called **sub-basins**. Each tributary contributes to overall streamflow for the entire basin. Oregon has 20 major river basins (see Figure 4.)

All watersheds have an aquatic (or water) area, a riparian area, and an upland area. Aquatic areas include standing waters like ponds, lakes, wetlands, bogs and running surface waters such as streams and rivers. The corridor of vegetation next to and influencing the aquatic area is called the **riparian area**.

The point where two watersheds meet is called a **divide**. Connecting the divide with the valley or lowland areas below are the hill slopes or **uplands**. Events in the uplands ultimately

Figure 4. Oregon River Basins



Vocabulary

aquifers	perennial
baseflow	plant associations
climate	radial drainage
dendritic drainage	residual soils
deposition	riparian area
divide	streamflow hydrograph
ephemeral	sub-basins
erosion	sublimation
first-order streams	transported soils
forage	trellis drainage
gradient	tributaries
intermittent	uplands
leaching	water equivalent
parallel drainage	watershed

affect the capture of water on the surface of the land, storage and movement of water below the surface, and release of water to riparian and aquatic areas.

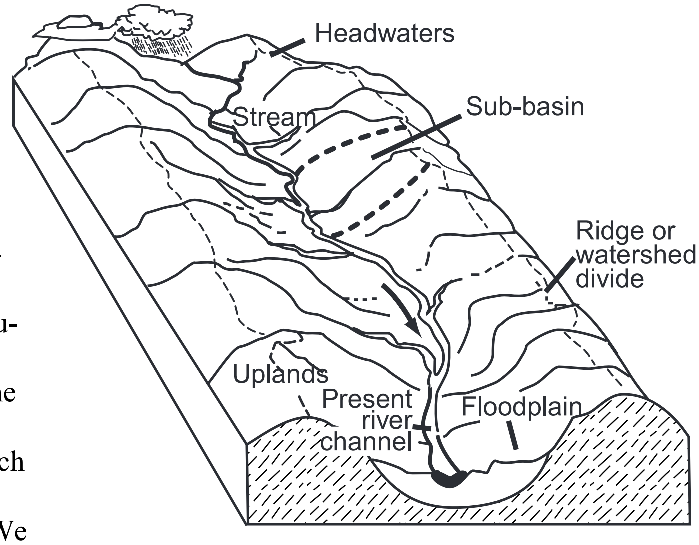
Each stream in a watershed is an ever-changing open-water system. It carves through valleys, collects water and sediments, and conveys the surface runoff generated by rainfall, snowmelt, or groundwater discharge to the estuaries and oceans. The shape and pattern of a stream is a result of the land it is cutting and the sediment it must carry.

Each of us has a "watershed address," which describes our basic relationship with a watershed. One part of our address is our location. We all live in topographic watersheds—areas drained by a common stream. When a raindrop falls on the roof of our house, where is it going? What creeks or rivers will carry it toward the sea?

Some people also live in engineered watersheds, which may not follow topographic lines. When we turn on the faucet in the kitchen sink, what watershed did that water come from? When the water runs down the drain, what watershed is it going to? For example, while rainwater in much of the Portland Metro area flows into the Willamette River, much of Portland's domestic water supply is piped from the nearby Bull Run Watershed, a watershed that flows toward the Columbia River. In this way, one watershed is artificially connected to several other watersheds at once. The watershed of surface flow, the watershed where domestic water originates, and the watershed where wastewater goes are all connected. This means Portland residents live in one watershed and drink water from another, while their wastewater may affect their "home watershed" and others.

Physical features of a watershed

Rain, snow, wind, ice, and temperature variations are all agents of erosion in a watershed. The erosional effects of surface water create stream channels. As streams carve their way through a watershed, they are responsible for most of the "topographic identity" of a watershed.



A watershed is almost like a domicile, a mini-biosphere, with halls of hills and mountains, a floor of river or lake, and a roof of rain clouds. Adapted from *Co-Evolution Quarterly*, Winter 1976/77.

Area

The area of a watershed affects the amount of water that flows from the river or stream that drains it. Generally, with similar climates large watersheds receive more precipitation than small ones. Greater precipitation and runoff may occur on a smaller watershed in a moist climate than on a large watershed in an arid climate.

Shape and slope

Shape and slope of a watershed and its drainage pattern influence surface runoff and seepage in streams draining the watershed. The steeper the slope, the greater the possibility for rapid runoff and erosion. Plant cover is more difficult to establish and infiltration of surface water is reduced on steep slopes.

Orientation

Orientation of a watershed in relation to the direction that storms move across it also affects runoff and peak flows. A rainstorm moving up a watershed from the mouth releases water in such a way that runoff from the lower section has passed its peak before runoff from the higher sections has arrived. A storm starting at the top and moving down a watershed can reverse the process.

Orientation of a watershed relative to sun position affects temperature, evaporation, and transpiration. Soil moisture is more rapidly lost by evaporation and transpiration on steep slopes facing the sun. Watersheds sloping away from the sun are cooler, and evaporation and transpiration are less. Slopes exposed to the sun usually support different plants than those facing away from the sun. Orientation to prevailing winds has similar effects.

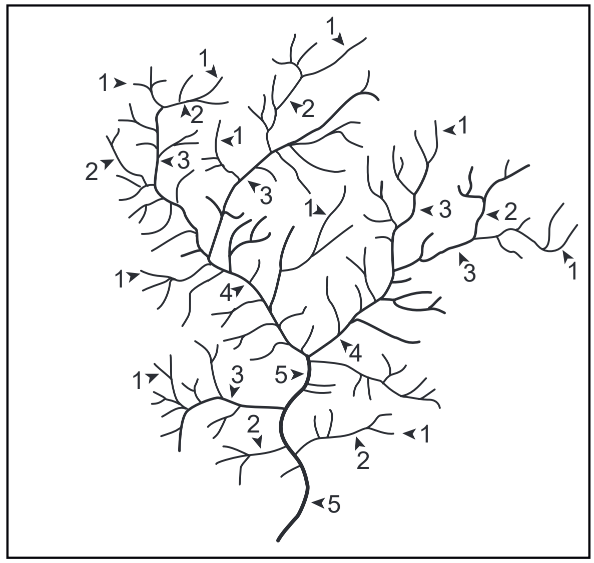
Drainage patterns

Viewed from above, the tributaries of each river system create a distinct pattern. Geology, topography, and climate are responsible for this pattern. Regions with parallel valleys formed by the folding of the earth's surface have a **parallel drainage** pattern. Where the geology is sedimentary rock, fault lines may create a drainage pattern where streams flow parallel to each other and tributaries join at nearly right angles in a **trellis drainage** pattern.

In the Pacific Northwest two of the most common patterns are **radial drainage** and **dendritic** (treelike) **drainage**. When streams drain a central high point, such as a mountain top, they create a pattern similar to the spokes on a wheel radiating out from the central hub. This is radial drainage.

The branching tributaries of a river may also create a pattern similar to the branches of a tree. This is dendritic drainage. Both types may occur within the same watershed. For example, the radial pattern of streams that drain Mount Hood are all within the Columbia Basin, but the drainage pattern of the individual sub-basins formed by these streams have a dendritic pattern.

Figure 5. Stream Orders

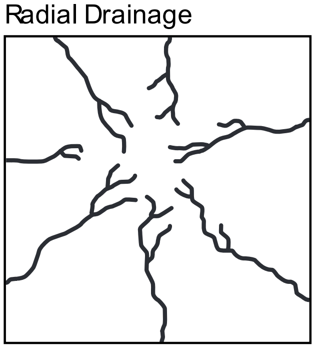


Stream orders

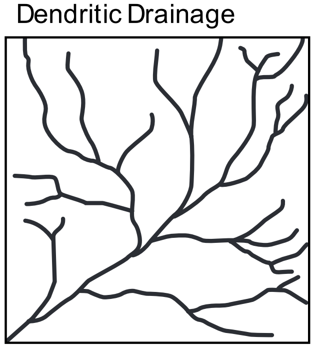
In most cases, a watershed system is almost entirely hillsides, called uplands. Only about one percent of a watershed is stream channels. The smallest channels in a watershed have no tributaries and are called **first-order streams**. When two first-order streams join, they form a second-order stream. When two second-order channels join, a third-order stream is formed, and so on (Figure 5). First- and second-order channels are often small, steep, or **intermittent**. Orders six or greater are larger rivers.

Channels change by **erosion** and **deposition**. Natural channels of rivers increase in size downstream as tributaries enter and add to the flow.

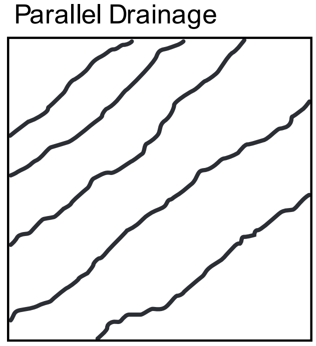
Radial Drainage



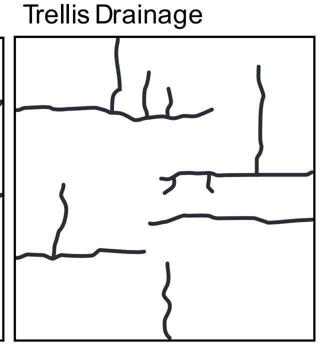
Dendritic Drainage



Parallel Drainage



Trellis Drainage



A channel is neither straight nor uniform, yet its average size changes in a regular and progressive fashion. In upstream reaches, the channel tends to be steeper. **Gradient** decreases downstream as width and depth increase. The size of sediments tends to decrease, often from boulders in the hilly or mountainous upstream portions, to cobbles or gravels in middle reaches. More sand or silt are found downstream. In some cases, large floods cause new channels to form, leaving once-productive streams dry and barren.

Streamflow types

Besides the ordering system previously described, streams may be classified by how much of the year they have flowing water.

- **Perennial** flow indicates a nearly year-round flow (90 percent or more) in a well-defined channel. Most higher order streams are perennial.
- **Intermittent** flow generally occurs only during the wet season (50 percent of the time or less).
- **Ephemeral** flow generally occurs during and shortly after extreme precipitation or snowmelt conditions. Ephemeral channels are not well defined and are usually head-water or low order (1-2) streams.

Factors affecting watersheds

Climate

Land and water are linked directly by the water cycle. Solar energy drives this and other cycles in the watershed. **Climate**—the type of weather a region has over a long period—is the source of water. Water comes to the watershed in seasonal cycles, principally as rain or snow. In some areas, condensation and fog-drip contribute water. The seasonal pattern of precipitation and temperature variation control streamflow and water production.

Some precipitation infiltrates the soil and percolates through porous rock into groundwater storage, which recharges areas called **aquifers**. Natural groundwater discharge, called **baseflow**, is the main contributor to streamflow during dry summer and fall months. Without baseflow, many streams would dry up.

Pumping water from an aquifer for industrial, irrigation, or domestic use reduces the aquifer's volume. Unless withdrawals are modified or recharge increased, the aquifer will eventually be depleted. A drained aquifer can collapse from the settling of the overlying lands.

Collapsed underground aquifers no longer have as much capacity to accept and hold water. Recharge is difficult, volume is less, and yields are considerably reduced. Springs once fed from the water table also dry up.

Land and water are linked directly by the water cycle.

Climate affects water loss from a watershed as well as provides water. In hot, dry, or windy weather, evaporation loss from bare soil and from water surfaces is high.

The same climatic influences that increase evaporation also increase transpiration from plants. Transpiration draws on soil moisture from a greater depth than evaporation because plant roots may reach into an available moisture supply. Transpiration is greatest during the growing season and least during cold weather when most plants are relatively dormant.

Wind also causes erosion, controls the accumulation of snow in sheltered places, and may be a significant factor in snowpack melting. Wind erosion can occur wherever wind is strong and

constant, or where soil is unprotected by sufficient plant cover.

Soils and geology

Soil, a thin layer of the earth's crust, could be called the "skin" of a watershed. It is composed of mineral particles of all sizes and varying amounts of organic materials. It is formed from the breakdown of parent rocks into fine mineral particles. This occurs by:

- freezing and thawing in winter,
- heating expansion and cooling contraction in summer,
- wind and water erosion,
- the grinding action of ice, and
- action of lichens and other plants.

Soils are of two types. **Residual** soils are those developed in place from underlying rock formations and surface plant cover. **Transported** soils include those transported by gravity, wind or water.

Climate, particularly precipitation and temperature, strongly affects soil formation. Rainfall causes **leaching**—movement of dissolved particles through soil by water. Temperature affects both mechanical breakdown of rocks and breakdown of organic material. Soil bacteria, insects, and burrowing animals also play a part in the breakdown and mixing of soil components.

Soil often determines which plants grow in a watershed, which in turn establish a protective vegetative cover. Plants also modify and develop soil. Plant roots create soil spaces and extract water and minerals in solution from their roots. Plant litter adds organic matter to soil. It also slows surface runoff and protects the soil surface from rainfall's beating and puddling effects. Soil depths and moisture-holding capacities are usually less on steep slopes, and plant growth rates are often slower.

Forage, timber, and water are all renewable resources. Water is renewed by cycles of climate. Forage and timber are renewed by growth in seasonal cycles. The availability of these watershed resources is dependent upon soil. Soil is, except over long periods, a nonrenewable resource. It may take more than a century to produce a centimeter of soil and thousands of years to produce enough soil to support a high-yield, high-quality forest, range, or agricultural crop. Soil is the basic watershed resource. Careful management and protection is necessary to preserve its function and productivity.

Vegetation

The variety of plant species and their growth and distribution patterns within a watershed are the result of differences in soil type, light, temperature, moisture, nutrient availability, and human activity. For example, temperatures on the north and south slopes of the same hill may vary considerably. Different light intensities may account for the temperature variation on either side of the hill. Temperature differences in turn affect the moisture levels on each of the slopes. Generally south-facing slopes are warmer and drier than north-facing slopes in the northern hemisphere.

The plant species that are present directly affect the ability of a watershed to capture, store, and release water within that particular habitat. Branches of large conifers effectively intercept snow and rain. Some of the moisture in the precipitation will evaporate before it has a chance to reach the ground but the rest is slowed in its descent, lessening the impact to the soil's surface. Sagebrush and other arid land shrubs, on the other hand, are not as effective in slowing snow or rain. Yet in areas with less precipitation, this adaptation provides the greatest opportunity for moisture to infiltrate. Watersheds covered with dense grass cover help the soil capture water much more effectively than watersheds with sparse vegetation.

Plants directly affect the ability of a watershed to capture, store, and release water.

Groups of plants that have evolved together over time are called **plant associations (or communities)**. Plant associations share specific adaptations to certain watershed conditions—climate, soil type, light and temperature requirements, moisture, and nutrient availability as described above. Knowing the basic plant associations found in a particular watershed can tell you a lot about the health of that watershed.

Fish and wildlife

Each watershed has a diverse mix of wildlife species—mammals, birds, reptiles, amphibians, and invertebrates. Plant communities influence which species are found in a particular watershed. Plants, in some form or another, meet the basic habitat needs of food, water, shelter, or space for most all forms of wildlife. And, all wildlife species, large or small, become part of the interrelationships found within a watershed.

Some wildlife never leave their watershed residence while others move among several adjoining watersheds or even migrate hundreds or thousands of miles to live in a completely different watershed during different times of the year. Wildlife populations within a watershed may vary seasonally and annually. Migration, predation, wildlife management (like hunting seasons), or watershed management decisions (development, timber harvest, mining, recreation, agriculture) can all affect wildlife populations.

Wildlife perform a variety of functions within a watershed. Less commonly known but very important contributions include burrowing activities of animals like worms and mice. Their burrows allow moisture to penetrate deep into the soil, aiding the water storage capabilities of the watershed. Small rodents also collect and store nuts and seeds, many of which sprout and grow to provide more food and ground cover. Rodents are also an important part of many watershed food chains. Birds also help transport seeds. Dams built by beavers help increase water storage in the soil and their activities are often responsible for channel changes within a stream system.

Limited exclusively to the aquatic habitats found within a watershed, fish occupy a unique niche. Fish are part of complex aquatic food chains and, along with the aquatic organisms on which they feed, are indicators of water quality.

A number of factors within the watershed control a stream's ability to produce fish food. When producers such as algae and diatoms are plentiful, the aquatic insects that feed upon them also thrive. They in turn are food for other aquatic invertebrates and fish. Overhanging streamside vegetation also contributes insects to the aquatic dinner plate.

Plants, in some form or another, meet the basic habitat needs of food, water, shelter, or space for most all forms of wildlife.

Studies in recent years show considerable evidence that stream systems with migrating populations of salmon and trout are highly dependent on the nutrients provided by the decaying carcasses that remain after spawning.

Fish populations vary with the quantity and the quality of available water within a watershed. Streams that flow cold and clean throughout the year generally provide the conditions that salmon and trout need to be healthy and productive. Human management activities can affect the quantity and quality of water in streams.

Management objectives in a watershed

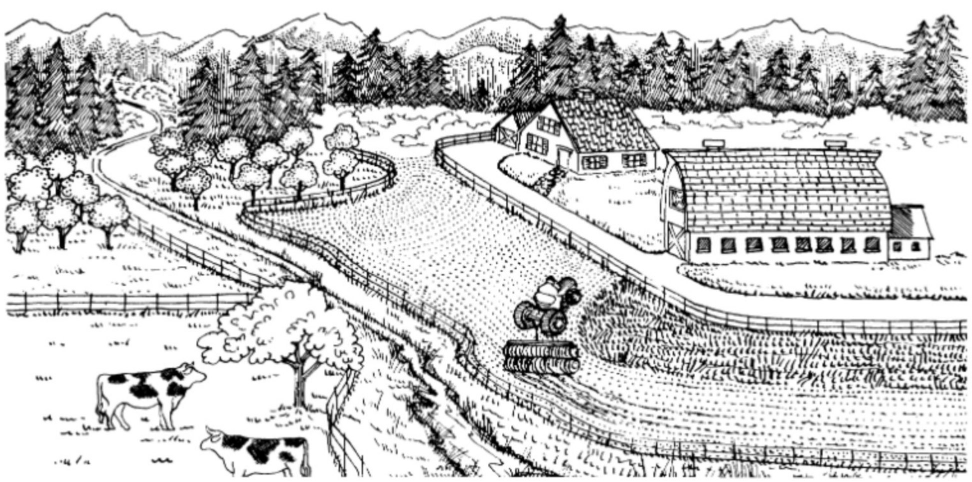
A key watershed management objective is to maintain effective vegetative cover and soil characteristics that sustain high quality water supplies. Meeting this objective enhances the usefulness and productivity of the land for other purposes. If the soil is protected and maintained in good condition, then other renewable resources that depend on this most basic form of productivity can be supported.

Timber, forage, minerals, food, and wildlife represent important watershed management considerations. Problems arise when development and use of these resources conflict with the primary objectives of maintaining and protecting high quality water supplies and promoting watershed integrity.

Land ownership is the principal institutional control of a watershed. A private individual or public management agency may be free to apply whatever measures they believe necessary or desirable on their own land. They may regulate access and prevent use and development of associated resources.

All watershed users should know that private actions have public consequences on water quality and quantity.

Many watersheds are in public or state ownership. Unless protected by specific legislation or agreement, most are used and developed to take advantage of all resources available for the general public benefit. It is in these multiple-use watersheds that management may face the most serious conflicts and challenges. Protecting the water resources of some of these watersheds may require limiting and balancing development to provide the greatest possible benefits with the least significant disruption of the water resource.



Adapted from original artwork by Sandra Noel, *Adopting A Stream A Northwest Handbook*, Adopt-A-Stream Foundation, 1988.

Legislation and government edicts also provide controls that can aid water resource management. These laws may include:

- land use planning,
- zoning,
- permitted and prohibited land uses or types of development,
- restrictions on water use,
- limitations on water development,
- pollution control, or
- fill and removal restrictions.

All watershed users should know that private actions have public consequences on water quality and quantity.

In Oregon, and the Pacific Northwest, watershed councils are a growing voice in guiding the management of local watersheds. These councils are voluntary local advisory groups formed around interest in a particular watershed. Watershed councils use consensus-based decision making (depending on the support of all council members rather than a majority) to foster coordination and cooperation in managing their local watershed. As advisory groups their determinations do not have the force of law, but inform management agencies about the concerns and wishes of those most closely affected by watershed management decisions. In many cases these councils also plan and implement projects for watershed protection, improvement, and education.

Watershed councils also play an important role in the Oregon Plan for Salmon and Watersheds. The Oregon Plan establishes local networks and partnerships between citizen groups, communities, local governments, state agencies and others to allow citizens to be proactive and address watershed problems. Currently the Oregon Plan has two parts. The Oregon Coastal Salmon Restoration Initiative, often called the Oregon Salmon Plan, seeks to develop programs to preserve and restore native coho salmon populations in coastal basins. The Healthy Streams Partnership is the second component. Its purpose is to create networks and partnerships to improve water quality throughout the state to meet the federal Clean Water Act standards.

Summary

Rivers, upland areas, mountaintops, and flood-formed bottomlands with their associated riparian areas are all part of one system. All are integrated with each other. Hillside shape controls the rate of water flow. All living elements in the watershed interact with and modify the energy flow through the system. The unique combination of climatic conditions, soil types, topography, vegetative cover, and drainage system define the specific character of each watershed.

Rivers do not stop at state lines or national boundaries. The effects of natural and human processes in a watershed are focused at its outlet, wherever it may be, even if a watershed crosses another state or country's borders. Each watershed is a part of a larger watershed whose downstream portion is affected by upstream influences.

Everyone depends on the resources watersheds provide. As the human population continues to grow, the demand on those resources intensifies. Human uses of land and water resources affect the ecological dynamics of a functioning watershed system, altering natural habitats as well as the quantity and quality of its water supplies. Some changes are improvements. Others are not. It is up to the public at all local, regional, state, and national levels to meet the challenges of balanced, productive watershed management.

Adapted from W.E. Bullard, "Watershed Management Short Course," Oct. 1975, and used with permission.

Extensions

1. "Where Does Water Run?"
   Aquatic Project WILD, pp. 21.
   Grades 6-12.
2. "Watershed," Aquatic Project WILD, pp. 132. Grades 4-12.
3. "To Dam or Not to Dam," Aquatic Project WILD, pp. 170.
4. "Identifying Your Watershed," Watershed Uplands Scene, pp. 17-36. Grades 9-12.
5. "Weather and Climate Investigation," Watershed Uplands Scene, pp. 89-108. Grades 9-12.
6. "Branching Out," Project WET, pp. 129-132. Grades K-2 and 6-8.
7. "A-Maze-ing Water," Project WET, pp. 219-222. Grades 3-8.
8. "Color Me a Watershed," Project WET, pp. 223-227. Grades 9-12.
9. "Common Water," Project WET, pp. 232-237. Grades K-8.
10. "Dilemma Derby," Project WET, pp. 377-381. Grades 6-12.
11. "Get the Ground Water Picture," Project WET, pp. 136-143. Grades 6-12.
12. "Irrigation Interpretation," Project WET, pp. 254-259. Grades K-8.
13. "A Grave Mistake," Project WET, pp. 311-315. Grades 6-12.

14. "The Pucker Effect," *Project WET*, pp. 338-343. Grades 6-12.
15. "Surface Water," *The Comprehensive Water Education Book*, pp. 141-143. Grades 4-6.
16. "Floods and Erosion," *The Comprehensive Water Education Book*, pp. 144-145. Grades 3-6.
17. "Lakes," *The Comprehensive Water Education Book*, pp. 146-147. Grades 4-6.
18. "Watersheds," *The Comprehensive Water Education Book*, pp. 151-152. Grades K-6.
19. To make a simple watershed model crumple up a large piece of butcher paper and put it on the floor. Imagine that the paper is the surface of the land, the edges the shoreline, and the floor the sea. Use a permanent marker to trace the ridgelines separating one watershed from another. Then trace the river systems with a various colors of water soluble markers. Spray water on the watershed. Each river system will have its own color, but all colors mix in the estuaries and sea.
20. Since everyone lives in one, a first step in understanding watersheds is to explore your own local watershed by outlining its boundaries. Check with your local library for topographic maps if you cannot determine the boundaries visually.
    a. On a map, trace the lines along the high points that separate your creek or river from the next.
    b. Map the land use in your watershed (e.g., streets, forests, farms, yards, etc.)
    c. List all possible places rain goes in your watershed.
    d. Go outside the school building. What happens to the rain when it falls on the school roof? Does any of it get to a stream or river? How?
    e. Are you ever anywhere that is not in a watershed?
    f. Collect newspaper clippings on watershed management problems in your area.
    g. In small groups have students design their own watershed. Each design should include the location, climate, uses of, abuses to, human impact on, and group perceptions of what a watershed should and should not be. After preparing visuals to depict their watershed, groups present their design to the class. (Contributed by Mary Roberts, 1989)
21. Have students develop an oral history of their watershed. Students should first develop a list of questions they want to research about their watershed, then set up interviews with people in the community. Questions should include past watershed events, both human-caused and natural, how it looked fifty or more years ago, and more. Students can then summarize their research into a written report or verbal presentation or both.

Bibliography

Borton, Wendy, et al. *Clean Water, Streams, and Fish: A Holistic View of Watersheds*. Seattle: Municipality of Metropolitan Seattle, n.d.

Brown, George W. *Forestry and Water Quality*, 2nd ed. Corvallis: Oregon State University Bookstores, Inc., 1985.

Carry, Robert. "Watershed Form and Progress—The Elegant Balance." *Co-Evolution Quarterly* (Winter 1976/77): 15-17.

Dunne, Thomas, and Luna B. Leopold. *Water in Environmental Planning*. San Francisco: W.H. Freeman & Co., 1978.

Environmental Education Project. "Understanding Watersheds." *Clearing: Environmental Education in the Pacific Northwest* (Spring 1983): 8-10.

Ferschweiler, Kate, et al. *Watersheds Uplands Scene—Catching The Rain.* Salem, OR: Governor's Watershed Enhancement Board, 1996.

Horton, R.E. "Erosional Development of Streams and Their Drainage Basins: Hydrophysical Approach to Quantitative Morphology." *Geological Society of America Bulletin* 56 (1945): 275-370.

Kentucky Natural Resources and Environmental Protection Cabinet. *A Field Guide to Kentucky Rivers and Streams*. Water Watch, Division of Water, May 1985.

MacKenzie Environmental Education Center. *Stream Investigations*. Poynette, Wisconsin: Wisconsin Department of Natural Resources, n.d.

Murdoch, Tom, et al. *Streamkeeper's Field Guide, Watershed Inventory and Stream Monitoring Methods.* Everett, WA: Adopt-A-Stream Foundation, 1996.

Rude, Kathleen. "Watersheds: The World's Biggest Bathtubs." *Ducks Unlimited* (September/October 1985): 62-63.

State of Oregon Water Resources Board. "Mid-Coast Drainage Basin Map." Salem, OR, 1964.

State of Oregon Water Resources Board. "Umatilla Drainage Basin Map." Salem, OR, 1962.

State of Oregon Water Resources Department. *John Day River Basin Report.* Salem, OR, 1986.

Strahler, A.N. "Quantitative Geomorphology of Drainage Basins and Channel Networks." Section 4-2 in *Handbook of Applied Hydrology,* ed. Vente Chow. New York: McGraw Hill, 1964.

Sullivan, Peter L. *What is Happening to Our Water?* Washington: National Wildlife Federation, 1979.

Toews, D.A.A., and M.J. Brownlee. *A Handbook for Fish Habitat Protection on Forest Lands in British Columbia.* Vancouver, B.C.: Government of Canada Department of Fisheries and Oceans, 1981.

U.S. Department of Agriculture. *Soil and Water Conservation Activities for Scouts.* PA-978. Washington, D.C.: U.S. Government Printing Office, 1977.

U.S. Department of Agriculture. *Water Intake by Soil.* PA-925. Washington, D.C.: U.S. Government Printing Office, 1963.

U.S. Department of Agriculture. Forest Service. *Forests and The Natural Water Cycle.* FS-99. Washington, D.C., 1970.

U.S. Department of Agriculture. Forest Service. *Forests and Water.* FS-48. Washington, D.C., 1968.

U.S. Department of Agriculture. Forest Service. "Water Investigation." *Investigating Your Environment Series.* Washington, D.C., 1978.

U.S. Department of Agriculture. Forest Service. *Your Water Supply and Forests.* PA-305. Washington, D.C., 1972.

Warshall, Peter. "Streaming Wisdom." *Co-Evolution Quarterly* (Winter 1976/77: 5-10.

Wisconsin Department of Public Instruction. *Local Watershed Problem Studies.* Vicki K. Vine, Project Director and Charles Brauer, ed., 1981.

Young, Carolyn, et al. *Oregon Environmental Atlas.* Oregon Department of Environmental Quality, 1988.

UNIT 5B. WATER QUALITY AND QUANTITY

ACTIVITY	TIME	LEVEL
Water Temperature & Comfort	45 minutes	Introductory
Fish & Water Temperature Chart Analysis	60-90 minutes	Introductory
Goldfish Lab Activity	30-45 minutes	Advanced

BENCHMARKS	
Next Generation Science Standards	MS-LS2-1 MS-ESS3-5 MS-LS2.A MS-ESS3.C HS-LS2.C
Science & Engineering Practices	-Planning and carrying out investigations. -Analyzing and interpreting data -Using mathematics and computational thinking -Engaging in argument from evidence
Common Core State Standards-ELA/Literacy	CCRA.R.1 CCRA.R.4 CRA.R.7
Common Core State Standards-Speaking & Listening	CRA.SL.1
Common Core State Standards – Mathematics	MP.2

OBJECTIVE:

- Students will observe the properties of water and identify the qualities of water needed by salmon.

INTRODUCTION

Have you ever been thirsty? Do you remember water rationing in the summer? Are your water bills increasing? We all need water; we cannot live without it. Neither can we work without it. Manufacturing and agricultural processes use water and electricity. What about the salmon? Is water important to them? We know they need water to stay alive, much as we do. For what else do salmon need water? What does water provide for the salmon? In this section, we attempt to answer these questions.

In this section, we study and observe water for its properties and inhabitants. Then, we attempt to make some inferences about relationships that may exist between the inhabitants of a body of water, and the properties of that water. We do this by exploring the effects of temperature on dissolved oxygen, and on the respiration rates and temperature tolerances of fish species.

We have provided several lessons and activities to study water quality and quantity. Examine each lesson to find the appropriate fit for you class.

KEY QUESTIONS:

What kind of water do salmon need? How much of it do they need?
Why are water quality and quantity important to salmon?

VOCABULARY (Brief definitions of vocabulary terms are found in the Glossary.):

aquatic diversity ecosystem pH sediment microhabitat habitat

ACTIVITIES:

<u>WATER TEMPERATURE AND COMFORT</u>

MATERIALS:

- STUDENT HANDOUT 5B-1: Water Temperature, Stream Scene
- STUDENT HANDOUT 5B-2: Where Am I Comfortable?

PROCEDURE:

A. How do you feel when you're hot? Cold? Do other species have the same feelings? Have students read STUDENT HANDOUT 5B-1: Water Temperature, Stream Scene

B. Use the questions in STUDENT HANDOUT 5B-2: *Where Am I Comfortable?* to reinforce the learning in the reading. These readings discuss the effects of temperature on aquatic organisms, and the role of plants, air, surface area, streambed, stream flow, sediments and discharges in mediating water temperature.

<u>FISH AND WATER TEMPERATURE CHART ANALYSIS</u>

MATERIALS:

- STUDENT HANDOUT 5B-3: Fish and Water Temperature

PROCEDURE:

Discuss human reactions to heat stress. Then have students read and complete the activity in STUDENT HANDOUT 5D: Fish and Water Temperature. This reading describes the effects of temperature on fish, and how to perform a standardized measurement of a fish's temperature tolerance. Students are given temperature tolerance data for 20 fish, and then respond to questions based on that information.

UNIT 5: STUDENT HANDOUT 5B-1: WATER TEMPERATURE

Water Temperature

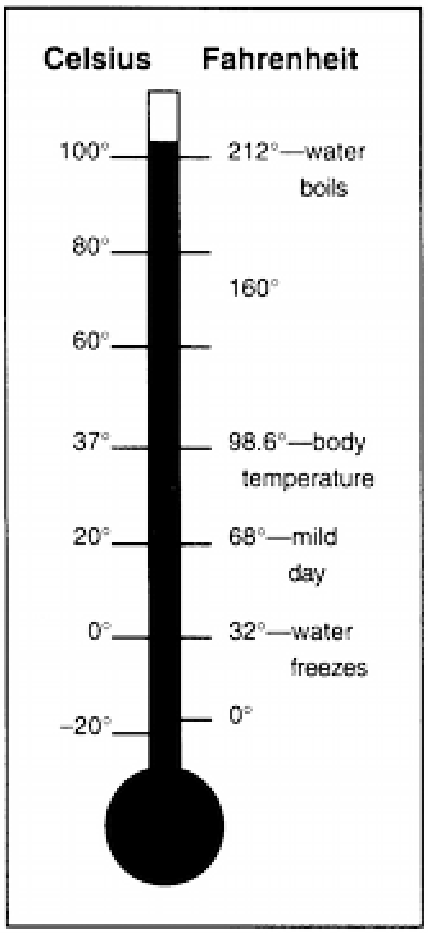
Stream Scene, Oregon Dept. of Fish & Wildlife, 1992

Water temperature is one of the most important factors for survival of aquatic life. Most aquatic organisms become the temperature of the water that surrounds them. Their metabolic rates are controlled by water temperature. This metabolic activity is most efficient within a limited range of temperatures. If temperatures are too high or too low, productivity can decrease or metabolic function cease. The organism can die. These extremes, or lethal limits, vary for different species.

Lethal limits

Within the lethal limits there is an ideal range of temperatures. In this range, an organism is more efficient, and the species has a greater chance of success. Various species of fish have adjusted to upper and lower levels of an optimum temperature range. Spawning, hatching and rearing temperature ranges vary from species to species. In this way, temperature determines the character and composition of a stream community.

In the Pacific Northwest, most streams have had populations of salmon and trout, which prefer temperatures between 40° and 65°F. In the summer, when temperatures are highest and water flows lowest, juvenile fish live in the pools of smaller streams. Pools offer deeper, cooler, oxygen-rich water and increased protection from predators. Because of low water flows, fish can be confined to a limited area. A temperature rise in a rearing pool can kill fish by exceeding their lethal temperature limits.



Plant cover's role

With the exceptions of hot springs and thermal pollution, solar radiation is the cause of increased water temperatures. Shade from riparian vegetation plays a major role in keeping streams cool. During midsummer, adequate shade will keep a stream 7° to 12°F cooler than one exposed to direct sunlight. Even the shade from debris in the water will help keep temperatures low. If there is enough debris, temperatures can be 3° to 8°F cooler than if there was no shade. Once water has warmed, it does not cool rapidly, even if it flows into a shady stretch.

It is important to recognize that water temperatures change from day to night and that cool-water areas exist in a stream.

Warmer temperatures encourage the growth of life forms that adversely affect fish and human health. Pathogens such as bacteria, as well as several parasitic organisms, thrive in warmer waters.

Water temperature is one of the most important factors for suvival of aquatic life.

Air temperature, surface area

As water in a stream mixes with air through exposure and turbulence at the surface, water is influenced by the air temperature. This mixing action can also increase the evaporation rate.

The greater the surface area of a body of water, the greater its exposure to both solar radiation and air. Because of its increased surface area a wide, shallow stream will heat more rapidly than a deep, narrow stream.

Streambed, streamflow, orientation and sediments

Color and composition of a streambed also affect how rapidly stream temperature rises. A dark bedrock channel will gain and pass to the stream more solar radiation than a lighter-colored channel. Similarly, solid rock absorbs more heat than gravel.

The streamflow, or volume of water in a stream, influences temperature. The larger a body of water, the slower it will heat. Rivers and large streams have more constant temperatures than smaller streams.

The direction a stream flows also affects how much solar radiation it will collect. Because of the angle of the sun's rays, southerly flowing streams receive more direct sunlight than streams flowing north. Eastward or westward flowing streams receive shading from adjacent ridges, trees and riparian vegetation.

Sediments suspended in water can absorb, block or reflect some of the sun's energy depending on their color and position in the water. Particles on or near the surface can have a beneficial influence through reflection, but those with a dark color increase the total energy absorbed from the sun.

Effects of thermal pollution

Thermal pollution occurs when heated water is discharged into cooler streams or rivers. This heated water generally has been used to cool power plants or industrial processes and can be as much as 20°F warmer than the water into which it is discharged. This increase in temperature can have drastic effects on downstream aquatic ecosystems.

Figure 11. Temperature Ranges (approx.) Preferred by Certain Organisms

Temperature (Fahrenheit)	Examples of life
Greater than 68° (warm)	Redside shiner, crappie, bluegill, carp, catfish, caddisfly, dragon fly, and much plant life
Middle range (55°-68°)	Brown trout, rainbow trout, stonefly, mayfly, caddisfly, water beetles, sculpins, and some plant life
Low range (cold, less than 55°)	Brook trout, sculpins, caddisfly, stonefly, mayfly, and some plant life

Adapted from Claire Dyckman and Stan Garrod, eds., *Small Streams and Salmonids*, p. 73.

UNIT 5: STUDENT HANDOUT 5B-2: WATER TEMPERATURE

Use STUDENT HANDOUT 5B-1 to answer the following questions: Name____________________

Where Am I Comfortable?

1. For the two questions below, list causes and explain how they work.
   a. What causes water to heat in a pond, lake or stream?

   b. What might cause water there to cool?

2. You measure the temperature of a stream. It is 62°. What kinds of organisms might you expect to find there?

3. You sample a stream and find rainbow trout, caddisfly larvae, dragon fly larvae, water beetles, and some plant life. Estimate, as closely as you can, the temperature of the water in that stream. Explain how you made your decision.

4. Explain how you can use a list of the organisms found in a stream to assess its physical properties.

5. Use all of the information in the article and on this sheet to make a stream analysis worksheet.
Your worksheet should be designed so that someone who had followed the directions in the stream analysis worksheet (made observations and recorded them on the worksheet) could determine the general health of the stream. Think carefully, consult with your partners, and then design your stream analysis worksheet.

UNIT 5: STUDENT HANDOUT 5B-3: FISH & WATER TEMPERATURE

Fish and Water Temperature

Adapted from Stream Scene, Oregon Dept. of Fish & Wildlife, 1992

Different fish require different water temperatures to survive. Most fish are killed by high temperatures, not by low ones. They may grow more slowly at lower temperatures, but they are not usually killed unless they freeze.

Human activities can quickly change water temperature. For instance, a coal or nuclear power plant takes water from the river, turns it into steam, then puts hot water back into the river, thereby raising the temperature. Removing the trees along a river or stream can also raise the temperature.

Biologists perform a test to find out what water temperature fish need. The fish are put into an aquarium at a certain temperature and left for twelve hours. The biologist then checks to see how many fish are still alive. The temperature is raised until half the fish die within a twelve-hour period. This temperature is the "12-hour tolerance limit median" (12-hour TLM). It is the tolerance limit because it is the highest temperature that fish can tolerate. It is called the median because half of the fish die.

Remember that this is not the temperature at which the fish do best. Rather, this is the temperature where half of them die in just twelve hours. A similar number for humans might be 150 degrees Fahrenheit. This is not where we do best, but the limit for our survival.

The table below lists the 12-hour TLM for several fish species.

COMMON NAME	12 HR. TLM	COMMON NAME	12 HR. TLM	COMMON NAME	12 HR. TLM
Cutthroat Trout	77 F	Speckled Dace	85 F	Bluegill Sunfish	94 F
Coho Salmon	77 F	Yellow Perch	87 F	Pumpkinseed	94 F
Brook Trout	78 F	Long Nose Dace	88 F	Redside Shiner	95 F
Steelhead	80 F	Tui Chub	89 F	Brown Bullhead	97 F
Rainbow Trout	80 F	Common Shiner	90 F	Largemouth Bass	98 F
Brown Trout	81 F	Short Nose Dace	92 F	Carp	106 F
Redband Trout	82 F	Fathead Minnow	93 F		

QUESTIONS - Fish and Water Temperature

Name___________________

1. Explain how you might perform a 48-hour TLM test?

2. Which five species would you expect to survive best if a coal plant raised the stream temperature by 10 degrees Fahrenheit from 80 degrees Fahrenheit?

3. How would Coho salmon probably be affected by an increase in stream temperature caused by a power plant?

4. Look only at the salmon and trout species listed in the table: which one is the least tolerant of high temperatures? Which is the most tolerant?

5. Explain how each of these human activities could cause problems for the salmon by increasing the water temperature.

   a. removing trees next to a stream

   b. building a dam

   c. taking water out of a stream for irrigation

STUDENT HANDOUT 5B-4

Name___________________________

Effects of Temperature on Goldfish Respiration Rate

(Adapted from Stream Scene, ODFW)

Purpose: To determine how temperature affects the respiration rate of a fish.

Materials needed:

- 600 ml beaker, filled with 300 ml of aquarium water
- goldfish
- thermometer (Celsius)
- large culture dish with ice

Procedure:

- Put the goldfish in the 600 ml beaker.

- Observe your fish carefully. Watch how the gill plates on either side of the head move. Watch the mouth open and close.

Questions:

1. How do the mouth and gill plates coordinate their movements?

2. As water moves from the mouth, across the gills, and then out of the gill slits, what type of gas will diffuse from the water into the blood of the fish? (This will be the same gas that humans take into their blood as they breathe). How do you think this transfer of gas occurs in the gills?

3. As water moves across the gills, what type of gas will diffuse from the blood and into the water? (Again, the same gas leaves the lungs of humans.)

4. Describe your fish's behavior.

5. Observe your fish. Count how many times the gill plate opens and closes in 15 seconds. Repeat this calculation until you are confident that you can record it accurately. Record that measurement here:

6. Predict: Will the fish open and close its gill plate faster or slower when the water is cold? Why do you think so?

7. Place your thermometer inside the beaker with your fish. Position it so that you can read it without disturbing your fish.

   - Fill the culture dish around the beaker with ice. Pack the ice against the side of the beaker. You may wish to add salt to the culture dish (not the beaker) to speed up the melting (and so speed the cooling of the water in the beaker). Allow the beaker to reach 5 degrees Celsius, then remove it from the culture dish. Dump out the ice.

   - Count the number of times that the gill plate opens and closes in 15 seconds. Repeat. Record your observations on the following chart. At each temperature, note your fish's behavior.

   - Fill the culture dish with lukewarm water. Place the beaker with the fish in the culture dish. Allow the fish to warm to 12 degrees Celsius.

   - Count the gill plate movements for 15 seconds. Repeat and record.

   - Continue to allow the fish to warm up, stopping at 15, 20, and 25 degrees Celsius to record gill plate movements. Do not warm the fish above 25 degrees Celsius! You will need to warm your water in the culture dish periodically.

   - Return the goldfish to the aquarium.

- Average your two observations for each temperature.
  Record your average on the overhead data sheet for the class.

	5 degrees C	10 degrees C	15 degrees C	20 degrees C	25 degrees C
Count 1					
Count 2					
Average					
Class average					

<u>Temperature</u> <u>Behavior</u>

5 Celsius

10 Celsius

15 Celsius

20 Celsius

25 Celsius

8. Graph your data on the graph below.

Label the Y axis “Breaths per 15 seconds”. Label the X axis “Temperature in Celsius”. Plot two lines on your graph: your average values, and the class averages.
Label your two lines carefully.

Discussion questions:

1. How did your goldfish change its behavior during your experiment?

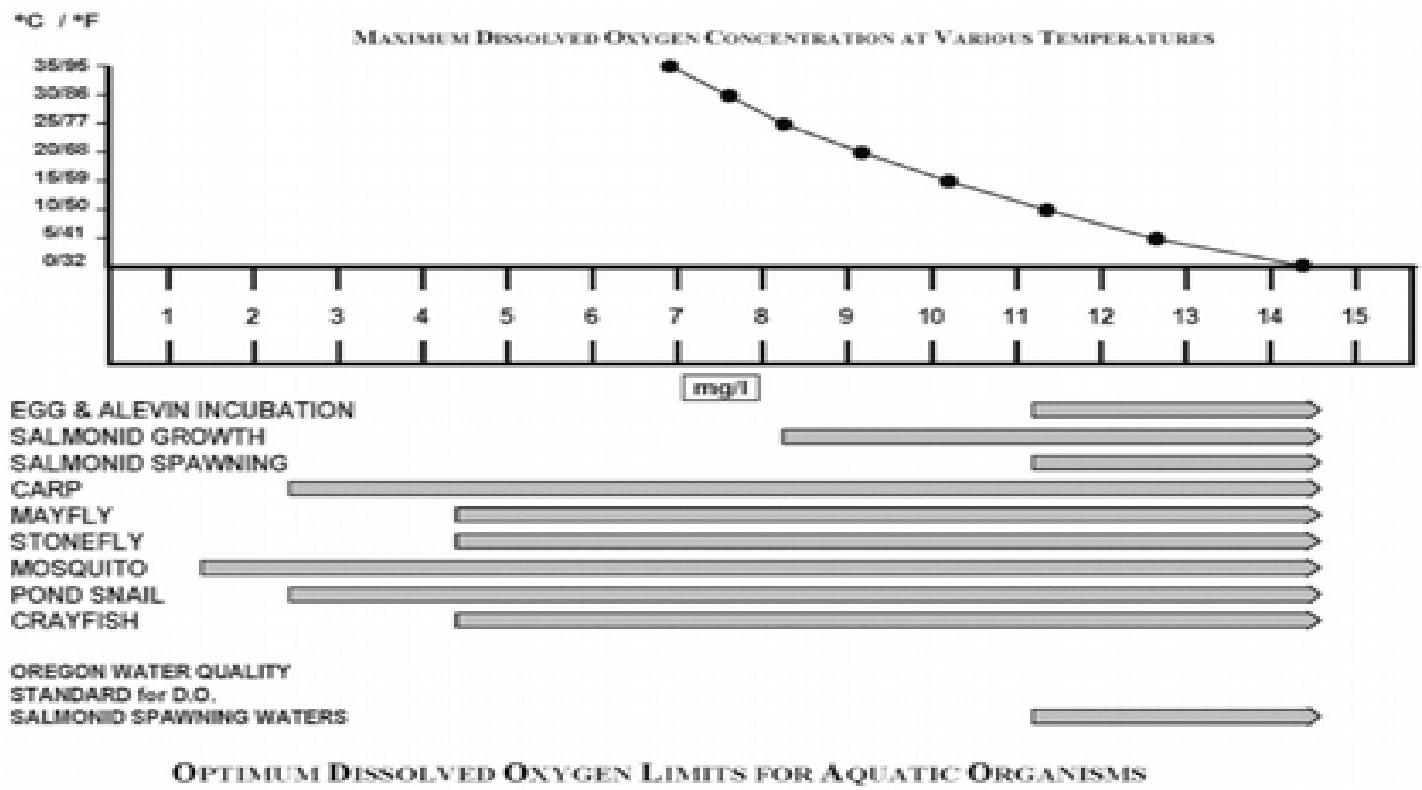
2. As the temperature increased, what happened to the respiration rate of the goldfish?

3. How does your graph compare to the class average?

4. What are some variables (differences) in your experiment that could explain why your data are different from the other groups? List as many variables as you can.

5. There are two types of animals: warm-blooded and cold-blooded. Warm-blooded animals maintain their bodies at about the same temperature at all times, examples of warm- blooded animals include humans, beavers, and whales. Cold-blooded animals change temperature as the environment changes temperature, such as lizards and frogs. Chemical reactions, such as using oxygen to get energy, happen more slowly at colder temperatures. Are goldfish warm-blooded or cold-blooded? Explain how you know from this lab.

6. If you had very little food for a goldfish and you wanted to make it last as long as possible, at what temperature should you keep your fish? Why?



7. Goldfish are a type of carp. How do their dissolved oxygen requirements compare to those of salmon

8. What is the maximum amount of dissolved oxygen that water can hold at 30º C?

9. What is the maximum amount of dissolved oxygen that water can hold at 0º C?

10. What happens to the amount of dissolved oxygen in a river as the temperature increases?

11. You discovered in question five that fish are cold-blooded (I hope). What happens to their metabolic rate (the rate of chemical reactions such as the consumption of oxygen by their cells) as the water temperature increases?

12. Using your answers to questions 7, 11 and 12, explain why an increase in river temperature can be lethal to salmon.

13. Why is it important to preserve the riparian forest canopy along salmon-bearing streams?

"I guess he made it. … It's been more than a week since he went over the wall."

"So! . . . you STILL won't talk, eh?"

UNIT 5C. WETLANDS SITE STUDY

(Adapted from Project Learning Tree: Watch on Wetlands)

TIME	LEVEL
45 minutes	Introductory
60-90 minutes	Introductory
30-45 minutes	Advanced

BENCHMARKS	
Next Generation Science Standards	MS-LS2-1 MS-ESS3-3 LS1.B HS-LS2.-2 HS-ESS3-4
Disciplinary Core Ideas	MS-LS2.A LS2.C HS-LS2.C
Science & Engineering Practices	-Planning and carrying out investigations. -Analyzing and interpreting data -Using mathematics and computational thinking -Constructing explanations & design solutions -Obtaining, evaluating & communicating information

OBJECTIVES:

- Through observation, data collection and study students will understand the properties of a wetland.
- Students will gain an understanding of the relationship between wetlands and salmon.
- Students will gain an understanding of the functions and benefits of wetlands.

INTRODUCTION:

This section provides guidelines for how to develop and implement a wetlands study near a school. The key objective is to develop an understanding of the life links between wetlands and salmon, humans, and wildlife. It is highly recommended that you obtain and use Adopting A Wetland: A Northwest Guide by Steve Yates for this section. It is an outstanding guide and resource.

KEY QUESTIONS:

What is the relationship between wetlands and streams? How do wetlands benefit salmon?
How do wetland benefit humans?
What are the properties that identify a wetland other than wetness?

MATERIALS:

- STUDENT HANDOUT 5C-1: *Wading into Wetlands*, National Wildlife Federation
-
- microscopes and slides (if available)
- pH and dissolved oxygen water test kits
- camera and film
- thermometers
- clipboards
- meter sticks
- flagging material
- several jars
- graph paper
- long-handled dip net
- magnetic compasses
- a sieve
- sketch paper (rite-in-the-rain paper is best)
- a magnifying glass
- field guides
- binoculars and/or spotting scope
- water sampling equipment (buckets, nets, etc.)
- clip boards
- aquarium or large jars (if applicable)
- white enamel tray
- drawing materials
- wildlife field guides

PROCEDURE:

GETTING READY

1. Designate a local wetland as a study site that your class could visit several times during the year. Make sure to contact all adjacent landowners to make them aware of your study.

CLASSROOM PREP

2. Using the information in STUDENT HANDOUT 5C-1: Wading into Wetlands, discuss with students the characteristics of a wetland. Describe various types of wetlands. Get students to begin thinking about the relationship between wetlands and creeks, streams and rivers and the benefits that wetlands can provide to salmon as well as humans. Also, with student participation, develop a set of guidelines for "wetland etiquette" in the field so that good observation and data collection will occur and impact on the site will be minimal.

3. Obtain local topographic map(s) with the wetland site. Have students look closely at the differing elevations. Wetlands are essentially topographic low spots!

4. Before visiting the wetland site, have students gather preliminary information about it from owners or managers or from local biologists or naturalists. Assign several students to be contacts for gathering this information. They should share with the rest of the class all information they receive. The class should determine the boundaries of the area they will study. Also, assign another group of students the task of characterizing the land use around the wetland. Is it stable or changing? Are there activities on nearby land that threatens the wetland?

5. Prepare for trips to the wetland site by dividing the class into several study teams. Be sure that each team is clear about their mission. Each time you go into the field, rotate the teams' duties.

IN THE FIELD

Photo Survey Team

Materials Needed:

- at least one camera and film (preferably color)
- clipboards
- flagging material

Pre-Trip Conference:

Discuss what features of the wetland they should capture on film (for example, photos of wetland vegetation).

Mission:

When visiting the wetland, they should walk slowly around the perimeter of the designated area. Several students should tie pieces of flagging to items they want to identify in the photos (such as a particular plant, boulder, or log). One or more students will take pictures of the flagged item plus general pictures of the area. One student will keep notes about every picture taken. Remind students to remove the flagging before they leave the area.

Map Survey Team

Materials Needed:

- graph paper
- clipboards
- magnetic compasses
- flagging material

Pre-Trip Conference:

Decide how to design their map of the area and what features they should highlight on the map.

Mission:

When they arrive at the site, pairs of students will use clipboards and graph paper to make rough maps of the area from different vantage points. Students should estimate the distances as best they can or use a long tape measure. They should use a compass to indicate directions on the map. Afterward, with colored markers and symbols, the team should use the pairs' rough maps to create a large, detailed map of the wetland on a piece of poster paper.

Plant Survey Team

Materials Needed:

- clipboards
- basic field guides for trees, plants, and grasses
- sketch paper (rite-in-the-rain paper is best)

Pre-Trip Conference:

Decide how they will categorize and record the plants they observe (tall trees, small trees, shrubs, tall grasses, short grass, flowers, water plants). For their plant survey, they will set up a chart that has columns for describing each plant, its immediate environment, and its location. Rather than spend a lot of time thumbing through field guides, have students sketch the plants and use time in class to identify.

Wildlife Survey Team

Materials Needed:

- several jars
- long-handled dip net
- a sieve
- a magnifying glass
- binoculars and/or spotting scope
- clip boards
- white enamel tray
- wildlife field guides

Pre-Trip Conference:

Decide how they will locate and record wildlife. Remind them to look for insects and other invertebrates in addition to birds, mammals, amphibians and reptiles. For recording wildlife, they should make up a chart that has columns for descriptions, immediate environment, and location.

Mission:

At the site, have students use binoculars, spotting scopes and magnifying glasses to look for wildlife. They can isolate aquatic creatures by dragging a dip net through the water or by gently straining wet mud. They can observe organisms in a white enamel tray or white plate partially filled with water. Students should describe or sketch these creatures as best they can and should use field guides to identify them.

Water Quality Team

Materials Needed:

- pH testing kit or litmus paper
- dissolved oxygen test kit
- thermometer
- meter stick
- clipboards

Pre-Trip Conference:
Practice using the testing equipment. Assign pairs to perform tests at different locations (in the water, at the water's edge, at five meters from water).

Mission:
When at the site, the pairs should gather information about water quality at various locations. Tests should include measuring the depth of standing water in various spots, along with describing the water's color, smell, and movement, or the soil's moisture.

Back in class, they should transfer their data to a chart that has columns for various water quality factors and for the location where factors were tested. Remember that sight and smell are not reliable indicators of water quality; low pH and low dissolved oxygen are more significant but also need to be analyzed by an expert.

POST SITE VISIT

- After teams make one or more data-collecting trips to their wetland site, have them prepare data charts, reports, or maps. Each team should take 20 minutes to brief the group on their team's findings, lead a class discussion on the general features of the wetland, and give an impression of the area's ecological health.

- Ask students to use the data presented so they can discuss whether some environmental warning signs in this wetland need further attention (such as low oxygen content in the water, oil in the water, trash in the area, lack of wildlife, etc). They should document why there might be problems and then should contact the owners or managers of the area to discuss ideas on how they might help improve the situation. Often, students can get permission to clean up a site or can take on more complicated projects under the supervision of those who manage the area.

EXTENSION ACTIVITIES

1. Ask your students to study a stream near their school or home. They draw or map a 500-foot length of a stream, then draw in and identify features or conditions that will benefit fish. Once a week for four weeks, they record observations on changes in the stream. These changes can be in the plants, animals, water level, water quality, or streambed. At the end of the four weeks, students draw their map again, and present both maps to the class, explaining changes they have observed.

2. If you plan to have your students sample for macroinvertebrates during the field trip, then do Aquatic Organisms, Stream Scene, pp. 143-168. This unit explores the place of macroinvertebrates in the watershed, and their use in determining water quality. This is a good unit, and presents the student with a water quality determination methodology that is used across the United States. It is relatively simple to do, and gives the student a good hands-on experience in the watershed.

3. Have your students complete Puddle Wonders! Project Wild Aquatic, pp. 114-117. Students predict where puddles will form and observe organisms that live in or near puddles. They then measure and records amounts of water in puddles and make inferences about the kinds of organisms which might occupy puddle habitats.

4. California's Salmon and Steelhead, Our Valuable Natural Heritage, p. 23 and pp. 78-81, contain readings, which can be used to teach some adaptations to anadromy and long migratory routes. Pages. 87-93 contains readings that can be adapted to teach the habitat requirements of salmonids.

5. Look up the World Wide Web address, http://www.streamnet.org/, for a very useful source of information about salmon. This is the StreamNet home page that contains an online database of information about salmon, the life history and ecology of species, color species of a male and female of each species listed, and extensive data on salmonids and their habitats. It might be used to organize Units 1-3 for your students.

6. If you cannot take your students away from the school, find a standing puddle on the school grounds, or bring the aquatic environment into the classroom by filling an aquarium with water and sediments from a local pond. (Wetland ponds usually provide a good assortment of living organisms, and they are not as fragile as streams, especially spawning grounds. You can fill one or two 5-gallon plastic buckets, and provide enough material for all of the work in this section.) Before going to a wetland, discuss "wetland etiquette" with your students. With student participation, make a very short list of guidelines, which will ensure a good set of observations, yet leave the environment unharmed, and ensure students' safety.

   Have student groups maintain pond water in 2-quart peanut butter jars. (Should you choose to maintain an aquarium in your classroom, it is best to leave it unattended. It may not look pretty from time to time, but it will provide your students with a rich source of aquatic organisms, as well as water to test.) These jars can be set in windows, and used when needed.

EXTENSION ACTIVITIES

(An interesting alternative to bringing pond water into the classroom is to collect a small part of a dried pond or pool and add it to tap water which has been left standing overnight. Eggs and spores contained in the collected material will provide a representative set of aquatic organisms within a few days. Two materials to collect are the sediments on the bottom and the pond “scum” that drapes in sheets over the grass and stubble at the edge of water bodies as they dry up. A small piece of plastic pipe can be used to take up sediment on the bottom, and this sample transferred to water; pond “scum” can be dispersed by simply punching out a “dot” with a paper punch into a test tube or baby food jar of water!

UNIT 5C: WETLANDS SITE STUDY-STUDENT HANDOUT 5C-1

Wading into Wetlands

Published by the National Wildlife Federation

WWEC96

The water's up to your ankles and a pungent smell reaches your nose. You move along slowly, watching a great blue heron search for its lunch. When you round a bend, you're startled by a flock of ducks as they take off from the water. A dragonfly zips past your head as you watch the ducks fly off over trees.

You could be in a swamp. Or a salt marsh. Or one of many different types of wetlands. In this teacher's guide you'll learn what we mean by the word "wetland"—and why wetlands are so special.

There are many kinds of bogs, marshes, swamps and other wetlands. But all wetlands share some characteristics that set them apart from other kinds of habitats.

Most ecologists define wetlands as areas that, at least periodically, have waterlogged soils or are covered by shallow surface water, which supports plants and animals that are adapted to living in a watery environment.

Various factors can create wetlands. Since most wetlands are located in low-lying areas, rain and runoff help to keep them saturated. Some wetlands lie where groundwater is at or very near the surface of the Earth and feeds the wetlands from below. Other wetlands stand next to rivers or other bodies of water that regularly overflow. In coastal areas, tides keep many wetlands saturated.

Some wetlands start with a little outside help. Beavers, for example, turn meadows into marshes or parts of forests into swamps by damming streams. People create wetlands, too. For example, a state wildlife agency might flood an area to create fish and wildlife habitat.

SALTWATER WETLANDS

Because they exist along coastlines, the major kinds of saltwater wetlands—salt marshes and mangrove swamps—support rich networks of life adapted to dynamic environments. Twice each day along most of the world's coasts, the tide rises and falls, exposing coastal wetlands to a rapidly changing environment. The plants and animals that live in these wetlands must be able to adapt to shifting water levels, fluctuating temperatures, periodic exposure to air and increases and decreases in the salt content, or salinity, of the water.

Salt Marshes

Found primarily along the Atlantic and Gulf coasts, but also in scattered locations along the U.S. West Coast, salt marshes are open areas filled with a sea of grasses or grass-like plants. Often they're found in the inner reaches of coves, inlets and bays since this protects them from the full force of the pounding surf. Sediment brought in on the tides and nutrient-rich silt carried by rivers can settle in these calmer areas, giving marsh plants an ideal place to

sprout, grow and spread.

Because of all the food salt marshes have to offer, they support a considerable amount of wildlife. But many salt marsh organisms are small or even microscopic. Few larger animals make the salt marsh their permanent home, and many migrating birds make only brief stopovers.

Mangrove Swamps

Mangrove swamps are the tropical counterparts to the salt marshes of cooler climates. They reach their most lush growth in the United States along the coasts of southern Florida. With their jungle of roots and dense leaves and branches, mangrove trees are the dominant plants in these swamps. They are great storm breakers, in addition to being popular places for wildlife.

Certain animals, like some oysters, cling to mangrove roots. Others, such as shrimp, fish and crabs, hide and feed among the roots submerged by high tide. And in the mangrove branches, storks, herons, egrets and a dozen other birds nest or roost. The swamps are also the last stopover for birds migrating across the Gulf of Mexico in the fall and the first stop for those returning in the spring.

FRESHWATER WETLANDS

Many ducks and geese, with numbers in the tens of millions, along with numerous shorebirds and other types of wildlife, start their lives in a marshy wetland area, better known as prairie pothole country. It covers more than 300,000 square miles throughout parts of the Dakotas, Minnesota, Montana, Iowa and Canada. Prairie potholes, which are numerous small ponds created by glaciers long ago, and other types of freshwater marshes along with swamps and bogs make up freshwater wetlands.

Marshes

From small cattail marshes along major highways in California to huge expanses of sawgrass in Florida to prairie potholes, freshwater marshes are a common sight throughout much of North America. Thick clumps of soft-stemmed plants such as grasses, sedges and rushes are abundant, along with cattails and water lilies. According to some biologists, freshwater marshes make up about 90 percent of our wetlands.

The water in a marsh fluctuates from season to season, rising during heavy rainfalls and often disappearing during dry periods. Seasonal or ephemeral wetlands are overlooked by people as vital areas because they may only be saturated with water for short periods during the year. The importance of these areas for migratory birds and flood control is often discounted simply because they don't look like typical wetlands.

Bogs

Bogs are freshwater wetlands that usually contain a huge build-up of peat—rich organic material that is made up of partially decayed plant material. Peat forms as plants die and their parts fall into the water.

Bogs are usually found in wet areas of the colder regions of the world where there is very little water flowing in or out. The high acidity of the peat, the cold year-round temperatures and the limited oxygen supply due to poor water circulation discourage bacteria and other decomposers from breaking down plant material, so peat layers grow year after year, becoming up to 40 feet thick.

Some bog plants, such as black spruce, have root systems adapted to low-oxygen supplies and waterlogged conditions. Others, such as some orchids and heath plants, have symbiotic relationships with fungi that help them get nutrients they need, which are in short supply in most bogs. Many bog plants, such as bladderworts, pitcher plants and sundews, trap and digest insects and other tiny animals as a source of nutrients.

Swamps

Swamps are wetlands dominated by shrubs or trees. They are usually saturated with water during the growing season but may dry out later in the summer. Swamps can have anywhere from a few inches to a few feet of water.

Two groups of freshwater swamps predominate. Forested swamps are often associated with major river systems, such as the Mississippi, and they often occur on river floodplains. These swamps are famous for their huge trees and contain stands of enormous bald cypress, overcup oak and water tupelo. On the other hand, shrub swamps are characterized by scrubby, low-growing vegetation. These swamps often form in poorly drained areas on the edges of lakes, forested swamps, marshes and streams.

WETLANDS AND WILDLIFE

Wildlife benefits from wetlands in many ways. Some examples follow:

Migration

While traveling between winter and summer homes, geese, herons, egrets, sandpipers, plovers and other birds converge on wetlands to "refuel" on rich food supplies before resuming their journeys. Many birds nest and winter in wetlands, too.

Natural Nurseries

The young of certain fish, crustaceans and other creatures spend their earliest days in wetlands, taking advantage of the rich food supply before moving to open waters. Thick wetland vegetation also provides a good place to hide.

Habitat and Breeding Grounds

Wetlands provide hundreds of kinds of plants and animals vital habitat in which to live. In particular, the health of our nation's waterfowl population is directly tied to these areas. Seventy-five percent of all waterfowl breed only in wetlands.

Havens for Rare Species

Wood storks, snail kites, whooping cranes and American crocodiles are all endangered species—and they all live in wetlands. In fact, about 43 percent of U.S. threatened and endangered species either live in wetlands or depend on them in some way for their survival. This means that almost half of the nation's rare animals and plants are inseparably linked to areas that, altogether, make up only about five percent of the total land area in the lower 48 states.

WETLANDS AND PEOPLE

Wetlands provide people with countless benefits. Here are a few:

Flood Busters

Sponging up excess water, wetlands offer an easy and cheap way to control floods. Because they lie in low spots or depressions, wetlands function like giant, shallow bowls. Water flowing into the bowls spreads out and slows down, which helps to reduce flood damage to the natural and human environment.

Natural Pollution Filters

As Mother Nature's maid, wetlands and the aquatic plants that grow there provide free cleaning services by removing excess nutrients, heavy metals and other toxic chemicals from polluted runoff water. Contaminants adhere to vegetation and sediment that settle on the wetland floor. In this way, wetlands help protect the nation's drinking water.

Silt Trappers

When wetlands slow flood waters, the silt and other sediments in the water settle out among the roots and stems of wetland plants. This helps to protect streams, lakes and other bodies of water downstream from a build-up of sediment that could stifle aquatic plants and animals.

Storm Breakers

Coastal wetlands buffer the effects of the ocean's strong winds and waves on shoreline communities of people and wildlife.

Groundwater Rechargers

The nation's groundwater can be replenished and recharged by wetlands. Surface waters that feed into groundwater systems recharge or refill these systems. Water migrates downward through wetlands to maintain groundwater levels.

Stock for Fisheries

Wetlands support the commercial fishing industry because they provide fish and shellfish with food and a place for breeding and raising young.

Recreation Hot Spots

Hunters and anglers of wetland-dependent species rely on intact wetland ecosystems to support and nurture their recreation. Many more Americans seek wetlands as retreats to birdwatch, photograph and otherwise appreciate wetland species and habitat.

WATCHING OUT FOR WETLANDS

Wetlands are highly sensitive to disruption caused by human activities. Since the first European settlers colonized North America, we have lost well over 50 percent of our wetlands. And the latest reports put the losses at up to 290,000 acres of wetlands every year.

As wetland areas have become more populated, development has crept farther and farther into these critical areas. More channels, dikes and diversions have been installed. Much of the rich peatland that had taken hundreds of years to form has been drained and turned into farmland. Other former wetland areas have become pastures for livestock. Fertilizers from farms and lawns seep into our water, reducing its quality.

Wetland areas are in trouble all over the country. Here are some examples:

Everglades

One of the largest marshes in the world, the Everglades once covered most of South Florida. Disrupting the balance of alternating wet and dry seasons, urban and agricultural development since 1900 have put the entire Everglades ecosystem in jeopardy, including the 1.2 million acres that lie in Everglades National Park.

Prairie Potholes

Only 5.3 million acres remain of the 17 million acres of prairie wetlands that once dotted North Dakota, South Dakota and Minnesota. About 33,000 acres of prairie potholes continue to disappear each year.

Great Lakes

Marshes along the Great Lakes have decreased 90 percent. These marshes not only provide habitat for fish and wildlife, but also help to prevent shoreline erosion and minimize the destructive effects of storms.

California

Less than 450,000 acres of California's original 5 million acres of wetlands remain.

Lower Mississippi Valley

Only about 15 percent of the bottomland hardwood wetlands that once covered the lower Mississippi Valley still exist.

TAKING CARE OF WETLANDS

From local zoning laws to state wetland acquisition to provisions in the national Clean Water Act, wetlands have some protection at all levels of government. But because of lack of support and money, much of the legislation for wetlands protection is poorly enforced, and some of it has been offset by conflicting legislation that encourages wetland destruction.

Two of the most effective wetland-protection programs are the Federal Migratory Bird Stamp Program (known as the Duck Stamp program) and Section 404 of the Clean Water Act. The Duck Stamp program, administered by the U.S. Fish and Wildlife Service, requires waterfowl hunters over 16 years of age to purchase a duck stamp annually. The funds raised help buy valuable wetland habitat. Section 404 of the Clean Water Act helps prevent wetland destruction while still allowing certain development under a permit program.

Although these and other programs have given wetlands a helping hand, many conservation groups feel that much more wetland protection is needed. The National Wildlife Federation and other groups are working to establish a national wetland policy that would: prevent any additional loss of wetlands; restore wetlands that have been dredged, drained and overdeveloped; construct artificial wetlands as needed; support wetland research; and strengthen existing wetlands legislation.

UNIT 5D. PHYSICAL STRUCTURE OF STREAMS

ACTIVITY	TIME	LEVEL
Stream Structure & Fish Habitat	45 minutes	Introductory
Fish Habitat Needs Vocabulary	35 minutes	Advanced

BENCHMARKS	
Next Generation Science Standards	MS-LS2-1 MS-ESS3-5 MS-LS2.A MS-ESS3.C HS-LS2.C
Science & Engineering Practices	-Planning and carrying out investigations. -Analyzing and interpreting data -Using mathematics and computational thinking -Engaging in argument from evidence
Common Core State Standards-ELA/Literacy	CCRA.R.1 CCRA.R.4 CRA.R.7
Common Core State Standards-Speaking & Listening	CRA.SL.1
Common Core State Standards – Mathematics	MP.2

INTRODUCTION

If the water is the “neighborhood” where a salmon grows up and lives, then the physical structure of the stream is the neighborhood’s streets, roads, houses and parks. The physical structure, which you observe, is developed by forces, which originate outside the “neighborhood,” much like development in our own areas is generated by forces outside the neighborhood. What is the nature of these forces? How do they affect the stream in front of you? How does the stream affect spawning salmon? This section provides some answers to these questions. The answers will affect your students’ perceptions of their field trip site.

In this section, we study the needs of salmon and the properties of streams that meet salmons’ needs. Students learn how the stream provides riffles and pools, and how these affect the salmon. They prepare themselves for the questions they will ask on the field trip: Where will we observe spawning when we go on our field trip? Where will the adult salmon prefer to be? Would fry prefer to be there also? What are a fry’s requirements for life?

OBJECTIVE:

- Students will identify, know and understand the physical characteristics of streams and their effect on salmonids.

KEY QUESTIONS:

- ➔ What are the parts of the physical structure of streams? How are these parts organized?
- ➔ How is this related to spawning salmon?
- ➔ How is this related to the needs of salmon fry?

MATERIALS

- reference materials
- STUDENT HANDOUT 5D-1: Stream Structure and Fish Habitat
- STUDENT HANDOUT 5D-2: Fish Habitat Needs Vocabulary
- drawing materials

VOCABULARY (Brief definitions of vocabulary terms are found in the Glossary.):

riffle	carrying capacity	eddies
porous	sediment-free	stream gradient
stable	substrate	debris
scouring	root wad	riparian

PROCEDURE

1. Engage students in a discussion in which they recall what they have learned about salmon habitat needs during the life cycle of a salmon. Then hand out copies of the STUDENT HANDOUT 5D-1: Stream Structure & Fish Habitat.

2. Ask your students to read STUDENT HANDOUT 5D-1. Use a strategy of your choosing for this text reading. Have them work in small groups to answer the reading questions as they encounter them.

3. This is a homework assignment. The student reads STUDENT HANDOUT 5D-1: Stream Structure and Fish Habitat and STUDENT HANDOUT 4A-1: The Journey of Wild Pacific Salmon, then, working from the STUDENT HANDOUT 5D-2: Fish Habitat Needs Vocabulary List, write the term and the definition vocabulary using the following format: They read the sentence where the word is found, and write a definition for each term. Remind them not to use a dictionary. They should try to find the meaning from context instead. Students leave a blank line below the definition to revise or clarify it after reading the whole article and talking about the subject. If the students have worked to learn these words, then they will have a useful vocabulary to employ on the field trip.

4. Assign groups of students to describe the three recommended habitat by a combination of written descriptions and drawings to show desired conditions. Have them present and explain these to the class.

EVALUATION

Evaluate this work by requiring its completion, then by evaluating students' field records after the field trip. They should use many of these descriptive terms knowledgeably and include appropriate observations.

EXTENSION ACTIVITIES

1. While an ideal course would include a complete set of observations on the streambed and waters which flow through it, our time limits what we can learn about the structure of streams. The unit, Riparian Areas, Stream Scene, pp. 41-64, provides a minimal background for the student. In it, students learn how the riparian area of a stream is compartmentalized, and the part it plays in the life in a stream.

2. Fish Habitat Needs, Stream Scene, pp. 181-208, explores fish habitats in the Northwest. It uses prior understandings about stream structure and water quality, and then relates them to stages in the life cycle of salmon. The unit begins with spawning habitats, so would be a good one to consider in order to prepare your students for the field trip. (Note: This extends learning from Riparian Areas, above.)

EXTENSION CURRICULUM

1. Hands On Streams & Rivers, Save Our Streams, pp. 2 - 10, outlines a program for describing a stream channel from in situ measurements. Students measure channel area, monitor channel movement, and determine channel gradient. They observe stream flow, sediments and temperature. These observations are then compared with land uses and ecological relationships of organisms inhabiting the stream. It can be taught in this section as well as in the Salmon and Humans and the Environment units.

2. California's Salmon and Steelhead, Our Valuable Natural Heritage, pp. 100-110, supplements the Stream Scene Riffles and Pools section. In this section, students use a game format involving a map of a stream and "critters" hidden in the stream, to reinforce learnings about habitat requirements. Pages. 133-135 teach how to make physical measurements of a stream, and would be a good preparation for the field trip. Pages. 94-99 teach about life cycles and habitat requirements via a "rummy" card game.

INTERDISCIPLINARY INTEGRATION IDEA

During steps 4 and 5 in the Core Curriculum procedures, have an art teacher emphasize nature drawing. For each term which students define, they also make a drawing. The drawings must graphically describe the term they illustrate, and include a salmon during some stage in its life cycle. Review this section with the art teacher, and then integrate the work that you will do. Students should learn how to shade, draw elevation vs. plan views, scale, annotate drawings, and make thematic illustrations showing good/bad habitat. This work relates well to the field trip, where students often journal and/or illustrate their field logs.

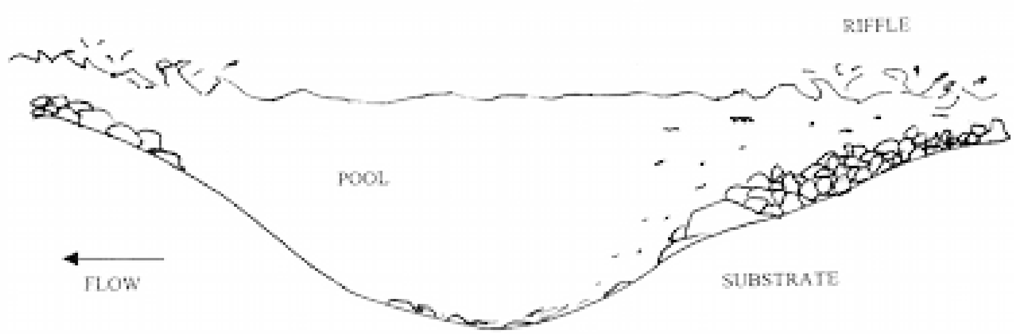
STUDENT HANDOUT 5D-1

Stream Structure and Fish Habitat

Streams are unique, constantly changing environments that support an array of aquatic life. The organisms that live in a stream are adapted to the changes and fluctuations that occur in a stream over time. Here we will discuss the structure of a stream and how aquatic animals, such as insects and fish, use the stream to their advantage.

Stream Structure

The way water moves through a stream is heavily influenced by the land that is surrounding and underneath the stream channel. The stream channel or bed consists of the area that cradles the water. If this area is narrow the water moves quickly, if it is wide the water slows down. The depth of the stream also influences water movement, and the reverse is also true: the water alters the depth of the stream. The stream bed itself is constantly changing. When the water level is high and the stream is moving quickly, rocks and soil in the stream bed are easily moved. Banks can be carved away or gravel can be scoured out. When the water slows, rocks and soil are deposited at the bottom of the stream.



The land at the bottom of the stream is called the stream substrate. Examples of substrate are bedrock, gravel, or silt. When you look at a river bottom you can see the substrate change in relationship to the movement of the water. Where the water is moving quickly there is usually more rock and where the water slows you see finer particles like sand and silt.

As the water moves through the stream channel, it changes its speed, depth, and temperature depending upon the surrounding conditions. When water enters an area that is deep and wide, it spreads out and slows down as it fills the channel. This area is called a pool. When the channel narrows and is shallow, the water moves swiftly, forming small waves or white water. This area is called a riffle.

A Chain Reaction

If we look at how the structure of the stream bed influences the movement of the water and how the water influences the stream channel, we can see that there is a chain reaction that occurs when a change takes place in a stream. When the bank of a stream gives way, the soil falls into the water. The water carries the soil particles downstream to a slow moving section of the river where the particles drift to the bottom, becoming substrate. This new substrate makes the stream bed shallower. The water begins to move a little more quickly in the shallow area. As the water moves more quickly, some of the deposited soil is stirred up and carried further downstream. The area where the bank originally eroded also widens the stream channel, slowing the water a bit as it passes.

Fish Habitat

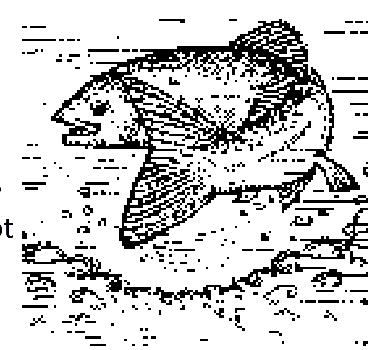
Their riffles, pools, different substrates help to characterize streams. If we think about the needs of fish like salmon and trout, we can identify what stream characteristics they need. Fish need oxygen to breathe. They don’t breathe oxygen from the air like we do; they breathe it from the oxygen in the water called dissolved oxygen. Oxygen can be added to the water when it interacts with air.

Question: Does the water mix more with the air in a riffle or a pool?

The “white water” of a riffle adds fresh oxygen to the water, so our fish need streams with riffles and adequate dissolved oxygen. Salmon and trout are also in need of cool water. The speed or velocity of the water in a stream helps keep it cool as does the depth.

Question: Would shallow or deep water warm up more quickly in the summer sun?

When the water level in a stream goes down in the late summer, the temperature goes up. Shallow water warms up more quickly than deep water. Our fish need cool water so they need streams that have deep pools to keep the water cool and that have water moving all summer long. In addition, shade from the plants along the bank of a stream keeps the temperature down. These plants in the riparian area (the area along the stream) are important not only for shade but also to help stabilize the bank and provide a food source for aquatic insects.



Salmon and trout also need places in the stream to lay their eggs. Like birds, these fish build nests or redds, to protect their eggs while they develop. The eggs need cool water and oxygen to develop.

Question: Think about the substrate of a stream. Where would you want to hide your eggs? Where will they get cool water and oxygen? Where will predators not find them and they won’t wash away?

Salmon use gravel as the substrate for their nests. They dig a depression in the small rocks, lay their eggs, and cover them up with gravel. Gravel allows water to circulate through the rocks bringing oxygen to the eggs. It also hides the eggs from predators and keeps the eggs from drifting downstream.

The best location for their redds is found at the end of a riffle where the water is beginning to slow down as it enters a pool but is oxygen rich. It is also in this area where aquatic insects hide, the future food source for young salmon.
Juvenile salmon spend time in the stream eating and growing before heading to the ocean. These small fish need to protect themselves from predators and from strong currents that might push them downstream.

Question: Where in the stream can a young fish hide? Where will food be found?

Young salmon vary in the use of the stream depending upon species. In general, young salmon stay close to the banks or near fallen logs or rocks to hide from predators. They find their food, aquatic insects, drifting in the current. As the salmon get bigger they venture into faster water to find more insects being carried downstream.

Salmonids and Physical Stream Characteristics

Physical stream characteristics useful in differentiating habitat preferences of salmonids.

	SPECIES			
Habitat preference	**Coho**	**Chinook**	**Steelhead**	**Cutthroat**
% pools	50–80	50–100	< 50	40–60
% gradient	<3	< 2	>1–5	1–20
Stream order	2–5	≥ 5	2–5	> 2
Maximum temperature	<65°F 18°C	< 68°F 20°C	< 73°F 23°C	< 65°F 18°C

Physical stream characteristics useful in evaluating stream quality preferences for salmonids.

Characteristics				
Cover	woody structure	pool depth	boulders & wood	wood, volume, boulders
Channel profile	flat	moderately flat	steep	undercut banks
Riparian	Presence of riparian vegetation important for all species. Vegetation type (fir, alder) and age of vegetation determine quality.			

Stream Scene, Oregon Dept. of Fish & Wildlife, 1992

STUDENT HANDOUT 5D-2

Name ______________________________

Fish Habitat Needs Vocabulary

DIRECTIONS:

1. Read Stream Structure and Fish Habitat (5D-1)

2. On a separate sheet of paper, write definitions for the terms below, using the following guidelines:

    - Read the sentence where the term is found.
    - Write a definition for the term. Do not use a dictionary. Instead, try to find the meaning from context.
    - Leave a blank line below the definition to revise or clarify it after reading the whole article and talking about the subject.
    - Find examples of these words in your neighborhood. Name and describe them.
    - Where appropriate make and label a sketch to illustrate the concept.

3. The terms are:
    riffle
    stable
    porous
    sediment-free
    stream channel
    substrate debris
    litter
    dissolved oxygen
    pool
    root wad
    riparian
    carrying capacity

UNIT 5E. SALMON AS AN INDICATOR OF THE HEALTH OF A WATERSHED

TIME	LEVEL
45 minutes	Advanced

BENCHMARKS	
Next Generation Science Standards	MS-LS2-4 MS-ESS3-5 MS-LS2.A MS-ESS3.C HS-LS2.C
Disciplinary Core Ideas	MS-LS2.A

OBJECTIVE:
Students will identify characteristics of the stream needed by salmon and recognize the role of salmon as indicator species

MATERIALS:
- reference materials
- STUDENT HANDOUT 5D-1: Stream Structure and Fish Habitat
- STUDENT HANDOUT 5E-1: Home Wet Home…, Stream Scene

INTRODUCTION
Did you ever have a fever when you were a child? Your forehead often told your parents how you were feeling. Aquatic organisms are like foreheads, they act as “thermometers” which tell us about the state of the health of the environment that they inhabit. What in the watershed of a salmon acts as a thermometer? In this section, students learn that they can ascertain the probable state of an environment by knowing which organisms live in it.

In this section, we relate aspects of stream structure and quality to the needs of the salmon during stages in their life cycle. Then, we alter our perspective to relate the organisms inhabiting a stream to its probable structure and quality.

KEY QUESTIONS
- How are salmon like thermometers?
- What is the relationship between a salmon and the watershed's health?

VOCABULARY (Brief definitions of vocabulary terms are found in the Glossary.):

spawning area	riffle
indicator species	substrate embedded

PROCEDURE

STUDENT HANDOUT 5D-1: Stream Structure and Fish Habitat, explores fish habitats in the Northwest. It uses your students' prior understandings about stream structure and water quality, and then relates them to stages in the life cycle of salmon. Begin with a discussion of the idea of "indicators." You might refer to indicators of the starting line for a popular race, or atmospheric indicators of weather.

Pass out STUDENT HANDOUT 5E-1: Home Wet Home..., Stream Scene. In this activity, students relate various components of a hypothetical stream's structure to its effect on salmon. When students have finished, discuss their responses to questions (answers to Home Wet Home follows).

EXTENSION ACTIVITY

If your students have kept pond water, then you can observe its inhabitants under different conditions of water quality. In this "heartbeat" activity, students take a sample of the pond water containing aquatic organisms which they can see and moderate its temperature or chemistry. Begin by having students transfer a sample of the pond water to a small container (like a vial or baby food jar). Next, have the students observe the movements of any organisms in their sample. For instance, copepods move in a series of jerks, and make very good organisms to observe in this activity.

Cool the container in ice or cold water, then count the number of jerks, or other movements which have been observed. Next, warm the container and make another count. If these temperatures have an effect on the organisms, then the rate of the motion might have changed. Other effects you can measure include the effects of adding salt or mud. Have your students keep records of their observations, and then share them with the class.

EXTENSION CURRICULUM

1. Water Canaries, Project Wild Aquatic, pp. 24-30, describes an activity in which students conduct investigations on a water body. They assess its relative environmental quality through interpretations of measurements of pH, water temperature, and the diversity of the organisms found there.

2. Water Wigglers, Stream Scene, pp. 155-168, describes an activity to do in a stream, which relates the quality of the water in the stream to the macroinvertebrates found in it. If you cannot go to a stream, read the activity and adapt it to the classroom.

BIBLIOGRAPHY

Adopt a Stream Foundation's Field Guide to the Pacific Salmon. 1992. Robert Steelquist. Sasquatch Books. Seattle, WA.

Adopt A Wetland: A Northwest Guide. 1989. Steve Yates. Adopt-A-Stream Foundation.

California's Salmon and Steelhead, Our Valuable Natural Heritage. Teacher's Guide and Student Activities: Grades K-6. California Advisory Committee on Salmon and Steelhead Trout.

The Comings and Goings of Coho, Water Water Everywhere.... Oregon State University Sea Grant College Program and Oregon Department of Education.

F.I.S.H. Habitat Education Program; Watersheds, Wildlife and People. Pacific States Marine Fisheries, 45 SE 82nd Drive, Suite 100, Gladstone, OR 97027-2522; (503) 650-5400.

The Illustrated Salar the Salmon. Henry Williamson. Webb and Bower, Devon, England. Copyright 1935, 1987. ISBN 0-86350-152-4.

Macroinvertebrates and River Continuum (video 21:18). Oregon Department of Fish and Wildlife.

Project Wild. Kate Ferschweiler. Western Regional Environmental Education Council, Inc. Boulder, CO 80308-8060.

Project Wild Aquatic, Revised. 2002. Western Regional Environmental Education Council, Inc. Boulder, CO 80308-8060.

Project Learning Tree: Environmental Education Activity Guide. 1994. American Forest Foundation. Washington, DC 20036.

Riparian Pastures. Univ. of Nevada Cooperative Extension Fact Sheet Pages 87-53.
Salmonids in the Classroom: Intermediate. Canadian Department of Fisheries and Oceans, B.C. Teachers Federation Lesson Aids. 105-2235 Burrard Street, Vancouver, B.C. Canada V6J 3H9.

Salmonids in the Classroom: Primary. Canadian Department of Fisheries and Oceans, B.C. Teachers Federation Lesson Aids. 105-2235 Burrard Street, Vancouver, B.C. Canada V6J 3H9.

Save Our Streams, Hands On Streams & Rivers. Richard D. Klein. Maryland Department of Natural Resources. Owings Hills, MD 21117.

Save Our Streams, Monitor's Guide to Aquatic Macroinvertebrates. 1992. Loren Larking Kellog. Izaak Walton League of America. Arlington, VA. 22209.

Save Our Streams, Stream Quality Assessment. Richard Klein. The Izaak Walton League of America. Arlington, VA 22209.

The Stream Scene - Watersheds, Wildlife and People. 1992. Oregon Department of Fish and Wildlife, PO Box 59, Portland, OR 97207, (503) 229-5403.

Wading into Wetlands. 1995. National Wildlife Federation. Vienna, Virginia 22184.

STUDENT HANDOUT 5E-1

Name

Home wet home . . .

Do you know . . .

Salmon and trout (salmonids) are important to anglers. Salmonids are also important to biologists because their presence helps indicate the health of the stream in which they live. Salmonids are one of the first organisms to be affected if their watery home starts to change or if their habitat is unsuitable. Biologists refer to sensitive animals like salmonids as "indicator" species.

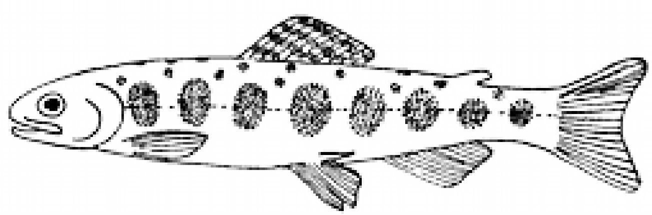
Because salmonids are so significant, fish biologists have developed many ways to improve stream habitat to enhance fish survival. In some cases, biologists can produce a fishery where none was previously found.

The ecological requirements of salmonids are:

- Cool, clear, well-oxygenated water
- Sections of gravel bottom for spawning
- Occasional pools for feeding and resting
- Adequate food (aquatic and terrestrial insects, the latter usually falling from streamside vegetation)
- Cover for protection from predators

Now it's your turn . . .

The figure on the next page shows several ways a stream can be modified to improve salmonid habitat. Each structure or management technique has been used to meet the special needs of these sensitive fish. Next to each feature, describe fully the contribution each will provide for fish.



STUDENT HANDOUT 5E-1

A. streamside vegetation

B. rock weir

C. root wad

D. cover logs

E. rip rap (rocks or vegetative)

F. rock wing deflector

G. shade plantings

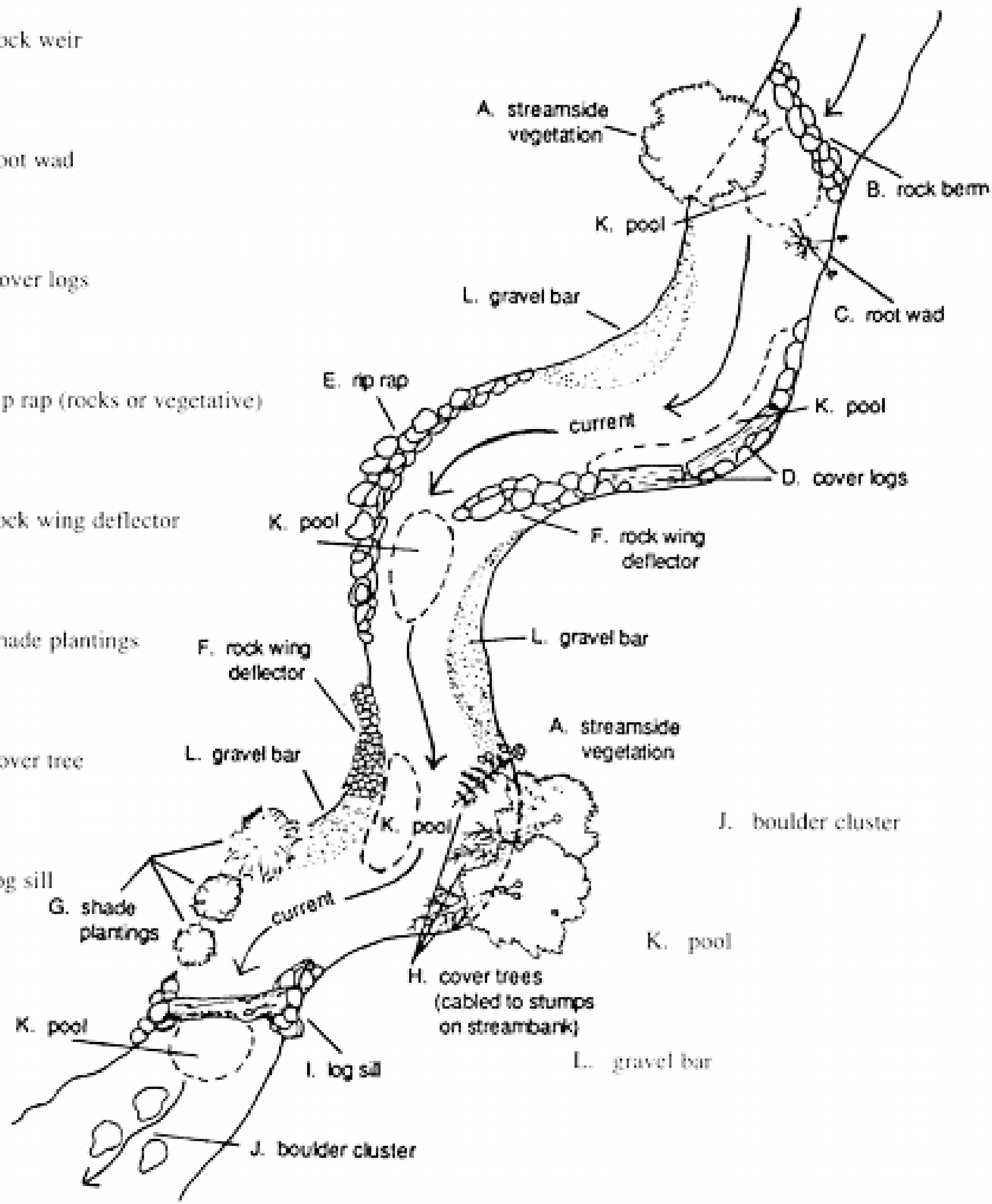
H. cover tree

I. log sill

J. boulder cluster

K. pool

L. gravel bar



Answers to STUDENT HANDOUT 5E-1: Home Wet Home…

A. streamside vegetation

Provides cover in addition to shade for temperature regulation. In autumn, leaves drop into stream and eventually provide food for invertebrates that are eaten by fish.

B. rock weir

Slows the water, traps gravel for spawning, and creates pools.

C. root wad

Provides shade, cover, and resting areas, and produces spot scouring.

D. cover logs

Provides shade, cover, and resting areas, and produces spot scouring.

E. rip rap (rocks or vegetative)

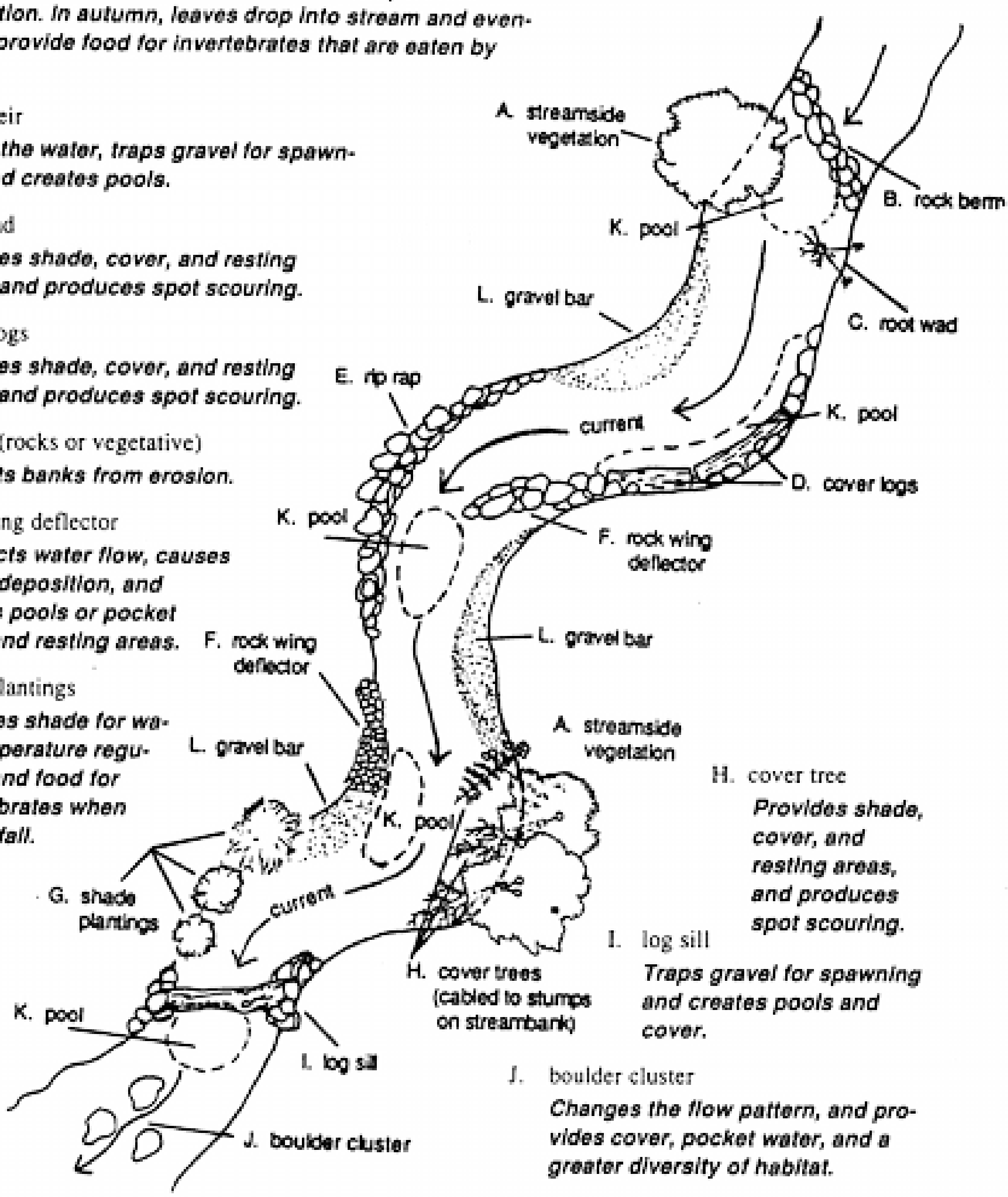
Protects banks from erosion.

F. rock wing deflector

Redirects water flow, causes gravel deposition, and creates pools or pocket water and resting areas.

G. shade plantings

Provides shade for water temperature regulation and food for invertebrates when leaves fall.



H. cover tree

Provides shade, cover, and resting areas, and produces spot scouring.

I. log sill

Traps gravel for spawning and creates pools and cover.

J. boulder cluster

Changes the flow pattern, and provides cover, pocket water, and a greater diversity of habitat.

K. pool

Provides a resting area.

L. gravel bar

Provides spawning habitat.

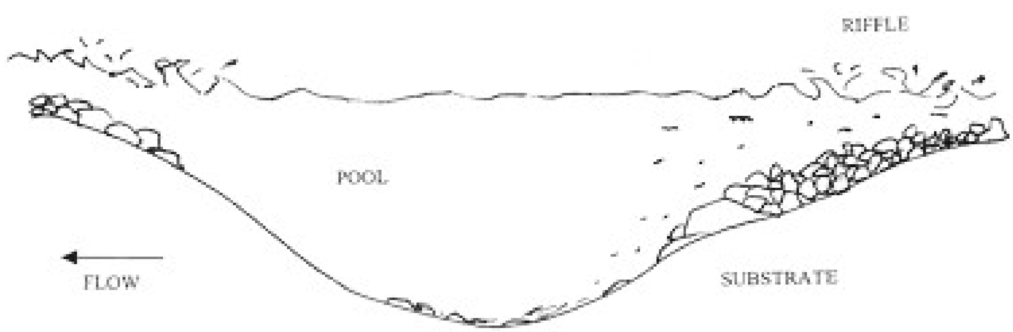
STUDENT HANDOUT 5D-1

Stream Structure and Fish Habitat

Streams are unique, constantly changing environments that support an array of aquatic life. The organisms that live in a stream are adapted to the changes and fluctuations that occur in a stream over time. Here we will discuss the structure of a stream and how aquatic animals, such as insects and fish, use the stream to their advantage.

Stream Structure

The way water moves through a stream is heavily influenced by the land that is surrounding and underneath the stream channel. The stream channel or bed consists of the area that cradles the water. If this area is narrow the water moves quickly, if it is wide the water slows down. The depth of the stream also influences water movement, and the reverse is also true: the water alters the depth of the stream. The stream bed itself is constantly changing. When the water level is high and the stream is moving quickly, rocks and soil in the stream bed are easily moved. Banks can be carved away or gravel can be scoured out. When the water slows, rocks and soil are deposited at the bottom of the stream.



The land at the bottom of the stream is called the stream substrate. Examples of substrate are bedrock, gravel, or silt. When you look at a river bottom you can see the substrate change in relationship to the movement of the water. Where the water is moving quickly there is usually more rock and where the water slows you see finer particles like sand and silt.

As the water moves through the stream channel, it changes its speed, depth, and temperature depending upon the surrounding conditions. When water enters an area that is deep and wide, it spreads out and slows down as it fills the channel. This area is called a pool. When the channel narrows and is shallow, the water moves swiftly, forming small waves or white water. This area is called a riffle.

A Chain Reaction

If we look at how the structure of the stream bed influences the movement of the water and how the water influences the stream channel, we can see that there is a chain reaction that occurs when a change takes place in a stream. When the bank of a stream gives way, the soil falls into the water. The water carries the soil particles downstream to a slow moving section of the river where the particles drift to the bottom, becoming substrate. This new substrate makes the stream bed shallower. The water begins to move a little more quickly in the shallow area. As the water moves more quickly, some of the deposited soil is stirred up and carried further downstream. The area where the bank originally eroded also widens the stream channel, slowing the water a bit as it passes.

Fish Habitat

Their riffles, pools, different substrates help to characterize streams. If we think about the needs of fish like salmon and trout, we can identify what stream characteristics they need. Fish need oxygen to breathe. They don't breathe oxygen from the air like we do; they breathe it from the oxygen in the water called dissolved oxygen. Oxygen can be added to the water when it interacts with air.

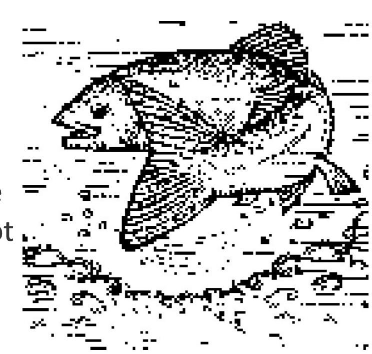
Question: Does the water mix more with the air in a riffle or a pool?

The "white water" of a riffle adds fresh oxygen to the water, so our fish need streams with riffles and adequate dissolved oxygen. Salmon and trout are also in need of cool water. The speed or velocity of the water in a stream helps keep it cool as does the depth.

Question: Would shallow or deep water warm up more quickly in the summer sun?

When the water level in a stream goes down in the late summer, the temperature goes up. Shallow water warms up more quickly than deep water. Our fish need cool water so they need streams that have deep pools to keep the water cool and that have water moving all summer long. In addition, shade from the plants along the bank of a stream keeps the temperature down. These plants in the riparian area (the area along the stream) are important not only for shade but also to help stabilize the bank and provide a food source for aquatic insects.

Salmon and trout also need places in the stream to lay their eggs. Like birds, these fish build nests or redds, to protect their eggs while they develop. The eggs need cool water and oxygen to develop.



Question: Think about the substrate of a stream. Where would you want to hide your eggs? Where will they get cool water and oxygen? Where will predators not find them and they won't wash away?

Salmon use gravel as the substrate for their nests. They dig a depression in the small rocks, lay their eggs, and cover them up with gravel. Gravel allows water to circulate through the rocks bringing oxygen to the eggs. It also hides the eggs from predators and keeps the eggs from drifting downstream.

The best location for their redds is found at the end of a riffle where the water is beginning to slow down as it enters a pool but is oxygen rich. It is also in this area where aquatic insects hide, the future food source for young salmon.
Juvenile salmon spend time in the stream eating and growing before heading to the ocean. These small fish need to protect themselves from predators and from strong currents that might push them downstream.

Question: Where in the stream can a young fish hide? Where will food be found?

Young salmon vary in the use of the stream depending upon species. In general, young salmon stay close to the banks or near fallen logs or rocks to hide from predators. They find their food, aquatic insects, drifting in the current. As the salmon get bigger they venture into faster water to find more insects being carried downstream.

Salmonids and Physical Stream Characteristics

Physical stream characteristics useful in differentiating habitat preferences of salmonids.

	SPECIES			
Habitat preference	**Coho**	**Chinook**	**Steelhead**	**Cutthroat**
% pools	50–80	50–100	< 50	40–60
% gradient	<3	< 2	>1–5	1–20
Stream order	2–5	≥ 5	2–5	> 2
Maximum temperature	<65°F 18°C	< 68°F 20°C	< 73°F 23°C	< 65°F 18°C

Physical stream characteristics useful in evaluating stream quality preferences for salmonids.

Characteristics				
Cover	woody structure	pool depth	boulders & wood	wood, volume, boulders
Channel profile	flat	moderately flat	steep	undercut banks
Riparian	Presence of riparian vegetation important for all species. Vegetation type (fir, alder) and age of vegetation determine quality.			

Stream Scene, Oregon Dept. of Fish & Wildlife, 1992